1. *The Bobath Concept: Developments and Current Theoretical Underpinning*

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Introduction

There are a number of neurological approaches used in the management of the patient following a neurological deficit. The Bobath Concept is one of the most commonly used of these approaches (Davidson & Walters 2000; Lennon 2003), and it offers therapists working in the field of neurological rehabilitation a framework for their clinical interventions (Raine 2006). This chapter will provide the reader with an overview of the Bobath Concept including the founders of the approach and its inception, the theoretical underpinning and its application into clinical practice.

The founders and development of the Bobath Concept

Karel Bobath was born in Berlin, Germany in 1906, and trained there as a medical doctor, graduating in 1936. Berta Ottilie Busse was also born in Berlin, in 1907. Her early training was as a remedial gymnast, where she developed her understanding of normal movement, exercise and relaxation (Schleichkorn 1992). They both fled Berlin in 1938 just before the Second World War. In London Mrs Bobath trained as a physiotherapist, graduating from the Chartered Society of Physiotherapy in 1950 (Schleichkorn 1992). Dr Bobath started his career working in paediatrics and later more specifically with children with cerebral palsy (Schleichkorn 1992).

Prior to the 1950s, conventional neurological rehabilitation had a strong orthopaedic bias, and promoted the use of massage, heat, passive and active movement techniques such as the use of pulleys, suspension and weights (Partridge et al. 1997). Splints and walking aids such as calipers and tripods were provided to enable the patient to function. Stroke sufferers at that time presented with the same stereotypical spastic patterning, with flexion of the upper limb and extension of the lower limb (Bobath 1970). The hemiparetic upper limb, a non-functional appendage, and the lower limb acting as a prop during ambulation.

In 1943 Mrs Bobath was asked to treat a famous portrait painter, who had suffered a stroke and was unhappy with conventional treatment (Schleichkorn 1992). Mrs Bobath focused her treatment on the affected side, basing her interventions on her knowledge of human movement and relaxation. She observed that with specific handling, tone was changeable and that there was potential for the recovery of movement and functional use of the affected side. Mrs Bobath continued to explore and further develop these early observations and techniques into principles of treatment. Mrs Bobath developed an assessment procedure that was unique and of great significance to the advancement of the physiotherapy profession, as it moved away from the medical prescription. Working in partnership with Mrs Bobath, Dr Bobath studied and applied the available neurophysiology at that time, to provide a rational explanation for the clinical success.

Together they created the Bobath Concept, a revolutionary approach which has continued to develop and help change the direction of neurorehabilitation. They described the Concept as hypothetical in nature, based on clinical observations, confirmed and strengthened by the available research (Schleichkorn 1992).

The neurophysiology available to Dr Bobath during the early years was based on animal experimentation (Bobath 1970). The evidence supported a hierarchical model with the emphasis on descending control from the cortex to the primitively organised spinal cord. The complexity of the nervous system was defined in terms of size and number of connections and was seen as being a number of hard-wired tracts with electrical activity running through them. Movement was thought to be elicited through the stimulation of reflexes in the spinal cord, with the primitive reflex patterning seen at birth refined during maturation, through inhibition from higher centres. Lesions to the pyramidal tract were found to produce a loss of inhibitory control and therefore contralateral spastic hemiplegia. Inhibition was therefore seen by Mrs Bobath as important in adapting motor behaviour, and her early clinical interventions demonstrated that it was possible to influence tone through afferent input (Bobath 1970, 1978). This led to the development of ‘reflex inhibiting postures’ and later the less static ‘reflex inhibiting patterns’, which used rotational movement components to fractionate the stereotypical patterns (Bobath 1990). Although the nervous system was thought to be irreparable, Mrs Bobath found changes in clinical presentation that demonstrated modification of the nervous system.

Mrs Bobath described, in 1990, that the main problem seen in patients was abnormal coordination of movement patterns combined with abnormal tonus, and that strength and activity of individual muscles were of secondary importance (Bobath 1990). Assessment and treatment of motor patterns was seen as key to functional use. Reflex inhibiting postures were discarded for greater emphasis on movement and function, with the patient taking an active role in their treatment. The best inhibition was seen as the patient’s own activity (Mayston 1992). The emphasis in treatment was on normalising tone and facilitating automatic and volitional movement through specific handling. Mrs Bobath felt it was important that treatment was not a structured set of exercises to be prescribed to all patients, but a wide variety of techniques that could be adapted and flexible to meet the individual's changing needs (Schleichkorn 1992). Mrs Bobath advocated a 24-hour, holistic approach which involved the whole patient, their sensory, perceptual and adaptive behaviour as well as their motor problems (Bobath 1990). Although preparation was seen to be important, Mrs Bobath stressed that it had to directly translate into function.

The Bobath Concept was not exclusive but could be applied to all patients with a disorder of motor control, regardless of how severe their cognitive or physical deficits might be.

The Bobath Concept continued to develop throughout Dr and Mrs Bobath's lifetime. In 1984 the Bobaths founded the International Bobath Instructors Training Association (IBITA 2007), an organisation that maintains the standards of teaching and developments of the Bobath Concept worldwide. Mrs Bobath stated that each therapist works differently according to their experiences and personality, but all can build treatment upon the same Concept (Schleichkorn 1992). Dr Bobath stated 'the Bobath Concept is unfinished, we hope it will continue to grow and develop in years to come' (Scheichkorn 1992; Raine 2006).

In conjunction with the growth of knowledge in areas of neuroscience and the evaluation of clinical practice, there have been ongoing developments in both the theoretical underpinning of the Bobath Concept and its clinical application (Raine 2007; Gjelsvik 2008).

Current theory underpinning the Bobath Concept

Advances in clinical techniques and technical resources over the last decade have provided therapists with increased evidence in the fields of neuroscience, biomechanics and motor learning (Royal College of Physicians 2004). These developments deepen the understanding of human movement and the impact of pathology, helping to guide therapists in their clinical interventions to maximise the patient's functional outcome. There is strong evidence to support the effect of rehabilitation in terms of improved functional independence and reduced mortality (Royal College of Physicians 2004); however, there has been insufficient evidence to identify if any one therapy approach is better than another. Research that has been designed to evaluate effectiveness of individual neurorehabilitation approaches has been fraught with methodological difficulties (Paci 2003; Luke et al. 2004).

The contemporary Bobath Concept is a problem-solving approach to the assessment and treatment of individuals with disturbances of function, movement and postural control due to a lesion of the central nervous system (CNS), and can be applied to individuals of all ages and all degrees of physical and functional disability (Raine 2006; IBITA 2007). The theory underpinning the Bobath Concept considers an approach to motor control that encompasses not only important key features about the individual but also how they interact in the world around them. The ability of the individual to plastically adapt and learn from new challenges enabling them to refine their motor behaviour is the basis by which patients have the potential to recover following injury. Motor learning theories provide the principles that guide and enhance the physiological modifications which support refinements in movement to change functional performance over time. In order to optimise motor learning and recovery in patients with neurological dysfunction, it is essential to have an understanding of how a lesion of the upper motor neuron (UMN) will impact on the individual and their motor control.

Systems approach to motor control

The systems approach to motor control provides the foundation of the current theoretical underpinning of the Bobath Concept (Raine 2006). The systems theory is based on the work of Bernstein (1967). Bernstein recognised that it was important to have an understanding of the characteristics of the movement system, and the external and internal forces acting on the body, in order to develop an understanding of the neural control of movement. From a biomechanical viewpoint, he considered the many degrees of freedom provided by the numerous joints within the body and the control needed to enable them to work together as a functional unit.

Bernstein considered the control of integrated movement to be distributed throughout many interacting systems working cooperatively. He stated that 'coordination of movement is the process of mastering the redundant degrees of freedom of the moving organism', recognising the importance of stability and control in movement. He described how muscles could work in synergies to help solve this movement problem, such as in postural control and locomotion.

Shumway-Cook and Woollacott (2007) expand Bernstein's theory to describe the systems approach, emphasising like Mrs Bobath, that human motor behaviour is based upon a continuous interaction between the individual, the task and the environment. They describe movement as resulting from a dynamic interplay between perception, cognition and action systems, and highlight the CNS's ability to receive, integrate and respond to the environment to achieve a motor goal (Brooks 1986). Many systems and subsystems work cooperatively for the integration of movement into function. They work both hierarchically by means of ascending pathways and through parallel distributed processing where many brain structures are processing the same information simultaneously (Kandel et al. 2000). The nervous system uses a shifting focus of control depending on many biomechanical, neuroanatomical and environmental influences.

It is the systems approach theory to motor control which forms the foundation for the underlying principles of assessment and treatment encompassed within the contemporary Bobath Concept (Raine 2007). The Concept considers that motor control is based on a nervous system working with both hierarchical and parallel distributive, multi-level processing amongst many systems and subsystems involving multiple inputs, and with modulation on a number of levels within this processing. It sees the potential for plasticity as the basis of development, learning and recovery within the nervous and muscular systems.

Plasticity

Neuroplasticity

The plasticity of a structure is its ability to show modification or change. Motor learning is the permanent change in an individual's motor performance brought about as a result of practice (Wishart et al. 2000; Lehto et al. 2001). The structures undergoing modification which need to be considered during motor learning are neural plasticity and muscular plasticity. The capacity of the nervous system to change is demonstrated in children during the development of neural circuits, and in the adult brain, during the learning of new skills, establishment of new memories, and by responding to injury throughout life (Purves et al. 2004).

Modification in neural function in maturity appears to rely primarily on carefully regulated changes in the strength of existing synapses (Kandel et al. 2000). Learning an activity is synapse and circuit specific, and can be modified with synaptic transmission being either facilitated (strengthened) or depressed (weakened). These short-term changes in the efficacy of synapse transmission are due to modification of existing synaptic proteins which may last up to a minute (Purves et al. 2001; Calford 2002). For motor learning to occur these short-term changes need to be reinforced to promote more significant cellular and molecular modifications (Calford 2002).

Changes lasting days, weeks, months and even years, demonstrating carry-over in a motor performance and learning, require the synthesis of new proteins and changes in gene expression, which directs change in synaptic circuitry and localised formation of new axon terminals and dendritic processes. These structural modifications can strengthen the synapse by long-term potentiation or can weaken the synapse by long-term depression (Calford 2002). It is the strengthening of some synapses, and circuits, over others which enables refinement of a motor skill or performance to allow carry-over from one day to the next.

The nervous system and neuromuscular system can adapt and change their structural organisation in response to both intrinsic and extrinsic information. The manipulation of this information can directly effect a change in the structural organisation of the nervous system through spatial and temporal summation and the facilitation of pre- and post-synaptic inhibition. If two or more stimuli are presented and then reinforced together, associative learning can occur. This enables relationships in stimuli to be predicted and can link two aspects of motor behaviour occurring at the same time, such as hip and knee extension through stance phase in gait. Neuronal cortical connections are strengthened and remodelled by our experiences; this means that 'neurons that fire together, wire together' and promote motor learning (Hebb 1949; Johansson 2003). There is a direct relationship between the neural molecular form and functional performance (Kidd et al. 1992). The nervous system is continually undergoing modification based upon its experiences, and it is these modifications which then support its role in achieving efficient and effective functional goals in a variety of environments.

Neuroplastic changes following injury

Any acquired brain injury will result in subsequent neuronal cell death, interruption of their axonal projections and potential cascade of degeneration to communicating neurons (diaschesis) (Cohen 1999; Enager 2004). The impact the lesion has on motor control and function will depend upon the location and the size of the lesion. The model of neuroplasticity provides evidence that the brain will respond to injury by reorganisation and adaptation aimed at restoring function (Stephenson 1993; Nudo 2007). There are three neuroplastic phenomena that occur in the nervous system following a lesion which facilitate structural and functional reorganisation (Bishop 1982; Kidd et al. 1992). These include denervation supersensitivity, collateral sprouting and unmasking of silent (latent) synapses.

Denervation supersensitivity occurs when there is a loss of input from other brain regions. An increased release of transmitter substance causes a heightened response to stimulation (Wainberg 1988; Schwartzkroin 2001). Post-synaptic target neurons become hypersensitive to the transmitter substance, increasing the number of receptor sites. Collateral sprouting appears in cells around the lesion, where collateral dendrites make connections with those synapses lost by cell necrosis (Darian-Smith & Gilbert 1994). Unmasking of silent synapses occurs when previous non-functioning neurons are accessed to form new connections (Nudo 1998; Johansson 2000). There has been increasing work demonstrating regeneration within the nervous system (Nudo 1998; Johansson 2000). Changes within the structure of the nervous system can be organised or disorganised producing adaptive or maladaptive sensorimotor behaviour, which can promote or be detrimental to recovery (Nudo & Friel 1999; Nudo 2007).

Cortical plasticity

Cortical representation areas have been found to be modified by sensory input, experience and learning, as well as in response to brain injury (Bruehlmeier et al. 1998; Nudo 2007).

Cortical changes following injury include the loss of specific sensorimotor functional representation with direct physical and functional consequences. Although not totally reversible, there have been numerous findings demonstrating cortical plasticity and remapping following a cortical lesion. Where representation of an area has not totally been lost, the representation of the peri-infarct tissue and areas in axonal communication with the lesioned area, through axonal sprouting, have been found to take on representation and therefore function of the lesioned area (Rapisarda et al. 1996; Cramer et al. 1997). Reorganisation has been seen in areas of the visual cortex which becomes associated with tactile tasks in blind subjects who read Braille (Sadato et al. 2004).

Changes seen following peripheral lesions are based on the cortical response to changing input which can either be upgraded or downgraded, such as remapping in subjects following amputation or selective anaesthesia, where there is a reduced representation of the affected area and an increase of representation of adjacent areas within the cortex (Merzenich & Jenkins 1993; Yang et al. 1994). The Bobath Concept explores this potential for cortical reorganisation through selective afferent input to optimise internal representation and influence movement control. Selective motor training or manipulation of the task, environment, or aspects of the individual as part of movement re-education also aims to promote plastic changes. This has been seen in the cortical representation of the left hand, in a left handed string instrument player which when scanned shows greater cortical representation compared with the left hand of a non-string player (Elbert et al. 1995). Enriched environments giving subjects greater than normal stimulation have been shown, at the right time, to promote significant neuroplastic changes and improvement in functional outcomes (Ohlsson & Johansson 1995; Johansson 1996).

Emergent properties of each cortical area are constantly shaped by behavioural demands, driven largely by repetition and temporal coincidence (Nudo 2007). Bernstein (1967) describes the importance of not just repetition, but 'varied' repetition. Such repetition drives motor cortical areas to form discrete modules in which the conjoint activity is represented as a unit, rather than fractionated and individual muscle contractions (Nudo 1998). Skilled motor activities requiring precise temporal coordination of muscles and joints must be practised many times over and applied into everyday meaningful activities for optimal carry-over. Bayona et al. (2005) describe the consequence of the motor system as 'use it or lose it'. In the somatosensory system of the brain it is 'stimulate it or lose it'. Both are essential considerations in the Bobath Concept.

Muscle plasticity

Like neuroplasticity, the adaptability of muscle has been investigated extensively. Skeletal muscle is one of the most plastic tissues in the human body (Kidd et al. 1992; Lieber 2002). Virtually every structural aspect of muscle, such as its architecture, gene expression, fibre type distribution, number and distribution of alpha motor units and motor end plates, number of sarcomeres, myosin heavy chain profile, fibre length, mitochondrial distribution, tendon length, capillary density and muscle mass, has the potential for change with the appropriate stimulus (Dietz 1992; Pette 1998; Mercier et al. 1999; Lieber 2002). Skeletal muscle can be either conditioned or deconditioned depending upon the demands put on the muscle, and these can influence properties such as strength, speed and endurance of the muscle. The range of muscle fibre types allows for the diverse role and function of muscle needed to support human movement (Scott et al. 2001). It is the adaptability of the proteins and the design of sarcomeres and myofibrils which provides the basis for the modelling and remodelling of a large spectrum of fibre types to match the specific requirements and altered functional demands (Pette 1998). Muscle fibre phenotype is driven by neural activity and mechanical factors, a combination of stretch and activity (Goldspink 1999).

Studies have shown that with an increased demand there is a shift from fast to slow fibre types, an increase in size and number of mitochondria and an increase of the capillary density with an overall hypertrophy of the muscle (Mercier et al. 1999; Lieber 2002). With reduced demands or disuse there is muscle wasting due to decreased protein synthesis. This atrophy is more rapid in slow oxidative, postural and biaxial muscles with a slow to fast shift in fibre type and a reduction in the capillary density (Mercier et al. 1999; Lieber 2002). Inactivity in a shortened position results in an increase in connective tissue, an increase in stiffness and resistance to passive stretch (Williams & Goldspink 1973). Muscles immobilised in a shortened position have been found to lose sarcomeres, with the remaining sarcomeres increasing in length to maximise tension in this shortened position (Grossman et al. 1982).

Neurological lesions and the resultant neuroplastic changes have a significant impact on the demands placed upon muscle. Early stages show an inability to achieve the execution of a voluntary command and leave the muscle in a position of inactivity and immobility (Gracies 2001). Muscles may receive an increase or loss of drive to the alpha motor neuron and its motor end plate, which will lead to a complex combination of conditioning and deconditioning. Where hypertonic muscles are immobilised in a shortened position the potential for a contracture develops with muscle atrophy, loss of sarcomeres, failure of actin and myosin cross-bridges to disengage, and accumulation of connective tissue (Watkins 1999; Gracies 2001). It has been found that even in the case of increased drive, however, muscles have been found to weaken due to insufficient motor unit synchronisation and decreased torque generated by the muscle (Gracies, 2001). Muscle imbalance in compliance, length and strength will all influence coordination for selective movement control. The main length associated changes interfering with function have been identified as a decrease in muscle length and an increase in muscle stiffness, and it is these secondary musculoskeletal complications that are associated with poor functional outcome (Ada et al. 2000).

Andrews and Bohannon (2000) identified that it is not only the hemiparetic side that presents with muscle changes but that the non-hemiparetic side also presents with muscle weakness compared to normal subjects. This highlights the significance of learned non-use in both hemiparetic and non-hemiparetic sides and highlights further the need for an individualised, holistic approach to the treatment of patients with neurological dysfunction (Hachisuka et al. 1997).

Kandel et al. (2000) describe plasticity as the potential that endows each of us with our individuality. It is the ability of the CNS to be manipulated and restructured, which is the key to successful therapy (Stephenson 1993; Schaechter 2004), and it is this neuroplasticity that is the primary rationale for treatment intervention in the Bobath Concept (Raine 2007).

Motor learning

Motor learning refers to the permanent change in an individual's motor performance brought about as a result of practice or intervention (Wishart et al. 2000; Lehto et al. 2001). Motor learning principles help identify how we can best manipulate the individual, the task and the environment to influence long-term neuroplastic changes to promote an individual's motor performance.

There are a number of stages that are necessary in learning a new skill. The stages describe a progression through cognitive to automatic levels whereby the performance is refined and shows carry-over of learning (Wishart et al. 2000; Halsband & Lange 2006). This process demonstrates the developments in cortical representation for the learning of the new skill. Motor learning theories suggest that active participation, practice and meaningful goals are all essential for learning (Schmidt 1991; Winstein et al. 1997). Taub (1993) and Winstein et al. (1997)

agree that practice is fundamental for motor learning and improving skill in both healthy and movement-impaired individuals.

There are numerous variables that are considered to be important determinants in motor learning which have been investigated using healthy individuals learning novel motor skills (Winstein 1991; Marley et al. 2001; Ezekiel et al. 2001; Lehto et al. 2001). These include:

- practice (amount, variability, contextual interference [order of repetitions such as blocked or random]);
- part or whole task;
- augmented feedback (frequency, timing, bandwidth [level of performance to be reached before feedback provided]);
- mental practice;
- modelling;
- guidance;
- attentional focus (goal attainment) and contextual variety.

One of the key features that needs consideration in all aspects of practice is to ensure a situation is created that allows the individual to engage in a problem-solving process to enable them to achieve the task (Marley et al. 2001). It has been found that the more practise the better (Sterr & Freivogel 2003).

Varied conditions and random practice are more effective for motor learning (carry-over in performance), whereas static conditions and blocked practice are more effective for improvements in the immediate motor performance (Wishart et al. 2000; Marley et al. 2001). Part and whole task practice benefits are dependent upon the task to be learned. Whole task practice is suggested when tasks are continuous (reach and grasp) or reciprocal (walking) in nature (Dean & Shepherd 1997). Part tasks are useful when an activity can be broken down into a number of separate discrete tasks. Augmented feedback shares information about the characteristics (knowledge of the performance) or the outcome (knowledge of the results) of the movement. Although performance may be improved with continuous feedback, motor learning has been shown to be better with infrequent feedback and/or summary of results (Saladin et al. 1994). Feedback provided once a set level of failure has been passed (bandwidth) has also been found to be beneficial for learning (Ezekiel et al. 2001). Feedback is also important in motivating the individual which is seen as essential in the rehabilitation process.

Mental practice, defined as the rehearsal of a task without overt physical activity, has shown a positive learning effect, especially when used in conjunction with physical practice. It can be useful when there are limitations in the amount of time or energy for engagement in activity, or when physical practice outside the therapy session would be hazardous or detrimental to the rehabilitation process (Lehto et al. 2001).

Physical demonstration of the task (modelling) and activities designed around meaningful goal-directed tasks have been found to be beneficial (Wulf et al. 1999). Without context of a task, movement patterns may exist but they will be devoid of strategies (Majsak 1996). The task is essential in providing context and meaning.

It is the task and the movement strategy that will determine and organise the movement patterns the individual selects. It has been found that excessive guidance or physical devices offering continuous restraint, directing movement reduces the need for problem-solving and does not improve learning (Ezekiel et al. 2001). Guidance must be selective, graded and must challenge the individual to problem-solve their movement difficulties.

Motor learning principles need to be taken into consideration with all patients. They need to be chosen and facilitated appropriately to enable the individual to be actively involved in finding solutions for their motor problems. Motor learning is often demonstrated not just by increased precision in the acquisition of the motor performance but the variability with which the individual is able to achieve the activity (Majsak 1996). The importance of giving the individual movement choices or diversity in movement strategies will also enable them to transfer their skills to numerous tasks and environments. Opportunities need to be made where the individual is problem-solving and error correcting their own movement in preparation for the transfer of skills and application of skills for achievement of meaningful motor activities.

Following stroke, the individual will present with a number of musculoskeletal (biomechanical), neuromuscular, sensory-perceptual and cognitive constraints which may limit or challenge the potential for the achievement of motor learning in certain motor skills. Preparing the individual's musculoskeletal and sensory systems may be necessary for the optimal integration of cognitive processing to enable efficient and effective goal attainment. There needs to be a balance between the amount of time in preparation and the amount of time used in selective part or whole task practice. Interactions between the constraints of the individual, the environment and the task are complex and continuous (Majsak 1996).

Upper motor neuron syndrome

Following a brain injury an individual will often have a complex presentation impacting not only on the neuromuscular system but also on the musculoskeletal, sensory-perceptual and cognitive systems (Cohen 1999). The upper motor neurone (UMN) syndrome encompasses all the dyscontrol characteristics associated with a lesion affecting some or all of the descending motor pathways (Barnes 2001). The features of an UMN syndrome have been divided into two broad groups. The negative phenomena of the syndrome are characterised by a reduction in motor activity (weakness, loss of dexterity, fatigueability), whereas the positive phenomena are associated with symptoms that demonstrate an increase in motor activity (spasticity, clonus, associated reactions) (Barnes 2001; Sheean 2001). The negative features are often more disabling than the positive features. Adaptive or mechanical features must also be acknowledged, and take into consideration the resultant changes on the neural system, muscle and soft tissue (Carr & Shepherd 1998).

Hypertonicity is a combination of disinhibition (neural changes), plastic reorganisation and mechanical changes (Raine 2007). Spasticity is the neural component of hypertonia and is velocity dependent, which means that the faster the muscle is stretched the greater the resistance that is felt (Lance 1980). The resistance associated with spasticity not only makes movements more difficult, but causes the muscle to remain in a shortened position leading to further hypertonicity and adaptive shortening (Grossman et al. 1982; O'Dwyer et al. 1996). The significance of hypertonia varies considerably from individual to individual and so does its impact. Spasticity is difficult to quantify and is not universally understood to be the same by everyone (Raine 2007). The most current definition, however, relates well to the clinical setting; spasticity is 'disordered sensory-motor control, resulting from an UMN lesion, presenting as intermittent or sustained involuntary activation of muscles' (Pandyan et al. 2005). Associated reactions are another positive feature which can lead to adaptive muscle shortening. Walshe (1923) described associated reactions as postural reactions in muscle deprived of voluntary control that is tonic in nature. They are abnormal, involuntary, stereotyped movement patterns of the affected side and are triggered in many ways (Lennon 1996). They are phasic contractions lacking a background of postural control (Dvir et al. 1996) and interfere with the recovery of function and the ability to perform efficient and effective movement.

There needs to be consideration of the combination of all the features of the UMN syndrome and the resultant impact that these have on the patient. Altered muscle tone, weakness and incoordination, along with adaptive changes in muscle, soft tissue and their alignment, will all impact on the ability to recover efficient movement and will limit function in a patient following stroke. It is often the inability to generate sufficient tone (negative feature) against gravity however, which creates the greatest difficulty for the patient following an UMN lesion. It has been identified that abnormal coordination of movement patterns, poor balance, sensory deficits and abnormal tone are the main physical problems of people with hemiplegia (Raine 2007). It is important to consider weakness not only as a muscular problem following stroke, but as reduced specificity of neuromuscular innervation, with weakness seen both in the trophic and synaptic components of neural activity (Kandel et al. 2000). Although strength of individual muscle groups is less important than their coordination in patterns of activity, strength may still be an issue for efficient movement in some patients, as muscles need sufficient activity to generate force for action and function (Mayston 2001). It is recognised that if the CNS is damaged, it has to compensate. It is the therapist's job to guide the individual's recovery so that they can achieve their maximal functional potential within the constraints of the damaged CNS (Raine 2007). Figure 1.1 shows the integration of the key theoretical areas underpinning the Bobath Concept.

Clinical application of the theory underpinning the Bobath Concept

Motor control

The Bobath Concept involves the whole patient, their sensory, perceptual and adaptive behaviours as well as their motor problems, with treatment tailored to the patient's individual needs (Lennon 1996; Raine 2007). In the Bobath Concept the potential of both patient and therapist is explored as an interactive process. It is

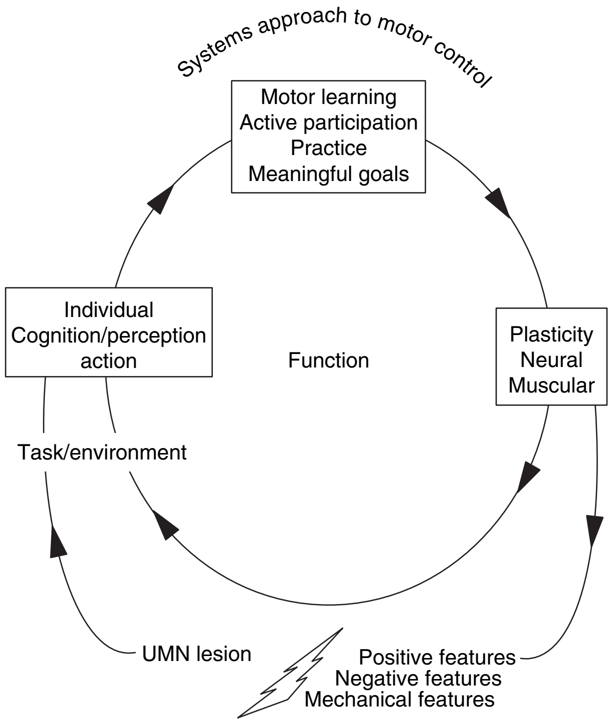

Fig. 1.1 Integration of the key theoretical areas underpinning the Bobath Concept.

essential for therapists to be skilled in movement analysis and have an understanding of the components of human movement. It is the application of knowledge of motor control and human movement, neurophysiology and motor learning which promotes specificity and individuality in assessment and treatment of an individual to optimise function. Each patient is assessed in terms of their lesion, individual movement expression and potential to maximise their movement efficiency. Treatment cannot be predicted, stereotyped or repetitive, as it must continuously adapt to the individual's changing responses (Partridge et al. 1997).

The Bobath Concept is goal orientated and task specific, and seeks to alter and construct both the internal (proprioceptive) and external (exteroceptive) environment in which the nervous system and therefore the individual can function efficiently and effectively (Raine 2007). Treatment is an interaction between therapist and patient where facilitation leads to improved function. The role of the therapist is to both teach movements and make movement possible by utilising the environment and the task appropriately. Treatment is aimed at improving the efficiency of the movement compensation following an UMN lesion. Rehabilitation is a process of learning to regain motor control and should not be the promotion of compensation that can occur naturally as a result of a lesion (Raine 2007). Therapy aims to promote efficiency of movement to the individual's maximum potential rather than normal movement (Raine 2007).

Therapy is an interactive process between individual, task and the environment (Shumway-Cook & Woollacott 2007). The individual is evaluated in terms of total function within changing environments, and the intervention process is individualised to their bio-psycho-social needs (Panturin 2001). Therapy addresses the neuro-muscular system, spinal cord and higher centres to change motor performance, taking into account neuroplasticity, an interactive nervous system, and individual expression of movement (Raine 2007). The Bobath Concept directs treatment to overcome weakness of neural drive after an UMN lesion through selective activation of cutaneous and muscle receptors. Early therapy will reduce secondary loss of cortical tissue and thus enable greater possibilities for recovery (Nudo et al. 1998).

Therapists need to be aware of the principles of motor learning: active participation, opportunities for practice and meaningful goals (Raine 2007). The emphasis in treatment is on active participation of the patient on either an automatic or a volitional basis, or a combination of both. Movements must be 'owned' by the patient and be experienced both with and ultimately without the handling of the therapist (Raine 2007). For learning or relearning to occur there needs to be the opportunity to practise (Mayston 2001). As soon as patients are able to practise aspects of movement with appropriate activity, this is encouraged as part of their rehabilitation programme. The decision to use part or whole task practice is selective and dependent upon both the task and the individual. If efficiency in the motor skill is inadequate, the therapist may look at movement components to improve skill. Repetition is important in the consolidation of motor control, but it does not mean moving in exactly the same way every time; 'repetition without repetition' (Bernstein 1967; Lennon & Ashburn 2000). As part of the rehabilitation process the therapist must consider the 24-hour management of the patient and their way of life (Raine 2007). Patients should be provided with advice and guidance on movement and function, for the periods between therapy sessions, in order to achieve carry-over. Preventative and promotive aspects of therapy need to be addressed on a continual basis, and should take into consideration issues of physical and cardiovascular fitness.

Therapy addresses abnormal, inefficient stereotypical movement patterns that interfere with function (IBITA 2007). Treatment is aimed at preventing the establishment of spasticity and maximising residual function (Cornall 1991). Therapists do not normalise tone but they can influence hypertonia at a non-neural level by influencing muscle length and range (Lennon 2003). Therapists can achieve tone reduction in a number of ways such as mobilisation of muscles and stiff joints, muscle stretch, practice of more normal movement patterns, and through more efficient, less effortful performance of functional tasks (Mayston 2002). Weight bearing can help influence abnormal tone only if the patient is able to adapt and change muscular alignment actively (Raine 2007). Therapists work on tone to improve movement, not to normalise tone for its own sake (Lennon et al. 2001).

Weakness is always underlying the presentation of associated reactions. Patients may use associated reactions as a pathological form of postural fixation when stability cannot be accessed (Lynch-Ellerington 2000). Bobath therapists seek to find the causal effect of associated reactions rather than merely changing the pattern produced by the associated reaction. Associated reactions are changeable and can be used as an indicator of the patient's efficiency of motor control, effort or complexity of movement or anxiety, and can guide the therapist in their clinical decision-making. The aim is to control rather than inhibit associated reactions (Lynch-Ellerington 2000).

A primary concern of the Bobath Concept is the activation of the patient to overcome postural hypotonia. In therapy there is a need to address the problem of an individual's specific ability to create tone against gravity for the necessary postural stability on which selective movement is based (Lynch-Ellerington 1998). If the cause of a movement compensation is the lack of posture and balance, then it is only giving the patient more appropriate control over their posture and balance that will ultimately reduce the presentation of the compensation. There may be many reasons other than just motor problems which can influence posture and balance, such as sensory and perceptual problems. Selective movements of the trunk and limbs, both concentric and eccentric, are interdependent and interactive with a postural control mechanism. Therefore, the recovery of selective movement is a prerequisite for efficient postural control, alignment and function (Raine 2007). Balance in an individual is achieved through improving their orientation and stability in relation to postural control (Mayston 2002). There may be an element of conscious control over muscle tone; however, the aim is for the patient to develop control of their balance and movement on an automatic basis in order to initiate and control functional movements. It is recognised that some movements may have to be cognitive, such as some manipulative activities of the hand or during learning of goal-directed movements. However, an individual who has to think about their balance will be unable to carry out any other activity simultaneously (Leonard 1998). A key aim of treatment intervention is to optimise postural and movement strategies in order to improve efficiency and maximise the patient's ability to interact automatically within their environment.

Sensory systems

Sensory systems provide essential information about both the internal and external environments upon which skilled movement is based and refined. Ultimately, in therapy, the aim is to re-educate the patient's own internal referencing system to provide accurate afferent input, giving the patient the best opportunity to be efficient, specific and have movement choices (Raine 2007). At some stages of skill acquisition, somatosensory referencing may be emphasised over verbal or visual feedback. This change of sensory priority is essential to reduce compensation strategies, such as visual fixation, and challenges the patient to use more appropriate sensory strategies for the task (postural control, balance, stereognosis). Specific stimulation may be necessary to promote localisation of movement, for example fingers, but sensory stimulation on its own is not the whole picture. It has to be combined with active movement (Raine 2007). Voluntary movement is one of the most powerful forms of sensory stimulation on which more refined movement can be built (Leonard 1998).

Musculoskeletal system

Muscles need sufficient activity to generate force for action (Mayston 2001). As part of treatment it is important to create the appropriate length and compliance of both muscle and soft tissues to have sufficient joint range to achieve the required functional movement components. It is also essential to achieve appropriate length for efficient muscle activation (Mayston 2001). Optimising muscle length must incorporate the complex relationship of stability and mobility components for the task (Mayston 2001). To achieve the appropriate muscle balance for function, treatment may require selective and specific strength training (Raine 2007). Body weight and gravity can be used to strengthen muscles as well as appropriate resisted exercises (Raine 2007).

Therapists' handling techniques aim to provide the patient with control over aspects of their stability and alignment, and guide them to achieve more efficient movement patterns (Raine 2007). Within therapy there is an emphasis on the patient learning to generate movements as efficiently as possible. However, movements must be owned by the patient and be experienced both with and ultimately without the handling of the therapist (Raine 2007).

Adjuncts to therapy

The Bobath Concept can be complemented with other modalities and adjuncts such as structured practice, use of orthotics and muscle strengthening (Mayston 2007). Splinting and orthoses may be indicated to gain alignment or a good weight-bearing base for improved proximal and truncal activity (Mayston 2001). Restraint of the less affected body parts manually during a therapy session may be used to assist activation of the affected parts (Raine 2007). The therapist utilises selective constraint through posturing a limb or through an environmental support. Constraint-induced movement therapy and motor mental imagery may be used as part of a patient's home programme. Mental imagery would be considered where there is insufficient active movement, where the effort of movement leads to an associated reaction or only generates inefficient detrimental movement strategies or where fatigue prevents sufficient physical practice. To improve postural control or aid reciprocal activity of the lower limbs as part of the walking pattern, the therapist may choose to use a treadmill with or without body-weight support and this could include facilitation to enable the most efficient pattern. The therapist through a variety of techniques of handling and activating the patient can make movement necessary and possible, and incorporate these more efficient ways of moving into everyday life (Mayston 2001). Using other techniques in parallel, such as Maitland mobilisations, is compatible with the Bobath Concept (Lennon & Ashburn 2000). The decision to use such adjuncts is made on the basis of the therapists' detailed observation, analysis and interpretation of the individual's functional task performance and a shared process of setting goals with the client (Mayston 2002).

Function

Therapy is based on the assessment of the patient's potential. A role of the therapist is to facilitate balance and selective movement as a basis for functional activity and successful goal acquisition. Successful goal acquisition in a given task must then be practised to improve efficiency and promote generalisation (Raine 2007). The therapist must address both the specific movement components of the task and the functional activity in order to achieve goals (IBITA 2007). In therapy, movement is facilitated and the therapist's handling is modified as the individual achieves independence, with the aim of giving the patient movement choices, which can be incorporated into functional activity. It is important that patients should not be stopped from moving in a certain way unless they have been provided with an alternative strategy, which achieves the same goal (Mayston 2002). For example, the therapist should not stop a patient from walking; however, where walking may be detrimental to their recovery the patient may be advised to walk only with the appropriate facilitation or walking aid (Raine 2007). Preparation is of no value in itself, but must be incorporated into functional activity, which is meaningful to the patient in order to promote carry-over (Raine 2007). Goals need to be realistic according to the patient's potential and appropriate to the environment encountered during daily life (Mayston 2001). The therapist must consider not only the application of therapy to explore the individual's potential for functional activity but also for participation within social, recreational and leisure activities. In the Bobath Concept treatment has 'change of functional outcome' at its centre (Raine 2007).

Summary

The Bobath Concept was developed by the Bobaths as a living concept, understanding that as therapists' knowledge base grows their view of treatment broadens (Raine 2006). These developments have been in response to, and supported by, advances in the fields of neuroscience, biomechanics and motor learning. As described by Mayston (2007), there have been many changes in the Bobath Concept and many aspects that remain the same.

Aspects that stay the same:

- It is a problem-solving and analytical approach.
- An understanding of tone, patterns of movement and postural control that underlie the performance of functional tasks.
- The idea that it is possible to modify the way a task is performed through handling and activation to make it more efficient, effective and successful for the individual.
- It encourages the active participation of the individual.
- The importance of application of movement, with practice, into function.

Aspects that have changed:

- Changes in the understanding of tone to encompass both neural and non-neural elements.
- The realisation that spasticity as understood by Lance's definition (1980) is rarely a major source of the patient's movement disorder.

- Greater openness to the use of other modalities and adjuncts which will complement the Bobath Concept such as treadmill training, structured practice, the use of orthotics and muscle strengthening.

It is necessary to continually apply and evaluate new knowledge and evidence as it becomes available as part of the ongoing development of the Bobath Concept. As Dr Bobath stated, 'the Bobath Concept is unfinished, we hope it will continue to grow and develop in years to come' (Schleichkorn 1992).

Key Learning Points

- The systems approach to motor control provides the foundation of the current theory underpinning of the Bobath Concept.
- Therapy is an interactive process between individual, task and environment.
- Preparation is of no value in itself, but must be incorporated into functional activity which is meaningful to the patient, in order to promote carry-over.
- Plasticity underlies all skill learning and is a part of the nervous systems function.
- Therapists need to be aware of the principles of motor learning: active participation, opportunities for practice and meaningful goals.
- The Bobath Concept can be complemented with other modalities and adjuncts such as structured practice, use of orthotics and muscle strengthening.

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