Review Of Complex Linguistic And Neurobiological Function In Client Outcomes: The Relevance Of Communication In Occupational Therapy.

H Jelinek, R Stocker

Citation

H Jelinek, R Stocker. *Review Of Complex Linguistic And Neurobiological Function In Client Outcomes: The Relevance Of Communication In Occupational Therapy.*. The Internet Journal of Rehabilitation. 2012 Volume 2 Number 1.

Abstract

Human occupational capacity and repertoire involves adaptation to external and internal influences. Where an individual has suffered some degree of incapacity, occupational therapy provides active intervention by professionals to promote and maintain the health and well being for that individual. Fundamental to active intervention is the teaching/learning process in which the client, under the therapists' direction, undergoes change. Effective and efficient communication is the foundation, which can be investigated and interpreted as part of a Neuro Linguistic Programming framework. What factors are key in the communication process? How are these factors relevant to therapeutic change? The aim of this study is to explore linguistic and neurobiological perspectives of communication in the literature and examine the relationship between language and brain/mind function. Our conclusions indicate that targeted linguistic constructs can have significant impact on events at a neurobiological level, and thus influence physical, cognitive and emotional events for the individual at the occupational level. There are consequent implications for occupational therapeutic intervention.

INTRODUCTION

Occupation is the active engagement in goal-directed, organised, self-initiated, intrinsically self-motivated, experiential and behavioural, self-satisfying, socially valued and recognised activities that support and add to the "quality of life experienced and that influence health" (Wilcock 1993; Yerxa 1993). It involves interaction with and adaptation to external and internal environmental needs of the human being that provides the basis for a human being's occupational capacity and repertoire. The multi-dimensional nature of occupation encompasses 'socio-cultural reality' (the environment) and 'development structure' (individual characteristics) in the relationship between occupational form and occupational performance (David Nelson cited in Christiansen 1994; Law, Manville & Dunn 2005). Occupations are 'culturally and personally meaningful activities that individuals do on a daily basis and at various times throughout their lives' (Yerxa et al. 1989 p341). Occupation has also been described as 'the fundamental mechanism by which people realise aspirations, satisfy needs and cope with their environment . . . When viewed as a 'mechanism', higher mental performance becomes crucial to realising aspirations, and the task of 'going away to have a think about it' is recognised by many as an outcome. The ability to exercise choice and perceive personal responsibility is espoused as an important feature of occupational engagement (Lin et al. 2009; Kielhofner 1995) and these two factors can have powerful benefits in terms of our wellbeing.

Humans are biologically and culturally "wired" to be occupational beings: the human brain is an "occupational brain" (Wilcock 1995). Understanding the function of neurons and their patterns of connectivity (as encapsulated in chaos and complexity disciplines) and self-organisation of neurological structure allows us to examine the occupational brain from a neurological perspective.

OCCUPATION, NEUROLOGY AND LANGUAGE

During occupational activity, physiological and linguistic behaviours that are unique for each individual, define the mental strategies necessary for explicit occupational performance (Adler 1996). These behaviours mark out the neurological activity occurring and align with taxonomies of personality (Acton & Revelle, 2004; Holland 1959, 1973; Matthews & Deary 2003) that can be identified with various occupations and how people think about them. How they are integrated, displayed, and recognised in thought, is of major interest to occupational science research. It is integral to

enabling individuals to engage in occupations that will help them to overcome limitations in biological, psychological, physiological or social functioning and realise their goals and dreams.

Occupational therapy is the active intervention by professionals in the promotion and maintenance of health and well being for the individual, particularly those for whom physical or mental injury has resulted in various forms of incapacity or disability. Active intervention requires the engagement of the therapist and client in a teaching/learning process in which the client, under the therapists' direction, undergoes change. Such change for an individual may be relatively small and short-term, or may involve the individual undergoing a difficult and long-term rehabilitation that requires adjustment to new and/or alternative function. Regardless, fundamental to this process is effective and efficient communication. The therapist's language therefore must encompass relevance for the client and focus on the change process. That is, it must influence the client's identity, attitudes and values, beliefs, capabilities and behaviours (Dilts, 1998), towards occupational rehabilitation, within their environment.

BEHAVIOR AND THE BRAIN

The link between mind, brain and behaviour is clearly critical. The physical basis of thinking, the subjective experience (Barber, 2004; Dilts, 1980) of the individual and behavioural capacity can be viewed from the perspective of knowledge from other disciplines (e.g. NeuroLinguistic Programming – NLP), many of which provide insight into how humans interact in a purposeful manner with each other and their environment.

Structural and functional features of the brain include populations of cells that encode spatial and temporal information and discriminate between the quality of various sensory inputs.

Our current knowledge of the function of single neurons and their connectivity patterns and complexity in biological pattern formation, has improved our understanding of the cognitive processing that occurs as an individual (or group) is occupied in particular behaviours (i.e., the process of "doing"). However, it does not relate directly to our understanding of the relevance of brain structure and communication in the development of, or the rehabilitation towards, occupational outcomes, and thus their relevance to occupational therapy in the promotion of health and well being for individuals. Neither does it explain how the wiring of the brain makes processing of the sensory data we gather as input, lead to a cogent purposeful activity.

Consciousness is most certainly a prerequisite for individuals to be self-aware, and thus to engage purposefully with their environment (Penrose 1994). During altered states of consciousness (e.g. dreaming, hypnosis, visualization, self-talk, etc.) we reflect, and often act, upon those thoughts that are directed, purposeful and personally meaningful (Grodon & Gruzelier (2003), when we return to "normal" conscious states (Rosen 1982). Models that relate neurological function to states of consciousness and overt or covert behavioural patterns can therefore be useful explanatory tools (Shieber 2004).

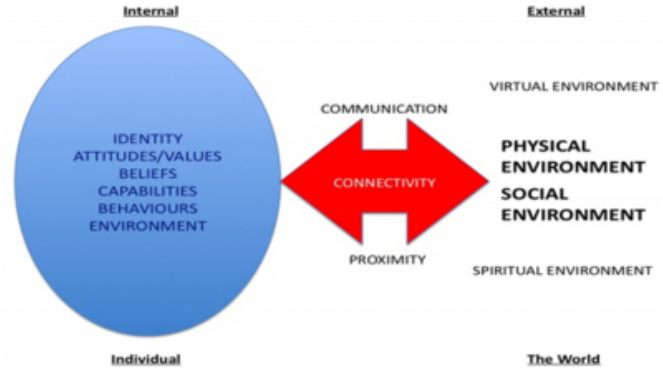
In the Section "Complexity of systemic interaction" we examine therapeutic intervention as a complex adaptive systemic change process comprising various entities and sub-systems interacting to produce recognizable and measureable outcomes (i.e. the client's engagement in living and ability to adapt to environmental pressures). In the section "Complexity of systemic interaction" we first discuss (in an abstracted sense) the general system and the specific entities and processes that enable effective and efficient communication in "Communication and neurobiology". We then discuss the relevance of neurological and linguistic structures to therapeutic change processes in "Communication and linguistics". We finally propose a framework for the application of neurological and linguistic aspects of occupational therapeutic intervention and communication in "A framework for intervention and communication".

COMPLEXITY OF SYSTEMIC INTERACTION

Occupation comprises the complex responses of an individual to multiple external or internal environmental stimuli, and adaptations to those stimuli that influence future responses (Figure 1).

Figure 1

Figure 1. General system and sub-system components in the interaction between an individual and their environment: an NLP perspective (Adapted from Dilts1998).



Knowledge of the structure and function of the human brain provides a foundation for understanding how humans can achieve and/or rehabilitate to certain occupational outcomes, and how the wiring of the brain makes processing of the sensory data we gather as input, lead to a cogent purposeful activity. The function of neurons, their patterns of connectivity and complexity (Holland 1995; Langton 1990), and the self-organisation (Edelman 1979; Kaufmann 1992; Slezak & Albury 1989) of neurological structures are important for examining the "occupationality" of the human brain (Gordon 2000). The neurons, the modular structures in the brain and patterns of connectivity provide unique neurological activity as well as specific response patterns to stimuli for every individual.

During occupational activity (including therapeutic intervention), physiological and linguistic behaviours are uniquely exhibited by each individual and define the mental strategies necessary for explicit performance (Adler 1996). They mark out the neurological activity occurring in the brain involved in transformation of deep structure experience to surface structure communication of that experience (Chomsky, 1957; Chomsky, 1968; Pinker 2007). They align with the individual's personal characteristics (Christiansen, 1994) that are specific to the NLP logical levels of identity, attitudes, beliefs, capacities and behaviours (Dilts, 1998). They are key to therapeutic rehabilitation that guides the change process to overcome limitations in a person's biological, psychological, physiological or social functioning (Figure 2).

Figure 2

Figure 2. Complex systematic communication processes connect the client, the therapist, and the environment in occupational rehabilitation interaction: an NLP perspective (adapted from Dilts 1998)

The therapist then, as an agent of change and adaptation, assists clients to make mental and physical adjustments through surface structure to deep structure. The therapist applies linguistic and physical methodologies and techniques, through demonstration and communication that drives surface structure function, providing the framework for the client's sensory adjustment towards change.

COMMUNICATION AND NEUROBIOLOGY

The structure, organisation and physiology of the brain and nervous system is complex, predisposed to occupational behaviour (Wilcock 1995) and adapts and responds to specific stimuli through self-organization. Here, specific building blocks (the neurons and their patterns of connectivity) change over time and with experience, providing unique neurological activity as well as specific response patterns to stimuli. Humans thus have the ability to manage their biology and environment in advanced ways including the way they perceive themselves and visualise their environment and interactions within (Zemke 1996).

Neuron connectivity patterns undergo continuous changes known as neural plasticity, which is the basis for our changing thought processes associated with experience. For example, from an occupational perspective, people with chronic disease may need to be alerted to their thinking practice.

Can neurobiology provide answers for the proposal that language is critical in therapeutic intervention? To do so it must identify inherent structures that support purposeful activity, self-direction and self-organisation towards a

purposeful outcome. Our description of language as the medium for communication suggests that neural processing provides the physical basis for our understanding of the communication process. Here we describe the neurobiological structures and processes that underpin the characteristics of linguistic performance.

NEUROBIOLOGY

Fundamentally, the brain is occupied with functions of detecting, amplifying, discriminating and adapting to the environment (Moore 1996; Shepherd 1994; Wilcock 1993). This is reflected by an individual's response to the ever-changing array of inputs through the holistic action of the senses (of which vision is the most important), by integrating these into meaningful "memory maps" and by responding (doing some activity) in an appropriate manner (Moore 1996; Sherrington 1975; Wilcock 1996).

Neurons in the brain encode spatial and temporal information and discriminate between the quality (and meaning) of sensory input and memory data. These operations occur in parallel as well as in series, incorporating the primary and association sensory cortices. Processing within and between neurons is influenced by activity fluctuation (Andersen et al. 1977; Kupfermann 1991) and this flexibility (or plasticity) of the nervous system results from the capacity of the nervous system to change the strength of connections between neurons (Hebb 1949; Kandell 1991; Schatz 1992; Zemke 1996). Connections between neurons enable the construction, manipulation and storage of specific patterns called memory traces that are continuously available to the individual and are selectable during conscious thought. These are the foundations for thinking and provide physical (neuro-biological) support for our contention that thinking is a key component of occupational activity (Engel et al. 2001).

It is now possible to identify the neural circuits and networks that participate in information processing, and localise the sites of memory storage, and also to analyse the cellular and molecular mechanisms underlying some of these processes (Petersen et al. 1988). On a cellular level, the ordering of neural events, be it in time or space, is influenced by activity fluctuations (Damasio & Damasio 1992; Kandel 1991). Flexibility or plasticity of the nervous system, and functional localisation due to adaptive connectivity patterns and connection strengths between neurons, are a recurring proposition as observed in the hippocampus (Andersen et al. 1977). The cells in the hippocampus, thought for a long time to be important in information processing, display a particular pattern of activity, 'long term potentiation' (LTP) which is postulated to reflect the cellular basis for memory. LTP requires that the activity patterns between incoming fibres (presynaptic) and responding cells (postsynaptic) coincide in time and space (Kail & Bisanz 1992). Two types of long-term potentiation have been demonstrated in the hippocampus: the associative type (as seen in the CA1 region of the hippocampus) and the non-associative type (the CA3 cells) (Atkinson & Shifrin 1968; Penrose 1994). These differ, in that the latter does not require cooperation or association between presynaptic and postsynaptic cells in time and space. Thus non-associative LTP may be a good model for complex behaviour in the cortex. Here input from various sensory modalities leads to dynamic changes which settle down as a new neural connectivity pattern, and thus as a new memory trace or cortical map (McNaughton et al. 2006).

SELF-ORGANIZATION IN THE NERVOUS SYSTEM

The changes in memory traces from the cellular level to neural circuits based on both associative and non-associative LTP has led to the suggestion of a chaotic or self-organising regimen for the organisation of information and memory (Seigler 1983). These operations occur in parallel as well as in series, incorporating the primary and association sensory cortices. At this level of cortical circuitry fundamental information processing functions can be mediated by families and superfamilies of cortical circuits, constituting certain basic or canonical patterns of functional properties and synaptic connections that can also be adapted for a variety of related specialised tasks (Byrne 1987; Krichmar et al. 2005).

Information processing of sensory modalities occurs to a large degree in different areas of the brain, for example, visual processing which occurs in the occipital cortex and language processing which is localised in the parietal and temporal cortex. Various association areas in the brain further process information. These include the anterior frontal lobe, the limbic system and tempero-parietal-occipital lobe association areas. In tasks concerning language and vision, it has been demonstrated (Moore 1996; Petersen & Petersen 1959) that visual imagery, word reading, and shifting visual attention from one location to another, are not performed by any single brain area. Each involves a large number of component computations that

must be organised to perform a particular cognitive task.

Selective attention appears to use neural systems separate from those involved in passively collecting information about a stimulus. In the posterior part of the brain, the ventral occipital lobe appears to develop the visual word form; the parietal lobe is involved if active selection or a visual search is required; the anterior cingulate gyrus becomes activated in computations involved in selecting language or other forms of information for action. Thus different cognitive functions activate different parts of the brain which are connected by association pathways.

PLASTICITY IN CORTICAL FUNCTION

Plasticity of cortical neural processing networks has also been demonstrated. For example, following permanent visual impairment, auditory or somatosensory stimuli can activate brain regions that are designed for processing of vision. Clinical studies of cortical plasticity pave the way to an understanding of how these areas may electively contribute to information processing in normal individuals. It has now been demonstrated that a specific cortical region accommodates representations of multiple modalities (visual, auditory and kinaesthetic), requiring a cortical module (in the form of a superfamily of connections), that transforms different types of input into a coherent response (Cornell & Bergstrom 1983). This processing can be accomplished by self-organisation of the neural connections within the brain's processing units. This is established by a dynamic mental, emotional, or behavioural bio-electrical trace, is altered by a change in the activity between synaptic connections, destabilising the existing neural connections and leading to a re-establishment of a new interconnected neural network (Bradshaw & Anderson 1982; McCrone 1991; Seigler 1983; Bemi et al. 2006). Spatial cognitive maps are thus capable of self-organising with the aid of sensorimotor feedback from their own target regions, which function on the basis of a modality-independent code (Hebb 1949; Kandel 1991; Kupfermann 1991). This calibration of sensory and motor experiences based on a self-organising system may be the neural basis of a super-capacity such as consciousness.

A LINK BETWEEN BRAIN AND PROCESS

The ability to strengthen neural connection enables individuals to see, hear, feel, smell and taste and also form abstract concepts in their mind (Bliss & Lomø 1973; Byrne 1987). Memory traces or patterns of neural connections are continuously re-organised through experience leading to changes in output. This complex re-organisation of the patterns of neural connections has similarities to other self-organising systems in nature sociological hierarchies (Bryant 1993; Tononi et al. 1992). Self-organisation or "conditionality" requires that organised components show evidence of communication between them. However, the dynamics of the whole system acts independently of organisation (Ashby 1962). Neural circuits that constitute basic (or canonical) patterns of functional properties can also be adapted for a variety of related specialised tasks, depending on the socio-cultural, biological and psychological state of the individual at the time. They are thus reflective of occupational activity (Peterson et al. 1988).

Humans, however, are not limited by a stimulus-response repertoire. They have the capacity to think about, reflect and act upon received information in an impressive variety of ways. They are also able to generate creative, imaginative and innovative higher mental activity outcomes. Thus, self-chosen directed thinking, as an example of occupation, relates individuals to their internal and external environments and leads to the formation and continuous restructuring of local cortical maps (interconnections) (Giannikopoulos et al. 2006). We argue that this thinking, including "unconscious/automatic" and "thought streaming", is purposeful, self-directed, goal-oriented and organized (Barber 2004). It serves a higher-order purpose (Edelman 1979; Sherrington 1975), is self-satisfying, and self-organizing and therefore relates directly to occupational performance.

No single brain area performs visual imagery, word reading, and shifting visual attention (Posner & Dehaene 1994). Rather, these tasks require a selective, cooperative, goal-oriented focus of many neural resources at the micro (cellular) and the macro (modular) levels. Such tasks rely on a neural capacity, constrained by neural structures, that purposefully engages in iterative, selective and sequential processing to achieve specific satisfying outcomes (Andersen et al. 1977; Bliss & Lomø 1973).

Higher mental activity is affected by the degree of meaning attached to input data and the amount of attention humans are able to focus on thinking (Seigler, 1983). Humans will learn and perform best in those situations that hold strong personal socio-cultural and psychological relevance. The level of meaning attached to input data and the attention given to it alters the depth to which it is processed. A

conscious effort is required for the human to freely choose within the teaching/learning situation. Personal cultural, sociological and psychological meaning is coded in the brain and is brought together with current input to determine subsequent output (sociological constraints).

All experience, including feedback from environmental and sensory sources, is the result of nervous activity that fans across the brain forming networks of connections (Seigler 1983; Fiete et al. 2010). Sensory and motor experiences are processed within and between nerve cell assemblies. It is the biological basis for our philosophical understanding of what thinking is. The outcome of this nervous activity, or thinking, establishes those behaviours for an individual that specifically relate to occupational preferences and performance. Thus specific outcomes of thought are a function of the ever-changing connectivity patterns between the neurons in the brain. Nervous system plasticity (the capacity of the brain to change and be self-aware) is the biological basis for human capacity to engage in thinking as an occupation. Socio-cultural change evolves from learning and can influence the absorption of information in the brain. The brain's capacity to change neural connections and strengths as required, suggests that socio-cultural change can cause neural changes reflected as changes in thinking and thus higher mental activities (Bradshaw & Anderson 1982; Zemke 1996). Specific wiring of the brain endows individuals with certain innate capacities for rapidly processing that which is meaningful, and allows these capacities to change with experience (McCrone 1991).

MODELS OF THINKING

Researchers in the field of artificial intelligence use computers to model human thinking from physiological and functional perspectives. Based on simple wiring connections that represent neurons of the brain, the strength of connections between neurons were allowed to change with time (Kail & Bisanz 1992). For example, research based on Pavlov's classical conditioning modelled the learning function of neurons in the brain (Hebb 1949).

From a philosophical-psychological perspective, Atkinson and Shiffrin's Store Model (1968) of thinking most clearly resembles a computer-styled view of the human thought processing system. In this model, information is first stored then processed in three parts of the human mental system: the sensory register, the short-term memory, and the long-term memory. Information enters the sensory register and is then moved to the memory sites by control strategies, which are, self-directed, partially automatic and partially consciously controlled.

Information processing theory based in computer science and philosophy provides a connection between mental and biological events allowing a neural theory to fit along-side a philosophical model. Memory maps, consisting of neural connections and strengths within the brain, represent the biological basis of information acquisition, retention, retrieval and final thought patterns. How we think, how we develop our desires, goals and fears and how we motivate ourselves, and give meaning to our experiences requires different levels of processing that are a feature of an individual's subjective mental state (thinking).

Individuals develop strategies based on preference for one or more sensory modalities to obtain, analyse, store, and retrieve information. This suggests a system that is based on choice and a socio-cultural framework. Overt signs of the abstract thinking that humans require for language gives clues to how humans categorise information and reflects a basis for understanding the world around them. Key building blocks of occupations are that they are (mostly) self-directed, purposeful or, goal-orientated. Thinking can be characterised by these elements, particularly when one makes a conscious effort to think, or makes/takes specific time to 'think'. Thinking can also appear non-goal-directed and something that we don't choose to do, that is, there are some 'thoughts' that we neither reflect nor act upon. We argue that such thinking is still purposeful, since it facilitates discriminatory and evaluative comparisons (seeking best solutions) that enable the survival of the organism. For individuals, quality of life in terms of "being, belonging and becoming" suggests that doing and being are "intimately interrelated components of human occupation …. that do not require active engagement with the environment" (Stone 2005). They relate directly to self-awareness and consciousness. Either way, the thinking that we exhibit in daily living depends on neurobiological structures and processing mechanisms together with other innate characteristics of the individual, including levels of consciousness (Zemke 1996). Occupation appears then as a meta-phenomenon and includes abstract thought related to principles such as self-awareness, society, environment, and altruism.

For occupational science to come to terms with how occupation reflects the need of individuals to interact with their environments, an understanding of the non-observable

mental event has to be achieved, in order to provide a link between the occupation of higher mental activities and thinking in a coherent way. Occupational adaptation suggested by Schkade and Schultz (in Kramer et al. 2003) provides a theoretical frame of reference that helps us understand how humans' desire for mastery, combined with the environment's demand for action press us to accept occupational challenges. Occupational adaptation is the culmination of a process of weighing up, and reflecting on the outcome of a response to a challenge, and using those reflections to inform future behaviour (e.g. will I, and can I engage again, and how will I engage, if at all). Higher mental activity (thinking) becomes the real-time occupational adaptation process that combines multiple occupational challenges from within and external to the individual that are all represented as cognitive maps (occupational components).

COMMUNICATION AND LINGUISTICS

Connections between areas of the brain not only enable humans to integrate sensory events or instigate simple motor responses but also to develop knowledge and understanding of their environment. The question of knowledge and understanding requires consciousness which is a feature of an individual's subjective mental states and therefore not observable. For occupational science to come to terms with how occupation reflects the need of individuals to interact with their environments, an understanding of the "non-observable" mental event has to be achieved. The NLP framework proves a technique that enables practitioners to "read" the physiological and linguistic cues that people exhibit as they discuss their (occupational) experience. In addition it provides a methodology that uses targeted linguistic metaphors to enable specific change processes. Such techniques and methodologies can provide the occupational therapist's repertoire with useful tools to effect smooth ecologically balanced change for their clients.

NeuroLinguistic Programming as a description of the "structure of subjective experience" (Dilts, 1980) provides a model to explain human human cognitive function (thinking) that focuses on the process, rather than the content and is a framework for understanding how humans communicate their sense of the world. It explains the dynamics of unconscious communication, the influence of language patterns, the structure of belief and identity and the neurological patterns used for processing sensory input and internally generated thought patterns (Adler 1996; Ellis 2004; Patil 2003). These behaviours inform the occupational repertoire of individuals (White & Goldsmith 2002). During occupational activities the components of our nervous system undergo a process of self-organisation resulting in mental representations that lead to specific outcomes (Grodon & Gruzelier 2003). Fundamental dynamics between the mind/brain and thinking affects the operation of our mind and body when engaged in the activities humans choose as occupations.

It constitutes essentially a methodology or framework for recognising specific components of human communication. Subtle verbal and non-verbal accessing cues comprising language (structures and types of words: verbs, adjectives, adverbs), together with physiological responses (eye movements, breathing, etc.), can be critically examined to identify consistent patterns thought to be indicative of cognitive processing. These patterns link together to form a recognisable "strategy" which is consistently used by individuals or a group, for behaving (surviving) in their internal and/or external environments.

NLP AND COGNITIVE FUNCTION

Observation by NeuroLinguistic Programmers has shown that individuals have a preference for one of five sensory modalities for obtaining, analyzing, storing, and retrieving information. Motor activities also reveal similar preferences for sensory modalities. For example, individuals who are vision oriented will move their eyes upwards when speaking or recalling information. Overt signs of abstract cognitive processing required for language give clues to how humans categorize information and reflect their basis for understanding the world around them. Consciousness is a complex phenomenon greater than the sum of the cortical areas, which function to integrate and respond to specific environmental cues. Occupation consists of the activities based on innate capacities of the individual, including consciousness. Occupation is thus a meta-phenomenon, which includes a range of behaviors from simple stimulus-response to abstract thought related to principles such as self-awareness, society, environment, and altruism.

Cognitive function is dependent upon individual neural organisation for processing internally or externally generated experience, which consists of sensory inputs of varying intensities and modalities. Each modality has intrinsic sub-modality attributes (Andersen et al. 1977), for example, visual signals will possess color, brightness, clarity, dimension, and spatial location as well as other sub modality

classifications (Bandler & McDonald 1989). Cognitive function, which manifests itself in observable behaviors, is coincident with occupation and therefore, by identifying the language and physiological cues associated with complex behaviors can be modeled and reproduced. NLP provides us with the techniques for understanding the subjectivity of mental states such as consciousness and thus provides a context within which occupational science and occupational therapy can realistically build an understanding of occupational roles.

Selective attention to experience is governed by preferences for specific sensory components (modalities) of that experience. The focus of attention on an event is the activation of a specific network of connected neurons against the background of all other possible neural networks. The "noise level" or level of difference in the flaring net is the key to the urgency of attention needed (Tononi et al. 1992). It is very difficult, if not impossible, for the brain to accommodate all the external and internal sensory information that is available for a single event. Therefore cognitive processing will necessarily be selective and will occur around "the differences that make the difference"(Yeager 1985).

This selectivity as "neurological constraints" is unique to each person and translates and stores raw information into bio-electric impulses in various areas of the brain connected via cortical association areas (Posner 1994). Neurological constraints are evolutionary depending upon genetic hardwiring and the influence of environmental stimuli (including social and cultural) during the embryonic and early childhood stages of individual development (Rauschecker 1995). It is then apparent that, for any given experience, each individual may trigger quite different bio-electric impulses, producing significantly different perceptions of that experience.

IMPORTANCE OF LANGUAGE

Bio-electrical maps of internal and external information, coded as changes in the neuronal connections and strengths, and connections between association areas of the cortex, are then modified by filters called "social constraints". Language is the symbolic representation of these social constraints and provides the means by which individuals communicate their cognitive maps of a past, present or future event or experience (Dilts 1995). Language focuses the individuals' attention towards the external as well as internal environment. That language has influence on specific brain areas has been demonstrated by emotional behaviour instigated via the hypothalamus and amygdala following verbal cues. Language is closely linked with an individual's perceptual and conceptual processing, which in turn is linked to the individual's neurophysiology and neuroanatomy. Therefore any identifiable characteristics of an individual's language pattern will be indicative of the cognitive processing occurring, and suggests a dynamic and recursive nature in the neural connections (Edelman 1979; Thompson 2006). Studies in stroke patients displaying optic aphasia have suggested that the severely impaired naming of visual stimuli (despite spared recognition of visual stimuli and spared naming in other modalities) can be explained by proposing a deficit in accessing a complete modality-independent, holistic representation, from an intact stored, structural description of the object (Zemke 1996). Language indicates cognitive states and influences the cognitive functioning of the brain (Erdi & Barna 1985; Sherrington 1975).

The inference is, then, that careful observation of language patterns used by an individual engaged in or planning occupational pursuits, will provide an indication of the cognitive processing that is occurring. It might even be possible to model experts by their language (and other behavioural) patterns, and use those patterns to help novices to develop the skills knowledge and attitudes of that expert fro example in occupational fine-tuning.

Higher mental activity is uniquely human and transcends simple cause and effect behaviour. Selection of activities that translate into occupational engagement are the crux of higher mental activities being viewed as occupations that provide the cultural embedding. Two forms of selectivity exist: neurological and social. Neurological constraints are unique to each person and translate sensory information into bioelectric impulses in various connected cortical association areas of the brain (Shepherd 1994). For any given experience, each individual may trigger quite different bioelectric impulses, producing significantly different perceptions of that experience. Experiences are then uniquely represented in the neurological connectivity patterns of each person and mark out specific occupational perceptions and options for the individual.

Social constraints then filter or modify internal and external information, coded as changes in the neuronal connections and strengths, and connections between association areas of the cortex. That is, social, cultural, biological and

psychological dimensions guide higher mental activities that can be expressed as language. Language indicates cognitive states and influences thinking and higher mental activities. In turn, language and thinking can impact on what we choose to do.

How do we transform the contents of the past that includes the sum of our experiences into possibilities through thinking and become fully realised in the present? Conscious thought and altered states of consciousness can turn the impact of our dreams into reality.

Occupation is based on many bio-psychosocial factors that combine to provide the individual with potential flexibility and variability to achieve occupational outcomes. Occupations have social, cultural, biological and psychological dimensions (Bruce & Borg 1993). On a higher functional level, activities such as awareness of self, and creative thinking are manifestations of an occupational brain (Schmid 2004; Wilcock 1996). Deliberate or outcome-oriented creativity (divergent thinking) and spontaneous or process-oriented creativity (spontaneous thinking) are differentiated by the former being "in response to a need and having instrumental value" and a "search for a solution"; and the latter being "valued for the enjoyment derived from its process" and having "many elements of play" (Blanche 2007).

For example, learning can be thought of as a socio-cultural phenomenon, with the adoption of the role of student, providing the social context for a variety of associated tasks. These productive tasks can be classified as an occupation. However, learning, as one task associated with the role of being a student, is also a complex cortical task or super-capacity that involves attention, perception, encoding of information by the nervous system, storage and retrieval of information in the brain. These cortical tasks are self-chosen within a socio-cultural, biological and psychological domain that defines occupation, that is, they are occupationally bound (Wilcock 2003). Information processing theory suggests that humans receive information, store it in memory, and retrieve it in much the same way that a message may be typed to a word processor, saved on disk, and then printed on a printer. This analogy provides a link between what is typically seen as occupation (typing) and higher mental activity as an occupation (utilising information to make choices that lead to defined outcomes).

A FRAMEWORK FOR INTERVENTION AND COMMUNICATION

What then is occupation? There are diverse definitions of occupation and we have already highlighted some of these. Occupation is a purposeful human activity with an underlying neural, anatomical and physiological substrate (Barber 2004). Occupation has a measure of personal satisfaction in response to purposeful activity, being self-directed, self-initiated, goal directed, organised, and facilitates the adaptive process (Kielhofner 1995; Mortensen 1998; Schkade & Schultz 2003). Holism underpins the theory and practice of occupational therapy and acknowledges the physical, social, cognitive, psychological and spiritual dimensions of human behaviour (Gray et al. 1996). These criteria are key philosophical concepts that support the classification of an activity as an occupation. We must demonstrate that thinking exhibits these criteria to be endowed with the status of occupation.

Meaning defines the total interpretive experience of external structures encountered by the individual. It involves interpretation of physical and socio-cultural aspects of the external environment and the emotional experience of the person towards the external environment or occupational form (Nelson and Jepson-Thomas 2003).

However, in human beings occupation combines the "operation of biological, psychological, social and ecological" systems. Boulding's (1956) open systems framework that is applied to complex systems research exposes its philosophical relevance to human occupation. Component sub-systems guide the selection of, regulate patterns and routines of, and allow the individual to perform, occupational behaviour. Self-organisation of these human sub-systems and interactions with the individual's internal and external environment influence the dynamic nature of occupational behaviour (Kielhofner 1995). It provides the philosophical underpinning of thinking as an occupation since the interaction between these systems can be self-directed to achieve certain outcomes.

Philosophical, psychological, sociological, and biological research guide our understanding as to how humans interact in a purposeful manner with their environment (Zemke 1996). Science is better informed about how we collect, process, manipulate and store data that is acquired through the sensory systems of the body. Such research allows better understanding of how humans are able to control and manage their physical, biological and mental performance.

Human beings are differentiated from animals by their ability to "not only exist in time and space but in history", to be self conscious, and to be self-reflective – not only do we know, but we know that we know (Boulding 1956). Higher-level mental activities (e.g. abstract thought, planning, search for meaning, language and symbolism) are unique human qualities (Clark et al. 1996; Fortune 1996; Zemke 1996). They include the ability to be uniquely involved in activities that are culturally and socially sanctioned (norms) rather than biologically and ecologically determined (Wilcock 1993).

Types of thinking are differentiated by the cerebral locations in which they predominantly take place and how these, in terms of connectivity strengths, differ. For example, the differences in results from activity in the neo-cortical and limbic systems of the human brain differentiate purposeful/abstract and emotive thinking. Applying our definition of occupation, thinking has to reflect a purposeful activity and allow in response, some measure of personal satisfaction, although purposeful should not be confused with 'active' doing. Therefore it must be self-directed, personally initiated, goal directed and organised.

CONCLUSION

Information processing theory provides a connection between mental and biological events allowing a neural theory to fit along side the cognitive model. 'Memory maps' consisting of neural connections and strengths within the brain represent the biological basis of information acquisition, retention, and retrieval.

Connections between areas of the brain not only enable humans to integrate sensory events or instigate simple motor responses but also to develop knowledge and understanding of their environment. The question of knowledge and understanding requires consciousness which is a feature of an individual's subjective mental states and therefore not observable. For occupational science to come to terms with how occupation reflects the need of individuals to interact with their environments, an understanding of the "non-observable" mental event has to be achieved.

The NLP framework proves a technique that enables practitioners to "read" the physiological and linguistic cues that people exhibit as they discuss their (occupational) experience. In addition it provides a methodology that uses targeted linguistic metaphors to enable specific change processes. Such techniques and methodologies can provide the occupational therapist's repertoire with useful tools to effect smooth ecologically balanced change for their clients.

Observation by NeuroLinguistic Programmers has shown that individuals have a preference for one of five sensory modalities for obtaining, analyzing, storing, and retrieving information. Motor activities also reveal similar preferences for sensory modalities. For example, individuals who are vision oriented will move their eyes upwards when speaking or recalling information. Overt signs of abstract cognitive processing required for language give clues to how humans categorize information and reflect their basis for understanding the world around them. Consciousness is a complex phenomenon greater than the sum of the cortical areas, which function to integrate and respond to specific environmental cues. Occupation consists of the activities based on innate capacities of the individual, including consciousness. Occupation is thus a meta-phenomenon, which includes a range of behaviors from simple stimulus-response to abstract thought related to principles such as self-awareness, society, environment, and altruism.

Cognitive function, which manifests itself in observable behaviors, is coincident with occupation and therefore, by identifying the language and physiological cues associated with complex behaviors, can be modeled and reproduced. NLP provides us with the techniques for understanding the subjectivity of mental states such as consciousness and thus provides a context within which occupational science and occupational therapy can realistically build an understanding of occupational roles.

References

r-0. Acton GS Revelle W: Evaluation of ten psychometric criteria for circumplex structure. Methods of Psychological Research, 2004; http://www.dgps.de/fachgruppen/methoden/mpr-online/ 9, 1-27.
r-1. Adler H: NLP for Managers: How to Achieve Excellence at Work. London: Judith Piatkus (Publishers) Ltd. 1996.
r-2. Andersen P, Sundberg SH, Sveen O, Wigström H: Specific long-lasting potentiation of synaptic transmission in hippocampal slices. Nature; 1997; 266, 736-737.
r-3. Ashby W Ross: Principles of the self-organising system. in H. Von Foerster and G. W. Zopf, Jnr. (Eds). Principles of Self-Organisation: Transactions of the University of Illinois Symposium.London: Pergamon Press; 1996; 255-278.
r-4. Atkinson RC, Shiffrin RM: Human memory: A proposed system and its control processes. in K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory, New York: Academic Press. 1968; 2: 182-195.
r-5. Bandler R, McDonald W: An Insiders Guide To Sub Modalities. Cupertino, CA. Meta Publications, 1989.

r-6. Barber MD: Occupational science and phenomenology: Human activity, narrative and ethical responsibility. J Occ Sci; 2004; 11(3): 105-114.
r-7. Bemi T Hallam J Meyrand P Rinzel J: Electrical coupling and bistability in inhibitory neuronal networks; Biocybern & Biomed Eng, 2006; 26(2): 3–14.
r-8. Bliss TVP, Lomø T: Long-lasting potentiation of synaptic transmission in the dentate area of the anaesthetised rabbit following stimulation of the perforant path. J Physiol; 1973; 232: 331-356.
r-9. Bruce MA Borg B: Psychosocial occupational therapy. Thorofare NJ: Slack, 1993.
r-10. Boulding K: General Systems Theory – The Skeleton of Science. Manag Sci; 1956; 2(3): 127-139.
r-11. Bradshaw GL, Anderson JR: Elaborative encoding as an explanation of the levels of processing. J Verbal Learn Verbal Behav; 1992; 21: 165-174.
r-12. Bryant CGA: Social self-organisation, civility and sociology: Kumar's 'Civil Society'. Br J Sociol; 1993; 44(3): 397-401.
r-13. Byrne J: Cellular analysis of associative learning. Phys Rev; 1997 67: 329-439.
r-14. Clark FA, Parham D, Carlson ME, Frank G, Jackson J, Pierce D, Wolfe R, Zemke R: Occupational Science: Academic innovation in the service of occupational therapy's future. Am J Occ Ther; 1996; 45: 300-323.
r-15. Chomsky N: Syntactic structures. The Hague, Netherlands: Mouton, 1956.
r-16. Chomsky N: Language and mind. New York: Harcourt Brace Jovanovich, Inc, 1968.
r-17. Christiansen C: Classification and study in occupation: A review and discussion of taxonomies. J Occ Sci: 1994; 1(3): 3-21.
r-18. Cornell EH Bergstron LI: Serial position effects in infant recognition memory. Memory Cognition; 1983; 11: 494-499.
r-19. Damasio AR, Damasio H: Brain and language. Sci Am: 1992; 267(3): 62-71.
r-20. Dilts RB: NLP and self-organisation theory. Anchor Point; 1995; 9(6): 14-21.
r-21. Dilts RB: Modelling with NLP. Capitola, CA: Meta Publications, 1998
r-22. Edelman GM Group selection and phasic re-entrant signalling: a theory of higher brain function. in: F. O. Schmitt, & F. G. Worden (Eds.), The neurosciences: fourth study program, Cambridge: MIT Press. 1115-1139, 1979.
r-23. Ellis C: NLP in the medical consultation. South African Med J; 2004; 94(9): 748-749.
r-24. Engel A Fries P Singer W: 2001 Dynamic predictions: Oscillations and synchrony in top-down processing. Nature Reviews Neuroscience, 2001; 2: 704–716.
r-25. Erdi P, Barna G: Self organisation of neural networks: noise induced transition. Phys Lett A; 1985; 107(6): 287-290.
r-26. Fiete IR Senn W Wang CZH Hahnloser RHR 2010 Spike-Time-Dependent Plasticity and Heterosynaptic Competition Organize Networks to Produce Long Scale-Free Sequences of Neural Activity, Neuron; 2010: 65(4):563-676.
r-27. Fortune T: The proto-occupation/occupation interface: An exploration of human occupation and its symbolic origins. J Occ Sci Austr; 1996; 3: 86-92.
r-28. Giannikopoulos DV Eysel UT: Dynamics and specificity of cortical map reorganization after retinal lesions Proc Natl Acad Sci U S A. 2006; 103(28): 10805–10810.
r-29. Gordon E: Integrative Neuroscience: Bringing Together Biological, Psychological and Clinical Models of the Human Brain. Singapore: Harwood Academic Publishers, 2000.
r-30. Gray J Mc, Kennedy BL, Zemke R: Application of dynamic systems theory to occupation. in R. Zemke & F. Clark (Eds). Occupational Science – The Evolving Discipline. Philadelphia: F.A. Davis Company. 309-324, 1996.
r-31. Grodon C, Gruzelier J: Self-hypnosis and osteopathic soft tissue manipulation with a ballet dancer. Contemp Hypnosis; 2003; 20(4): 209-214.
r-32. Hebb DO: The organisation of behaviour. New York: John Wiley, 1949.
r-33. Holland JL: A theory of vocational choice. J Counsel Psychol; 1959; 6: 355.
r-34. Holland JL: Making Vocational Choices: A theory of careers. Englewood Cliffs, NJ: Prentice-Hall, 1973.
r-35. Holland JH: Hidden order: How adaptation builds complexity. Addison Wesley, 1995.
r-36. Kail R Bisanz J: The information processing perspective on cognitive development in childhood and adolescence. in: R. J. Sternberg & C. A. Berg (Eds.), Intellectual development. New York: Cambridge University Press. 229-260,1992.
r-37. Kandel ER: Cellular mechanisms of learning and the biological basis of individuality. in: E. R. Kandel, J. H. Schwartz & T. M. Jessell (Eds.), Principles of Neural Science, Connecticut: T. M. Appleton & Lange. 1009-1032, 2000.
r-38. Kielhofner G: (Ed) A model of human occupation: Theory and application. Baltimore: Williams and Wilkins, 1995.
r-39. Krichmar JL Nitz DA Gally JA & Edelman GM: Characterizing functional hippocampal pathways in a brain-based device as it solves a spatial memory task, PNAS 2005; 102(6): 2111-2116.
r-40. Kupfermann I: Learning and memory. in: E. R. Kandel, J. H. Schwartz & T. M. Jessell (Eds.), Principles of Neural Science, Connecticut: T. M. Appleton & Lange. 997-1008, 1991.
r-41. Law MC Baum C Dunn W: Measuring occupational performance: supporting best practice in occupational therapy. Slack Incorporated, New York, 2005.
r-42. Lin N Kirsh, B Polatajko H Seto M: The nature and meaning of occupational engagement for forensic clients living in the community. J of Occ Sci; 2009; 16(2): 110-119.
r-43. Matthews G Deary IJ Whiteman MC Personality traits (2nd edition). Cambridge: Cambridge University Press, 2003.
r-44. Mortensen C: A Theory of Human Nature for Occupational Science. J Occ Sci; 1998.
r-45. Moore J: The visual system and engagement in occupation. J Occ Sci; 1996; 3(1): 16-17.
r-46. McCrone J: The ape that spoke: Language and the evolution of the human mind. London: Pan Books, 1991.
r-47. McNaughton BL Battaglia FP Jensen O Moser EI Moser M-B: Path integration and the neural basis of the 'cognitive map' Nature Reviews Neuroscience, 2006; 7, 663-678
r-48. Nelson DL Jepson-Thomas J: Occupational form, occupational performance and a conceptual framework for therapeutic occupation. In: Kramer, P., Hinojosa, J., and Royleen C. B. (eds) Perspectives in human occupation participation in life. Baltimore, MD: Lippincott Williams and Wilkins. 87-155, 1996.
r-49. Patil A: Marital conflicts: Intervention through NLP. Ind J Soc W; 2003; 64(20): 200-209.
r-50. Penrose R: Shadows of the mind: A search for the missing science of consciousness. Oxford: Oxford

University Press, 1994.
r-51. Petersen LR Petersen MJ: Short-term retention of individual verbal items. J Exp Psychol; 1959; 58: 193-198Pinker S: The language instinct: How the mind creates language. New York: Penguin, 2007.
r-52. Posner MI Dehaene S: Attentional networks. Trends Neurosci; 1994; 17: 75-79.
r-53. Rosen S: My voice will go with you: The teaching tales of Milton H Erickson. New York: W. W. Norton & Company Ltd, 1982.
r-54. Schatz C: The developing brain. Sci Am; 1992; 267(3): 61.
r-55. Schkade JK Schultz S: Occupational adaptation. in P. Kramer, J. Hinojosa, & C. B. Royeen (Eds.), Perspectives in Human Occupation: Participation in Life. Baltimore: Lippincott, Williams and Wilkins, 2003.
r-56. Schmid T: Meanings of creativity within occupational therapy practice. Austr Occ Ther J; 2004; 51(2). 80-88.
r-57. Shepherd GM: The cerebral cortex and human behaviour. Neurobiology (3rd ed.), New York: Oxford University Press. 652-684, 1994.
r-58. Sherrington CS: The Integrative Action of the Nervous System, Cambridge: University Press, 1975.
r-59. Siegler RS: Information processing approaches to development. in: W. Kessen (Ed.), Handbook of child psychology: Vol. 1. History, theory and methods, New York: Wiley, 129-212, 1993.
r-60. Slezak P Albury W: Mental Images - Should Cognitive Science Learn from Neurophysiology? in P. Slezack & W. Albury (Eds.), Computers, Brains and Minds: Essays in Cognitive Science. Dordrecht: Kluwer, 123-36, 1989.
r-61. Stone SD: Being as doing: Occupational perspectives of women survivors of hemorrhagic stroke. J Occ Sci; 2005; 12(1): 17-25.
r-62. Shieber S: The Turing test: verbal behavior as the hallmark of intelligence, Cambridge, Mass, MIT Press, 2004.
r-63. Thompson HL: Exploring the Interface of the Type and Emotional Intelligence Landscapes, Bulletin of Psychological Type,; 2006:29(3): 14- 19.
r-64. Tononi G, Sporns O, Edelman GM: Re-entry and the problem of integrating multiple cortical areas: simulation of dynamic integration in the visual system. Cereb Cortex; 1992; 2: 310-335.
r-65. White K Goldsmith A: Look into my eyes: NLP. Nurs Spect; 2002; 11(23): 29.
r-66. Whiteford G, Townsend E, Hocking C: Reflections on a renaissance of occupation. Occ Ther; 2002; 67(1): 61-69.
r-67. Wilcock AA: A theory of the human need for occupation. Occ Sci Austr; 1993; 1(1). 17-25.
r-68. Wilcock AA: Reflections on doing, being and becoming. Austr Occ Ther J; 1999; 46(1): 1-11.
r-69. Wilcock AA: A science of occupation: Ancient or modern. J Occ Sci; 2003; 10(3): 115-119.
r-70. Yeager JC: Thinking about thinking with NLP. Cupertino CA. Meta Publications, 1985.
r-71. Yerxa EJ, Clark F, Jackson J, Pierce R, Zemke R: An Introduction to Occupational Science, A Foundation for Occupational Therapy in the 21 st Century. in J. A. Johnson & E. J Yerxa (Eds). Occupational Science: The Foundation for New Models of Practice. New York: The Hawthorn Press, 1989.
r-72. Yerxa EJ: Occupational science: A new source of power for participants in occupational therapy. Occ Sci Austr; 1993; 1(1): 3-11.
r-73. Zemke R: Brain, mind and meaning. in: R. Zemke & F. Clark (Eds.), Occupational science: The evolving discipline, Philadelphia, PA: F.A. Davis Co., 163-170, 1996.

Author Information

H. F. Jelinek
School of Community Health, Charles Sturt University

R. C Stocker
School of Engineering and Information Technology, University of New South Wales at ADFA (Australian Defence Force Academy)