Beyond Scalpels and Stethoscopes:

A Phenomenology of Cognitive Artefacts, Classifications, and Schema Integration in Rehabilitation Medicine

David J. Kellett, B. Med., FAFRM (RACP)

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This is to certify that the thesis entitled *Beyond Scalpels and Stethoscopes: A Phenomenology of Cognitive Artefacts, Classifications, and Schema Integration* submitted by David John Kellett in fulfilment of the requirements for the degree of Doctor of Philosophy, is in a form ready for examination.

Professor Ian D. Cameron

Sydney Medical School

Faculty of Medicine and Health

University of Sydney

Date: 16 October 2019

Candidate's Statement

This is to certify that to the best of my knowledge, the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes. The intellectual content of this thesis is the product of my own work and all assistance received in preparing this thesis and sources have been acknowledged.

David John Kellett

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Abstract

Tool use is a defining capability of the human species. In the field of Health, tools are pervasive and integral to practice. Whilst the function of many tools used in Health are overt, (e.g. a scalpel), tools designed to support cognition, (i.e. cognitive artefacts), may be less so. For this reason, the description and analysis of cognitive artefacts is important.

The ability to classify represents a primary cognitive skill in Healthcare practice where classifications serve to provide information infrastructures upon which practice unfolds. Formal classification systems in Health continue to evolve for which the development of cognitive artefacts can assist in their practical application.

With the availability of multiple classifications in Health, practitioners concerned with holistic, person-centred approaches to care require an ability to integrate classifications when engaging in cognitive tasks such as problem solving. The cognitive task of integrating classifications introduces a framing problem for practitioners where multiple schemas, or representations of the world, require simultaneous mapping to a common global schema or framework.

The design of cognitive artefacts targeting the integration of classificatory schemas in Health practice appeals to practitioners whose lived experience involves this work. To that end, this thesis provides a first-person phenomenological account of a cognitive artefact designed for the integrated application of the reference classifications of the World Health Organisation's Family of International Classifications (WHO FIC) in the field of Rehabilitation Medicine. Using a phenomenological approach, taken-for-granted assumptions about the WHO FIC are set aside to permit reconsideration of classifications with reference to basic phenomena of time and space from which the building blocks of the cognitive artefact are constructed.

Elaboration of this model occurs with the additional representation of the Body, Activities, and the Environment as dynamic interacting components within the temporospatial field. These 3 components are further represented in a 20-cell array derived using the main chapter headings from the International Classification of Functioning, Disability and Health (ICF) which is viewed as analogous to a 2-dimensional cellular automaton. Following description of the cognitive artefact design worked, examples of problems in Rehabilitation Medicine are provided that highlight the cognitive artefacts capacity to address and integrate multiple framing perspectives.

Key phenomenological findings from the study include: 1) recognition of the role of artefacts in grounding a subjects temporospatial 'lifeworld' using visual diagrams and imagery, 2) highlighting the value of utilising a generic problem space when approaching Rehabilitation Medicine problems that demand multiple-frame perspectives, 3) using a 2-dimensional automata-like structure to appreciate the relational complexity of problems encountered in Rehabilitation Medicine, 4) appreciating the role of artefact construction for framing integration in Rehabilitation Medicine problem solving, and 5) locating the lived experience of the practitioner as a moral actor who can be positioned (alongside their patient) within the artefact frame.

The study findings provide a sound basis for potential future research into the role of artefacts in Rehabilitation Medicine practice where an overarching goal is the integrated application of health classifications in the pursuit of person-centred care.

Key Words: Medical Cognition; Clinical Reasoning; Cognitive Artefacts; Phenomenology; ICF; ICD

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Acronyms

ADL	Activities of Daily Living
ALO	Aboriginal Liaison Officer
BOS#	Base of Skull Fracture
BNO	Bowel Not Open
BP	Blood Pressure
CA	Cellular Automata
CN	Cranial Nerve
CRP	C-Reactive Protein
CSF	Cerebrospinal Fluid
CVC	Central Venous Catheter
CXR	Chest X-ray
DAI	Diffuse Axonal Injury
ECG	Electrocardiograph
ENT	Ear, Nose, and Throat
EVD	External Ventricular Drain
GCS	Glasgow Coma Scale
Hb	Haemoglobin
JHH	John Hunter Hospital
ICD	International Statistical Classification of Diseases and Related Health Problems
ICU	Intensive Care Unit
IDC	Indwelling Catheter

ICF	International Classification of Functioning, Disability and Health
ICHI	International Classification of Health Interventions
LTCS	Lifetime Care and Support
LMN	Lower Motor Neuron
MI	Myocardial Infarction
MBA	Motor Bike Accident
MVA	Motor Vehicle Accident
PSH	Paroxysmal Sympathetic Hyperactivity
PTA	Post Traumatic Amnesia
TBI	Traumatic Brain Injury
SDH	Subdural Haematoma
UoN	University of Newcastle
UTI	Urinary Tract Infection
WCC	White Cell Count
WHO	World Health Organisation
WHODAS	World Health Organisation Disability Assessment Scale
WHO-FIC	World Health Organisation Family of International Classification

Chapter 1: Introduction

The expectations of life depend upon diligence;

the mechanic that would perfect his work must first sharpen his tools.

Confucius

Man is a tool using animal.

Without tools he is nothing, with tools he is all.

Thomas Carlyle

The Importance of Tools

Tools are an integral and defining part of human life. From a very early age we embark on a prolonged journey of learning and using tools that typically begins with simple objects such as spoons and cups (Henderson & Pehoski, 2005, p. 201). As well as hand-held physical tools, early human life is also an essential period for the protracted acquisition of what is perhaps our most important, yet abstract tool, namely, language (Clark, 2006; Pinker, 2010). As a result of this engagement with the world through the use of tools we develop what has been termed 'skilful coping' (Dreyfus & Wrathall, 2014). Formally, tools have been defined as 'technologies which support the performance of activities or actions' (Ruggles, 1997, p. 2); human activities are myriad and our range of tools diverse.

By adulthood most people have mastered the use of hundreds of tools that have become seamlessly incorporated into our everyday lives where their use, frequently in combination, becomes automatic. In most cases, the function of a tool is self-evident; a car gets us from A to B, a toothbrush keeps our teeth clean, and traffic lights help us from crashing into each other. In other situations, however, perhaps when a new tool is developed, or its function is not overt, detailed description and explanation becomes necessary to examine and communicate its potential benefits. Describing the design of a novel tool for use in applied settings (i.e. medical practice) is the primary goal of this thesis.

1.01 Tools in the Modern World

Increasingly in complex modern societies, tools abound, and the competent use of often highly specialised tools commonly underpins vocational success. Our modern-day, high-tech tools frequently demand rigorous training periods to meet the perceptual, motor and cognitive requirements for their successful application. For example, in the field of Medicine, the specialty of Cardiology has been further divided into 10 subspecialty areas (Fuster et al., 2004), most of which are premised on the knowledge and use of high-tech "tools of the trade". Indeed, Medicine has a heady relationship with "machines that go ping" and the profession’s material tool-kit has come a long way from its origins in the humble stethoscope and scalpel. There can be no doubt as to the success of Medicine and its sophisticated modern tool-kit that enables the intricate probing and manipulation of the human body.

However, beyond an ever-growing suite of manufactured, expensive medical tools there exists a class of tool that has important applications in Medicine, that, perhaps due to its more abstract nature, has received less attention than scalpels that glisten, or machines that go ping. Such tools, known as cognitive artefacts (Norman, 1991), constitute the specific type of tool that will be considered in this thesis.

1.02 Beyond "Machines that Go Ping": Cognitive Artefacts as Tools for Medical Practice

Beyond the range of diagnostic and interventional tools that allow medical practitioners to probe, scan, and dissect the human body there exists a group of tools whose primary purpose is to facilitate the tool-users cognitive function (e.g. clinical problem solving). So called, 'cognitive artefacts', i.e. devices concerned with the representational function of information (Norman, 1991), are defined as tools of this type.

As an example of a simple, non-medical cognitive artefact, a piece of string tied around a finger may act as a reminder for a person to do something later. In this case, the purpose of the string is to influence a cognitive process (i.e. prospective memory). More formally, cognitive artefacts have been defined as:

> 'an artificial device designed to maintain, display, or operate upon information in order to serve a representational function.' (Norman, 1991, p. 17)

In this thesis an artificial device, or 'artefact', is defined as 'an object that has been intentionally made or produced for a certain purpose' (Hilpinen, 2011) and will be used interchangeably with the term 'tool'. Whilst in Medicine the term artefact typically suggests misrepresentation of a structure or investigation finding, here, artefacts are seen as products that are intended to enhance practice. Other examples of typical cognitive artefacts include diaries, to-do lists, mathematical formulae, and language. In medical practice, checklists, templates, schedules, assessment scales, and graphs all constitute examples of cognitive artefacts that, perhaps mundanely, inform intimately the cognitive work that comprises the activity of modern health care delivery.

To better understand cognitive artefacts, particularly complex ones, detailed description and analysis is required that, in turn, may better inform practice where increasingly practitioners are challenged to appreciate broader perspectives of health that incorporate a person-centred approach (Strouse, 1996; WHO, 2015). The ongoing development and revision of cognitive artefacts to assist clinicians adopt the changes in practice required for the delivery of authentic person-centred care is fundamental to the success of this approach (West, Barron, & Reeves, 2005). To that end, it is useful to begin by outlining an example of a commonly employed language-based cognitive artefact that has greatly informed medical practice, namely, the medical history.

1.03 The Medical History: A Doctor's 'To-Do' List

A prototypical example of a cognitive artefact in Medicine is the traditional medical history that constitutes something of a medical 'to-do' list for patient consultations of which examples are evident in most introductory medical texts (Longmore, Wilkinson, Baldwin, & Wallin, 2014, p. 20).

The medical history taking format is a long-established approach to learning the basic format of medical consultation that is learnt by all medical students from an early stage of training (Demyer, 2009). The process is typically presented as a list (see Table 1.1) with items addressed sequentially throughout the consultation and documented using this standard approach that is eventually committed to memory. Structured approaches to medical history taking provide an invaluable approach for practitioners to organise the temporal flow of a consultation whilst 'ticking -off' essential topic areas to be covered. In time, using the artefact becomes an automatic process. With automaticity the practitioner can rely less on the externally represented tool and rely instead on an internally represented one (i.e. inside the head) that unconsciously informs behaviour.

Despite the value of the traditional medical history, however, its rational and linear format may inadequately represent real-world experience where complexity, uncertainty and 'mess' frequently underpin a clinical presentation (Heath, 2013). Furthermore, as mentioned earlier, contemporary approaches to medical practice increasingly recognise the value of person-centred approaches where strictly adhering to a profession-centered 'to-do list' may be inadequate alone to address person-centred concerns (Stewart, 2003). In addition, the traditional approach to medical history taking outlined above does not explicitly adopt a whole-of-system view that, as a result, may inadequately represent aspects of reality that may inform problem solving and decision making from a person-centred perspective.

Table 1.1 The Medical History

Medical History
Presenting problem
History of presenting problem
Past Medical History
Family History
Social History
Systems Review
Physical examination
Investigations
Provisional diagnosis
Differential diagnosis
Management Plan

Note. Adapted from Longmore, Wilkinson, Baldwin, & Wallin, 2014, p. 20

The medical history taking approach outlined above represents a typical approach to this essential activity that is reflected in general medical texts (Bickley, Szilagyi, & Hoffman, 2017). The medical history taking format represents one of a multitude of cognitive artefacts available in the practice of Medicine where there is increasing effort directed toward capturing both the complexity and specificity that is understood to underpin current conceptualisations of health and disease (Plsek & Greenhalgh, 2001).

In reality, medical practitioners employ multiple cognitive artefacts that are amenable to degrees and combinations of external and internal representation, thereby making clear boundaries between individual cognitive artefacts difficult to determine (Patel, Arocha, & Kaufman, 2001). Limitations of one cognitive artefact may be addressed through the partial or whole application of another that together inform our models of the world.

Further studies of cognitive artefacts in Medicine and other practice domains hold promise in providing greater insights into the nature of human cognition that rely heavily on both the internal and external representation of information at the level of both the individual and groups (Zhang & Patel, 2006).

1.04 Research on Cognitive Artefacts in Medicine

Research on cognitive artefacts in Medicine falls within the field of Medical Cognition that, in turn, can be viewed as a part of the broader domain of Cognitive Science (Patel et al., 2001). Cognitive artefact studies in Medicine to date have tended to focus on computer interface design and usability considerations by individual practitioners (Polson, Lewis, Rieman, & Wharton, 1992), and distributed cognition systems where multiple artefacts are used by multiple agents working in team settings (Nemeth, Cook, O'Connor, & Klock, 2004; Xiao, 2005). For example, Nemeth et al. (2016) undertook a 3-year project to develop a cognitive artefact for clinical teams working in a Military Burns Intensive Care Unit. This study utilized a participatory design focused on the design and application of an ecologically valid IT system where the goal was to provide a suitable interface for the integration and condensation of large volumes of spatially distributed data. In addition, a small number of studies have considered the use of cognitive artefacts generated by individuals as part of the handover process in healthcare settings (Blaz, Doig, Cloyes, & Staggers, 2016; Wilson, Galliers, & Fone, 2007)

Such work recognises the contemporary view that cognition can usefully be conceptualised as situated, extended, and distributed (Hutchins, 2010; Menary, 2010b). In other words: cognition is typically *situated* in dynamic, real world settings of action and not only in contrived and controlled laboratory environments, it *extends* to involve artefacts outside our heads, and is *distributed* across multiple agents and artefacts. This evolving view of cognition suggests that cognition exists 'beyond the skull' and therefore to understand cognition requires study of cognitive performance in real-world situations that includes the use of artefacts. This approach challenges historical conceptualisations of cognition that locate cognition exclusively inside the brain.

Current studies of cognitive artefacts in medical settings provide important insights into the role of artefacts in distributed cognition, however, are limited in their detailed description of the cognitive artefact design process. Further, there are limited accounts of cognitive artefact use by the individuals involved in their design. Here, a distinction can be made between artefacts that have been created by users to make their own work easier, so-called *endogenous* artefacts, and *exogenous* artefacts developed outside of the workplace that are installed there for use (Jones & Nemeth, 2005). This study will contrast with previous work on cognitive artefacts in Medicine by taking the phenomenological perspective of the medical practitioner involved in the design of an endogenous cognitive artefact used in practice.

1.05 Cognitive Artefacts and Niche Creation

The availability of a burgeoning array of sophisticated and specialised tools, in addition to the significant value they add to our lives, also presents an opportunity cost. As outlined above, cardiologists now assume ten different varieties each reflecting a unique cognitive 'niche' (Clark, 2008) for which the learning and upkeep of specific knowledge that pertains to the niche requires significant effort.

Whilst the development of increasingly specialised cognitive niches has allowed for the proliferation of new roles and skills in Medicine, potential challenges arise when attempting to coordinate and integrate work across specialist areas of practice (WHO, 2015). This may be the case where the specialty is required to function within a broader system e.g. a hospital or health service district. In such settings, practitioners may benefit from developing schemas that promote knowledge that may improve patient experiences and outcomes across the continuum of care. Here, a schema can be defined as 'a high-level conceptual structure or framework that organizes prior experience and helps us to interpret new situations' (Gureckis & Goldstone, 2010, p. 725). Further, schemas provide for the rapid processing of information and help frame the semantic content of a situation.

Such a position paves the way for the development of areas of work that devote themselves to practices that promote integration and coordination in response to the pressures of specialisation experienced by some groups. Examples of this approach are increasingly seen in healthcare and educational settings that are typically captured by the term interdisciplinary (Drinka & Clark, 2000).

Rehabilitation Medicine Practice

1.06 What is Rehabilitation Medicine?

As a medical specialty that brings both a human functional perspective and a traditional biomedical approach to its practice, Rehabilitation Medicine is highly interdisciplinary. To that end, Rehabilitation Medicine is a practice that is arguably sympathetic to cognitive artefacts directed toward the integrated orientation of interdisciplinary work.

The specialty of Rehabilitation Medicine focuses on the assessment and management of disability in the context of health conditions (Braddom, Chan, & Harrast, 2011). As such, Rehabilitation Medicine is concerned with a range of key concepts that include; disability, disease, health and wellbeing, human function, and, quality of life, amongst others. Schematically, these concepts can be considered as a group of overlapping sets that collectively inform Rehabilitation Medicine practice (see Figure 1.1). Such a schema is not exclusive to Rehabilitation Medicine, rather, is reflective of several fields in the health sector that are informed by relatively broad conceptualisations of human experience that manifest across multiple temporal and spatial scales. Examples of similar fields include Primary Care, Geriatric Medicine and Palliative Care. In contrast, other fields of practice exist within Medicine that are (importantly) concerned with a much narrower and often highly technical focus of care directed towards a single body system (e.g. reporting an MRI scan, placing a cardiac stent, excising a skin cancer, etc.).

Figure 1.1 Conceptual Intersections of Rehabilitation Medicine Practice

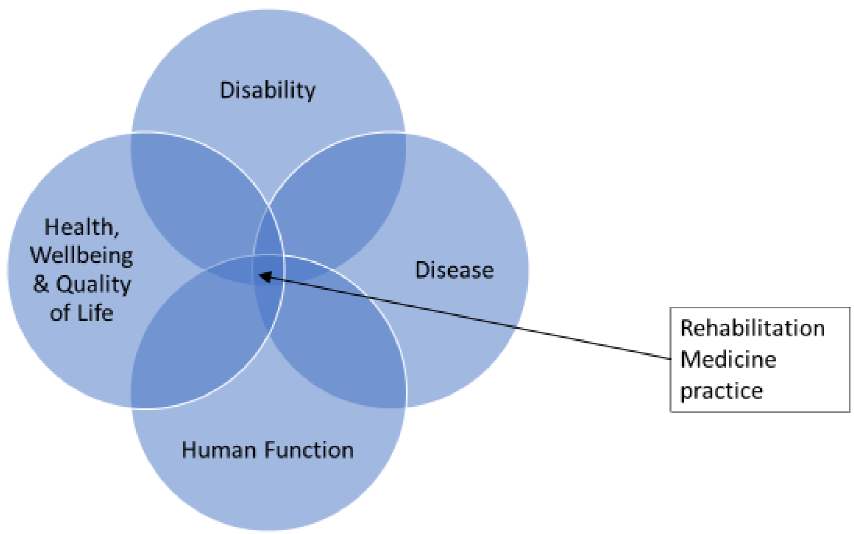

Figure 1.1 Rehabilitation Medicine practice exists at the intersection of several key concepts.

1.07 Complexity in Rehabilitation Medicine

Regardless of practice scope, however, there is an increasing awareness in Medicine and Healthcare of the concept of complexity (Plsek & Greenhalgh, 2001). Complex systems can be defined as those 'in which large networks of components with no central control and simple rules give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution' (Mitchell, 2009, p. 13).

An appreciation of the growing significance of complexity introduces a contemporary challenge for practitioners striving to articulate roles, and also develop a suitable knowledge base for their practice. For fields of practice like Rehabilitation Medicine that seek a broad approach to understanding human experience the challenge is two-fold; firstly, keeping up to date with advances in key conceptual strands that inform the role (e.g. knowledge of disease, disability theory etc.), and secondly, integrating these strands (see Figure 1) so that they reach an acceptable level of coherence (Thagard, 2000).

Mastering these two challenges, however, is necessary for high quality practice particularly in the numerous clinical situations where health conditions (i.e. diseases and disorders) and disability co-exist (AIHW, 2015). In order to coherently address this demand, tools that can integrate these concepts are required (Wade & Halligan, 2003).

An important goal of this thesis, therefore, will be to articulate a position that integrates key concepts informing Rehabilitation Medicine practice where holistic, interdisciplinary practice is a goal. Furthermore, in that a coherent position is sought at all is an attempt to better understand complexity as it pertains to the practice of Rehabilitation Medicine. Understanding the nature of cognitive artefacts that may support Rehabilitation Medicine practice requires further exploration of the nature of problems encountered in the field.

1.08 Problem Types and Solutions in Rehabilitation Medicine

As suggested earlier, much of the complexity experienced in the Rehabilitation Medicine practice role relates to the integration of information across a range of diverse concepts and schemas where the nature of the problem at hand may be poorly defined. Such problems are considered ill-structured and rely heavily on heuristics to generate solutions (Simon, 1973) where heuristics are 'efficient cognitive processes, conscious or unconscious, that ignore part of the information' (Gigerenzer & Gaissmaier, 2011, p. 451). Heuristics provide cognitive shortcuts in the context of intrinsic human brain processing capacity that is significantly limited (Halford, Wilson, & Phillips, 1998). The need for heuristic approaches to solving problems arises from the pragmatic need to deal with what is known as the 'combinatorial explosion' where the number of combinations that one must examine grows exponentially with modest increases in variables (Simon, 1989).

As problem solving in health frequently involves the consideration of many potential variables and combinations, interdisciplinary approaches are often called upon to achieve acceptable solutions. Problems of this type often traverse what is often referred to as the biopsychosocial spectrum (Engel, 1977). To address these problem types, Rehabilitation Medicine practice is premised on teamwork where Rehabilitation teams may take a variety of forms that span multi-, inter- and transdisciplinary structures. The reliance on teamwork in Rehabilitation Medicine reflects the ecological reality of the cognitive problem solving task that requires distribution across people and their environments (Hutchins, 1995; E. Smith & Conrey, 2009).

In Multidisciplinary team settings, Rehabilitation Medicine physicians have traditionally taken on an integrative role within a distributed cognitive network through training that aims to span the biopsychosocial perspective. In this setting, Rehabilitation Medicine practitioners are far from experts in a range of fields but, rather, know *enough* to assist in the dynamic construction of meaning within shared groups that typically include; patients, families, allied health, nursing and other medical specialties as well as non-health professionals (E. Smith & Conrey, 2009, p. 461). To inform this role, language is critical to support both cognition and communication to address problems that are frequently non-linear in nature. For these practice needs to be addressed, tools (i.e. cognitive artefacts) need to be able to capture the complexity inherent in this integrative role.

Beyond problems encountered in direct clinical work (i.e. patient care), the Rehabilitation Medicine physician role is also commonly concerned with educational, research and administrative problems for which tools are required to assist in structuring and solving problems (Mpofu et al., 2016). To that end, tools that can integrate clinical, educational, research and administrative priorities may support a coherent approach to overall practice.

So far in this chapter the symbiotic role of tools in human functioning has been introduced with a focus on cognitive artefacts as an intrinsically human category of tool. The case of cognitive artefacts as an important tool in Medicine has been outlined where cognitive artefacts inform aspects of Medical Cognition. A brief introduction to the field of Rehabilitation Medicine then provided some contextual background to the thesis following which aspects of cognitive artefact design can now be further considered.

1.09 Cognitive Artefact Design in Rehabilitation Medicine: The role of Classifications, Language and Space

This following section will consider an approach to the design of a cognitive artefact for application in the practice of Rehabilitation Medicine. To foreshadow this approach, it has been proposed that 'space, classification, and language are made for each other' (Clark, 2008, p. 66). In this next section, the potential role of classifications, space, and language in informing the design of the study's cognitive artefact will be elaborated.

1.10 Classifications Relevant to Rehabilitation Medicine

Classifications are spatio-temporal segmentations of the world that provide working infrastructures for our actions (Bowker & Star, 2000, p. 10). For Rehabilitation Medicine practice, the WHO Family of International Classifications (WHO-FIC) (Madden, Sykes, & Ustun, 2007) provide a prototypical example of health classifications that could usefully inform cognitive artefact design.

As longstanding, internationally recognised classifications, WHO classifications can be viewed as a legitimate starting point for exploring integrative cognitive artefact design. Indeed, the relationships between WHO classifications are currently being explored and developed that acknowledges the value of an integrative approach to their use (Fortune, Madden, & Almborg, 2018; Tudorache et al., 2010). To date, however, integrating WHO classifications at a deep conceptual and operational level has proved a challenge (Escorpizo, 2013, p. 2) and invites efforts toward conceptual change where such change lies at the creative heart of scientific practice (Nersessian, 2008). A better understanding of the current conceptual relationships between members of the WHO classifications is informed by an appreciation of the classifications themselves.

The WHO FIC

1.11 The ICD: The Basis of Classification in Medicine

As the longest standing member of the WHO FIC, The International Statistical Classification of Diseases and Related Health Problems (ICD) (WHO, 1992) has its origin dating back to a classificatory structure devised by William Farr in 1864 and advanced in Bertillon's *Nomenclatures des Maladies* (Bertillon, 1900; Moriyama, Loy, Robb-Smith, Rosenberg, & Hoyert, 2010). Indeed, the ongoing basic classificatory structure of ICD remains largely unchanged from that first proposed by William Farr over 150 years ago. Most recently ICD has undergone revision with its eleventh iteration now released with plans for use from 2022 (WHO, 2018b).

1.12 The ICF: Classifying Human Function

In contrast to ICD, The International Classification of Functioning, Disability and Health (ICF) is a much more recent health classification that, in the presence of a health condition, considers broader human functional domains relevant to the experience of disability and health for which the environment and personal factors assume an important contextual role. Historically, the ICF was proceeded by the ICIDH that lacked explicit consideration of contextual factors (e.g. the environment) and viewed disability as a consequence of disease (WHO, 1980). The ICF is seen as complementary to ICD, where the latter classification is premised on the biomedical approach to health as viewed from a framework of health conditions (i.e. diseases and disorders). The recent ICD revision includes improved integration with the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) where, as indicated above, database interoperability between these classifications is a major goal of this work. Despite this improved integration, it is recognised that the process of aligning concepts across the three WHO FIC reference classification is far from complete and that the WHO vision is for an underlying logical structure, or ontology, to ultimately inform the WHO FIC (WHO, 2018a).

1.13 ICHI: Classifying Health Interventions

Most recently, the International Classification of Health Interventions (ICHI) has been developed that, when complete, will round out the trio of WHO-FIC reference classifications (Madden et al., 2007; WHO, 2013). These three classifications; ICD, ICF and ICHI, will form the basis of frameworks that inform Rehabilitation Medicine practice as conceptualised in this study. In order to capitalise on the potential for classifications to better inform practice, the design and application of tools are necessary steps (A. Rauch, Cieza, & Stucki, 2008) and these factors will be considered in the next section.

Cognitive Artefact Design

1.14 Using Space in Cognitive Artefact Design

In proposing the integrated use of the multiple classifications outlined above, a necessary design step involves an ability to represent these classifications concurrently in space to practically support the problem-solving goals of Rehabilitation Medicine practice.

Indeed, as suggested above, classification and space are intimately related with the former reliant on the latter to provide a background for category relationships that underpin classifications. Categories exist in relationships that are constructed in spatial terms such as below and above, for example, when referring to hierarchical positions. Things in space (symbols etc.) foreground an ever present spatial background that together inform human cognition where both internal mental space (mental models, cognitive maps etc.) and externally represented space (e.g. diagrams, maps, graphs, metaphoric space) are recognised as highly relevant (Tversky, 2005). The importance of spatial representation of information and its relationship to important cognitive functions such as memory have recently been described (Moser, Moser, & McNaughton, 2017). More specifically, space can be represented both internally, as visual imagery, and externally in the world, for example, as 2-dimensional grids on a page. The concept of internal visual imagery is now an accepted cognitive ability for which an improved of understanding of its role to support mnemonic capabilities accessible in visual working memory tasks continues to develop (Keogh & Pearson, 2011; Kosslyn, 1973). Moreover, it is also known that there are significant inter-individual differences in the way in which individuals are able to access and utilise visual working memory capacities (Cornoldi & Vecchi, 2004). As a typical building block for classification, language is also represented using space with some arguing that space itself provides a powerful metaphor for the basis of much language (Lakoff, 1987).

1.15 Linearity: Moving from A to Z

As suggested earlier, Medical history taking is a universal example of organising information for problem solving and documentation in medicine that is linear in design. Here linearity means that events progress from one stage to another in a single series of steps for which space provides an underlying organisational framework. Similarly, a linear approach to cognitive artefact development is also evident in the recently published WHO Surgical Safety Checklist that has resulted in significant reduction in error and subsequent harm in operating room environments (Bergs et al., 2014). Information arranged in a linear way in space, such as the aforementioned checklist, lend themselves well to standardised practice routines where standardisation is increasingly held as a highly valued goal in health care delivery (Rozich et al., 2004). The desire for standardisation in fields such as health reflect a broader societal enchantment with standards that may neglect the requirement for workarounds in situations where standardisation is difficult to attain (Lampland & Star, 2009, p. 4).

1.16 The Limits of Linearity

Despite the success of linear approaches in documenting information and safely organising workflow in many areas of medical practice, the degree to which standardised linear approaches can work equally across all medical practice settings is questionable (Heath, 2013). For example, the important role of non-linearity in understanding the care continuum for stroke patients and their families has been acknowledged (Ghazzawi, Kuziemsky, & O'Sullivan, 2016). Assuming this premise, there is room for exploration of cognitive tools that move beyond traditional, linear approaches to information representation that could better capture the non-linear complexity of certain practice settings. Indeed, it has been suggested that the key to problem solving is adequately representing the problem to be solved (Jonassen, 2003). Accordingly, this study assumes that Rehabilitation Medicine cognitive artefacts would benefit from representational properties that are sympathetic to non-linear complexity. The use of 2 dimensional spatial arrays provide one example of how complex, non-linear processes can be represented (Wolfram, 2002).

Current Tools

1.17 Current ICF-based tools

In that the subject matter of Rehabilitation Medicine practice (presumptively) reflects non-linear complexity it is useful to consider to what extent this is captured by currently available ICF tools. As the most developed set of ICF tools, the ICF core sets (Bickenbach, 2012) comprise several sets of categories selected from the full ICF classification developed for various health care contexts, health conditions and condition groups, e.g. ICF Core Set for Multiple Sclerosis in long-term care. Currently there are approximately 30 Core Sets available for health conditions across acute, post-acute and long-term care.

The ICF core sets have been proposed as a means of putting the ICF into practice and, in particular, to provide a means of standardisation from which comparison across settings providing Rehabilitation care can be made (Bickenbach, 2012, p. 3). Appropriately, the ICF Core Sets comprise a suite of tools that are premised on the cyclical nature of problem solving typical of Rehabilitation processes. However, research suggests challenges arise in real-world application due to the administrative burden associated with completing standardised assessment forms (A. Rauch et al., 2008). The ICF core sets themselves, whilst developed in consultation with clinicians, were developed 'off-line' during expert consensus conference processes premised on pre-determined statistical methodology (Cieza, 2008) that may not reflect the requirements of situated cognition in practice (Robbins, 2009). Here, tensions may exist between exogenous and endogenous artefact design that impacts on end-user uptake in practice with the ICF Core sets representing the former artefact type.

There can be no question that standardised application of classifications in practice settings is a laudable goal, however, in applying the ICF in practice the goal of standardisation should not be put ahead of important considerations about the nature of practice when considering the design of cognitive artefacts. Indeed, the need for human-centered design of classifications themselves has been raised (Zhang, 2002) that reflects a current, broader concern for human-centered design (Norman, 2013). Further, the success of applying the ICF in practice based on currently available approaches has been questioned which may reflect, in part, an under emphasis on the aforementioned human-centered principles of cognitive artefact design (Wiegand, Reinhardt, Belting, Fekete, & Gutenbrunner, 2012).

This thesis takes the view that further exploration of ICF tool design is crucial to the development of cognitive artefacts that are sympathetic to the nature of the task involved. In that the task of practice is essentially a cognitive one, primacy is given to better understanding the place of situated cognition in tool development that recognises the ecological nature of cognition (Hutchins, 2010). Furthermore, tools suitable for practice benefit from their capacity, as described by Heidegger, to be 'ready-to-hand' where tools of this kind become skilfully manipulated to the degree that awareness of the distinction between the user and tool disappear (Wheeler, 2018). In such circumstances we demonstrate skilful coping (Dreyfus & Wrathall, 2014). With these ideas in mind, concerns about standardisation of cognitive artefacts, although important, become a secondary matter for consideration and not a primary concern for this study.

Instead, this thesis places a high value on themes such as Gestalt representation, coherence, situation awareness, and integration that are viewed as significant in the development of higher level conscious experience (Köhler, 1947; Singh, 2006; Thagard, 2000; Tononi, 2008) of which complex practices like Medicine are surely examples. These themes have been important in Psychology, Philosophy and Information Science and foreshadows a need to adopt an interdisciplinary approach to the development of this thesis. As a discipline, Cognitive Science aims to adopt these multiple perspectives that also acknowledges the role of linguistics in the understanding of cognition (MIT, 2014; Thagard, 2012).

How the goals of this thesis are best achieved raises important questions of methodology; on the one hand, abstract-theoretical approaches can be used, or, alternatively, experiential approaches can be applied grounded in practice. This thesis will take the latter approach whilst being cognisant of the former. Prior to discussion of methodology, the following section more clearly states the aims, questions and objectives of this research.

Study Considerations

1.18 Problem Statement

Using the WHO-FIC reference classifications (i.e. ICF, ICD and ICHI) together in Rehabilitation Medicine practice is limited by a lack of suitable clinical tools. Tools developed to date are limited in their capacity to address the dynamic complexity of Rehabilitation Medicine clinical problems where simultaneous use of the reference classifications is likely to be advantageous, and where tools need to be ready-to-hand to permit skillful coping in situated practice. Attempts to address these limitations may better inform the development of suitable tools for Rehabilitation Medicine practice based on the WHO-FIC.

1.19 Research Aims and Questions

The main aim of this thesis is to provide a detailed account of the lived experience of cognitive artefact design based on the WHO-FIC for use in the practice of Rehabilitation Medicine in an Australian setting. To do this, phenomenology is used as the research approach which is described in a subsequent section on methods. Furthermore, arising from this phenomenological account, the thesis aims to provide a conceptual analysis of the WHO FIC from the perspective of integration.

The research questions for this study are:

1. What is the phenomenological experience of using the WHO-FIC in the practice of Rehabilitation Medicine?

2. What cognitive artefact/s can emerge from this experience?

3. What are the design characteristics of the cognitive artefact?

4. How does the cognitive artefact inform the practice of Rehabilitation Medicine?

1.20 Research Objectives

Underpinning the research questions above are the following set of research objectives that will be addressed throughout the thesis:

1. To describe the design of a phenomenologically derived cognitive artefact, based on the WHO-FIC, for use in the practice of Rehabilitation Medicine.

2. To analyse the cognitive artefact from a Cognitive Science perspective.

3. To better inform the theoretical position of Rehabilitation Medicine practice within the broader context of Health.

1.21 Methodological Approach

This section begins by providing the broad philosophical context for the study following which specific considerations of method relevant to the research aims are outlined.

1.22 Philosophical Context and Orientation

Questions of 'what constitutes reality?' (ontology) and 'how we can come to know it?' (epistemology) comprise central, enduring themes in Western Philosophy. All research endeavors, whether stated explicitly or not, make some commitment to an ontological and epistemological position by virtue of the research methods used. In turn, choice of methods is informed by the research aims, and questions posed. An important goal of this section, therefore, is to sketch out the ontological and epistemological assumptions of this study from which any subsequent knowledge claims, however tentative, may arise.

Furthermore, a study's ontological and epistemological commitments ideally inform the selection of appropriate research methods (i.e. subject selection and data collection, description, and analysis) that, when well aligned, provide the reader with a clear opportunity to best evaluate the researcher's knowledge claims. To that end, the task of adequately articulating the specific research methods for this study constitutes another important goal of this section.

The three broad aims of this study are; 1) to provide a detailed account of a single (i.e. idiographic), first-person experience of using the WHO-FIC as an integrated suite of classifications in the practice of Rehabilitation Medicine, 2) to analyse this experiential account from a broad cognitive science perspective, and, 3) to provide *practice-level* theoretical perspectives on the WHO-FIC as an integrated suite of classifications.

In considering the first of these aims, the desire to provide a detailed account of the first-person experience, quickly focuses questions on the ongoing philosophical debate about how, if at all, such an aim can be satisfactorily achieved. At the heart of the debate is the question of how the subjective experience of a person (i.e. consciousness) can be objectively verified by another? In this case, objective verification is held as a fundamental criterion for establishing knowledge in the empirical sciences that is informed by philosophical empiricism. Consequently, the study of first person experience presents something of a methodological conundrum for the empirical sciences at a time when significant research efforts are being directed toward understanding the human brain and mind. Understanding consciousness represents something of a holy grail within the field of cognitive science that has been dubbed as the 'hard problem' (Chalmers, 1995).

Concerted efforts toward better understanding the problem of conscious first person experience in the field of philosophy occurred with the work of Husserl who is widely considered the founder of the philosophical movement known as phenomenology (Zahavi, 2003).

The next section introduces phenomenology as the major philosophical focus of this study which informs its ontological and epistemological commitments and, in part, its specific methods.

1.23 Phenomenological Inquiry

The philosophical movement that has come to be known as phenomenology has exerted a significant influence over the direction of philosophy as a formal discipline yet remains controversial in its interpretation and methods (Gallagher & Zahavi, 2012). The development of Phenomenology as a formal discipline within the field of Philosophy originates with the work of Husserl who famously proposed to go 'back to the things themselves' where 'things' comprise our experiences of the world as we live it. With this proposal, Husserl saw an opportunity to refocus philosophy from what he believed was an increasingly abstract practice that was moving further away from relevant issues of life. In particular, Husserl became concerned with the idea of consciousness and proposed phenomenology as a method for consciousness to become known. Husserl argued that current practices directed toward understanding consciousness, namely psychologism, were epistemologically wedded to formal logic which itself was too abstractly distanced from the subject matter (i.e. consciousness) to be of value in understanding it.

Despite its significant influence as a movement during 20th century philosophy, phenomenology nonetheless remains contentious and has been widely interpreted by the diverse group of philosophers who have continued, in their own way, Husserl's approach. Of these philosophers, Heidegger, Sartre, and Merleau-Ponty are generally considered significant contributors to the phenomenological movement (Gallagher, 2012).

A phenomenology of classification use in Rehabilitation Medicine practice allows exploration of taken for granted aspects of practice that may become apparent in situations of cognitive dissonance (Gallagher, 2012, p. 41). Recently, interest in phenomenological approaches has developed in the field of Cognitive Science where the importance of phenomenology as an approach to better understanding questions of consciousness is recognised. Consistent with the history of phenomenology, despite recognition of its potential value in advancing the goals of cognitive science, how phenomenology is practiced as a method remains controversial (Dennett, 2003). This study uses phenomenology as the main methodological approach where phenomenology can been defined as 'the study of structures of consciousness as experienced from the first-person point of view' (D. Smith, 2013).

1.24 Rationale for Using Phenomenology

According to contemporary views of phenomenology, conscious experience concerns notions such as: intentionality, temporality, perception, embodiment, action, how we know others, and self (Gallagher & Zahavi, 2012). Taking phenomenology as a starting point could then form the basis for the development and analysis of consciously informed cognitive artefact development in Rehabilitation Medicine where intention is focused on holistic application of the WHO-FIC in practice.

Importantly, the goal here is one of phenomenological exploration and description where the benefit of applying phenomenological methods is that of 'front-loaded' philosophical work that may usefully inform future empirically directed scientific enquiry (Gallagher & Zahavi, 2012, p. 44). Further, cognitive artefacts may broadly be considered idiosyncratic, as developed by single users, or standardised, where use is across groups (Heersmink, 2014). Given the apparent challenge of moving straight to standardised cognitive artefact use across groups, this study adopts a more cautious approach to cognitive artefact development that begins with a thorough account of experience of an idiosyncratic cognitive artefact that can then be analysed based on proposed criteria (Heersmink, 2013).

To that end, the limitation imposed by the study methodology (i.e. phenomenology) relates to the generalizability of the claims (i.e. to other practitioners). Despite this, the study constitutes an example of the sort of work that may be required to move closer to a better understanding of the nature of human cognition given the limits of conventional approaches to studying consciousness from the 'outside in'.

Further, in both the description and analysis of the cognitive artefact the use of analogy will be employed where analogy has been proposed by some as a fundamental component of cognition (Gentner, 1983; Hofstadter & Sander, 2013). Examples from the cognitive science (Lakoff, 1987), complexity science (Wolfram, 2002), and mathematics (Petkov, 2010) literature provide rich sources from which analogical reasoning in relation to the proposed cognitive artefact can occur.

1.25 Study Context

The study is situated in the field of Rehabilitation Medicine practice in the New South Wales Public Health system in Australia. The study concerns the experience of a single practitioner in this study setting where the object of study is an idiosyncratic cognitive artefact (see Figure 1.2) developed in the course of Rehabilitation Medicine practice by the study author. The artefact is informed by the phenomenological experience of using the WHO-FIC in practice (i.e. ICD, ICF and ICHI). In this sense, the study can be viewed as idiographic where this term infers the research subject is a given person, in a given context, making sense of a given phenomenon (Finlay, 2012). Figure 1.2 comprises an adapted 2-dimensional arrangement of the main chapter headings of the WHO ICF where the blue highlighted headings correspond to the 'Environment' chapters, the green headings to the 'Activity and Participation' chapters, with the orange headings based on a modified list of the 'Body Structure and Function' chapters. Whilst based on the ICF the artefact also aims to function as a framework for aiding in the understanding of clinical issues relevant to ICD and ICHI. The development of the artefact is described in detail in subsequent chapters.

Figure 1.2. Study Artefact

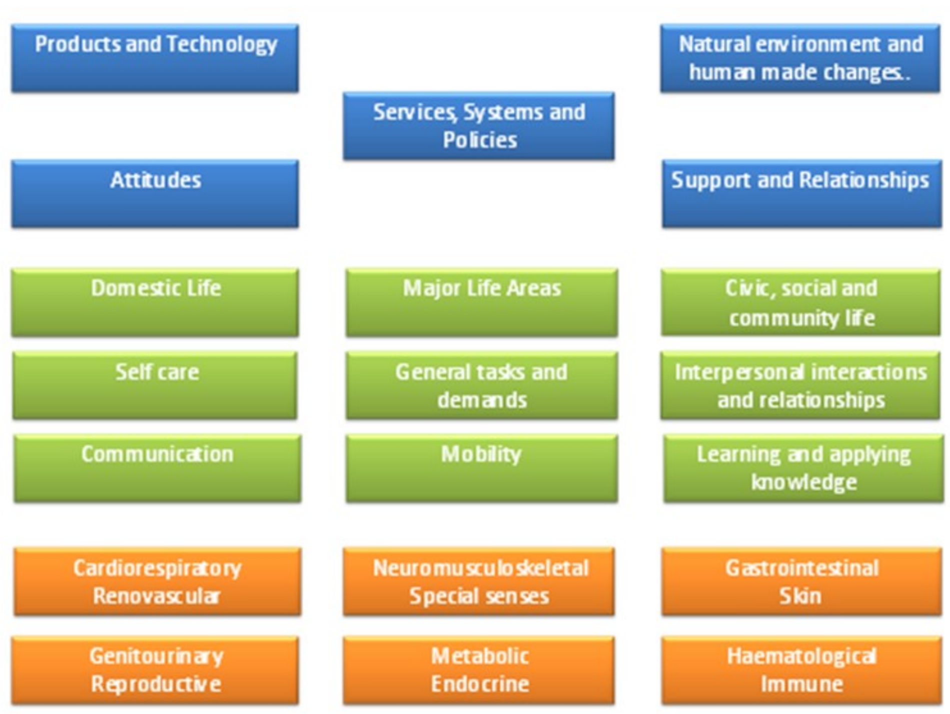

Figure 1.2. Cognitive artefact as basis for current study.

1.26 Ethical Considerations

This study is primarily informed by an idiographic phenomenologically-informed experience of practice and focuses on the description and analysis of cognitive artefacts. To assist in describing the use of the cognitive artefact, brief vignettes are used that are based on plausible, composite, hypothetical cases drawn from the author's experience as a practicing medical doctor and Rehabilitation Medicine physician. As such, formal ethics approval for this study was not deemed relevant.

Conclusion

Sophisticated tool design and application define our species for which cognitive artefacts play an essential role in complex cognitive activities that span individuals and groups alike. Cognitive artefacts inform practice in ecological settings such as formal work environments of which Rehabilitation Medicine provides a compelling example. Rehabilitation Medicine practice provides a setting where cognitive artefact design efforts may be employed to better inform practice goals premised on the management of complexity. Language-based classifications such as the WHO-FIC provide a potential basis for an integrative cognitive artefact design that recognises the importance of space in representing information during situated cognitive tasks such as clinical problem solving. Phenomenologically informed cognitive artefact development and conceptual analysis represents one approach that may assist in moving closer to the integrated application of WHO classifications in the increasingly complex environment of Medicine and Health Care where holistic approaches to person-centered health approaches are desired.

Chapter 2: Literature Review

Cognitive Artefacts

The previous chapter introduced the major interdisciplinary themes of the study, namely; cognitive artefacts, medical practice, and classifications. In this chapter these themes will be explored further with the goal of providing a more detailed contextual background for the study.

In line with the structure of the introductory chapter, cognitive artefacts will be discussed initially with a focus on their use in the practice of Medicine. Next, the development and status of classifications in Health will be outlined in further detail with emphasis on the WHO FIC. Following this, approaches to the application of the WHO FIC in practice will be explored focusing on existing Rehabilitation Medicine artefacts. Lastly, aspects of cognitive science in relation to cognitive artefact design in medicine will be considered. It is hoped that by the conclusion of this chapter the reader will be better positioned to appreciate the methodological approach taken in this study that is outlined in the subsequent chapter.

2.01 A Brief History of Cognitive Artefacts

The scientific study of cognition has moved ahead enormously over recent decades through the complementary efforts of several disciplines that together comprise the cognitive sciences (Chipman, 2017). However, there remains much to learn about cognition. In part, the challenge of studying cognition arises in defining clearly what cognition is and what it is not (Varela, Rosch, & Thompson, 2017). Traditional views of cognition hold that cognitive processes are confined to the brain alone. In other words, studying just the brain will provide all the answers we seek about cognition. However, contemporary views of cognition challenge this classical view by recognising the role of the body and the broader environment as an integral part of cognitive processes (Clark, 2008; Malafouris, 2013; Menary, 2010a). This conceptual shift regarding the nature of cognition has led to the formal notion of cognitive artefacts which were introduced and defined in the previous chapter.

As important environmental components that contribute to cognitive systems, cognitive artefacts are more recently being considered in their own right giving rise to a nascent field of study (Norman, 1991). As an example, the emerging nature of this field is reflected in recently proposed taxonomies of cognitive artefacts that aim to provide a descriptive framework to guide future cognitive artefact research (Heersmink, 2013). Additionally, the contribution of phenomenological accounts of how humans experience cognitive artefacts in the setting of the current technological revolution has also been identified (Dourish, 2004). More specifically, the role of cognitive artefacts in better understanding health care cognition has been established (Nemeth, Connor, Klock, & Cook, 2006).

In contrast to the early stage of development of a more formal cognitive artefact research program, the use of cognitive artefacts by humans likely predates recorded history (Kelley & Francis, 2005). As a result, there is a veritable treasure trove of cognitive artefacts in existence ripe for study that might better inform how cognitive artefacts are both understood, designed, and applied.

Given the high prevalence of cognitive artefacts in use, it is beneficial at this point to narrow the focus to consideration of cognitive artefacts in Medicine. Such an approach will provide a useful counterpoint to the cognitive artefact that will be the focus of this study.

Medical Cognitive Artefacts: Further Examples

The previous chapter introduced the idea of the Medical History as a prototypical example of a cognitive artefact in medicine that fundamentally informs the basis of medical practice. This section expands the theme of cognitive artefacts in Medicine to highlight their pervasive presence and diverse nature.

The idea of a device that can 'maintain, display, or operate upon information' (Norman, 1991) for representational purposes encompasses a potentially large number of objects that could be defined as cognitive artefacts that are used in medicine. As such, it is beyond the scope of this study to attempt a robust cataloguing of medical cognitive artefacts to which the artefact for the present study might be compared. Instead, focusing on a few common, typically paper-based examples of cognitive artefacts used in medicine provides useful comparison to the artefact that is subsequently described in this study. In doing so, outlining these examples aims to show the way in which cognitive artefact design might exploit particular cognitive abilities that helps inform cognitive artefact design considerations.

The few examples provided focus on artefact structures that use linguistic, pictorial, numerical and diagrammatic representational formats as their basis. The following examples of lists, scales, tests, questionnaires, maps and graphs provide a sampling of common artefacts in medicine that expand that of the medical history outlined in the previous chapter.

2.02 Lists

As outlined in the introductory chapter, the role of lists in Medicine as a typical structure for cognitive artefacts is uncontroversial. From a cognitive perspective lists provide a linear representational structure that guides practice in an orderly manner. Lists typically take the form of language-based questionnaires and checklists. The value of lists as cognitive artefacts is exemplified with the recent introduction of the WHO surgical checklist (Haynes et al., 2009).

2.03 The WHO Surgical Checklist

The WHO surgical checklist (see Figure 2.1) is a standardised list of operating theatre tasks that are arranged sequentially in order of performance that has been shown to significantly improve outcomes for surgical patients (Haynes et al., 2009). This example of a successful cognitive artefact in Medical practice reflects the value of a linear approach to the execution of predetermined tasks. In the case of the WHO surgical checklist, items are checked-off at three distinct time points and by at least two staff members at each of these points during the process; before anaesthesia is given, before the surgery begins, and before the patient leaves the operating theatre.

Despite the strong evidence for the benefit in using the WHO surgical checklist, and its apparent simplicity of use, there has been some difficulty with its consistent application to practice that reflects the real-world challenge of situated cognitive artefact use in group settings(O'Connor, Reddin, O'Sullivan, O'Duffy, & Keogh, 2013). Such difficulties with translation reflect the view that cognitive artefacts exist on a spectrum of idiosyncratic, individualised usage through to widespread standardised usage. A range of factors influence uptake that reflect both the properties of the artefact itself as well as the properties of the agents that use them (Agarwal, Sambamurthy, & Stair, 1997).

Figure 2.1. WHO Surgical Safety Checklist

Surgical Safety Checklist

World Health Organization | Patient Safety
A World Alliance for Safer Health Care

Before induction of anaesthesia

(with at least nurse and anaesthetist)

Has the patient confirmed his/her identity, site, procedure, and consent?
- ☐ Yes

Is the site marked?
- ☐ Yes
- ☐ Not applicable

Is the anaesthesia machine and medication check complete?
- ☐ Yes

Is the pulse oximeter on the patient and functioning?
- ☐ Yes

Does the patient have a:

Known allergy?
- ☐ No
- ☐ Yes

Difficult airway or aspiration risk?
- ☐ No
- ☐ Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?
- ☐ No
- ☐ Yes, and two IVs/central access and fluids planned

Before skin incision

(with nurse, anaesthetist and surgeon)

- ☐ Confirm all team members have introduced themselves by name and role.
- ☐ Confirm the patient's name, procedure, and where the incision will be made.

Has antibiotic prophylaxis been given within the last 60 minutes?
- ☐ Yes
- ☐ Not applicable

Anticipated Critical Events

To Surgeon:
- ☐ What are the critical or non-routine steps?
- ☐ How long will the case take?
- ☐ What is the anticipated blood loss?

To Anaesthetist:
- ☐ Are there any patient-specific concerns?

To Nursing Team:
- ☐ Has sterility (including indicator results) been confirmed?
- ☐ Are there equipment issues or any concerns?

Is essential imaging displayed?
- ☐ Yes
- ☐ Not applicable

Before patient leaves operating room

(with nurse, anaesthetist and surgeon)

Nurse Verbally Confirms:
- ☐ The name of the procedure
- ☐ Completion of instrument, sponge and needle counts
- ☐ Specimen labelling (read specimen labels aloud, including patient name)
- ☐ Whether there are any equipment problems to be addressed

To Surgeon, Anaesthetist and Nurse:
- ☐ What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged. Revised 1 / 2009 © WHO, 2009

Figure 2.1. The WHO Surgical Safety Checklist provides an example of a structured, linear documentation process designed for surgical environments (Haynes et al., 2009).

2.04 Tests, Scales and Questionnaires

Another group of related cognitive artefacts used in medicine are tests, scales and questionnaires that, unlike the aforementioned checklist, are typically designed to be completed by a single user on a single occasion. Again, these artefacts are usually structured in a linear fashion where the informant typically responds to a sequential list of linguistically-based questions where responses may be categorical, numerical or ordinal. Information from these formats may be then used later either qualitatively or quantitatively and compared against standardised information to assist in cognitive processing of information. e.g. Geriatric Depression Scale Short Form (see Figure 2.2) (Yesavage, 1988).

Figure 2.2. The Geriatric Depression Scale

Geriatric Depression Scale (Short Form)

Patient's Name: ______________________ Date: __________

Instructions: Choose the best answer for how you felt over the past week.

No.	Question	Answer	Score
1.	Are you basically satisfied with your life?	YES / NO	
2.	Have you dropped many of your activities and interests?	YES / NO	
3.	Do you feel that your life is empty?	YES / NO	
4.	Do you often get bored?	YES / NO	
5.	Are you in good spirits most of the time?	YES / NO	
6.	Are you afraid that something bad is going to happen to you?	YES / NO	
7.	Do you feel happy most of the time?	YES / NO	
8.	Do you often feel helpless?	YES / NO	
9.	Do you prefer to stay at home, rather than going out and doing new things?	YES / NO	
10.	Do you feel you have more problems with memory than most?	YES / NO	
11.	Do you think it is wonderful to be alive?	YES / NO	
12.	Do you feel pretty worthless the way you are now?	YES / NO	
13.	Do you feel full of energy?	YES / NO	
14.	Do you feel that your situation is hopeless?	YES / NO	
15.	Do you think that most people are better off than you are?	YES / NO	
		TOTAL	

Scoring:

Assign one point for each of these answers:

1. NO	4. YES	7. NO	10. YES	13. NO
2. YES	5. NO	8. YES	11. NO	14. YES
3. YES	6. YES	9. YES	12. YES	15. YES

A score of 0 to 5 is normal. A score above 5 suggests depression.

Figure 2.2. The Short Form version of the Geriatric Depression Scale provides a standardised, 15-item closed question list for the screening of depression in the Older Person (Yesavage, 1988).

In the field of Rehabilitation, the application of scales is widespread with instruments such as the Functional Independence Measure (FIM) having near universal application across rehabilitation settings (UDSMR, 2019). As with many of the above examples, the FIM also uses a top-to-bottom list of items that comprise the scale.

2.05 Maps and Diagrams

In addition to checklists, questionnaires, tests and scales, pictorial maps are also frequently used as cognitive artefacts in Medicine. In the example below, examination findings can be mapped directly onto a specialised body-map, in this case for documenting spinal cord function, that serves as an external aid to memory, as a form of communication between clinicians, and to assist with the task of diagnostic reasoning and planning (see Figure 2.3).

Figure 2.3. ASIA Spinal Cord Injury Classification Chart

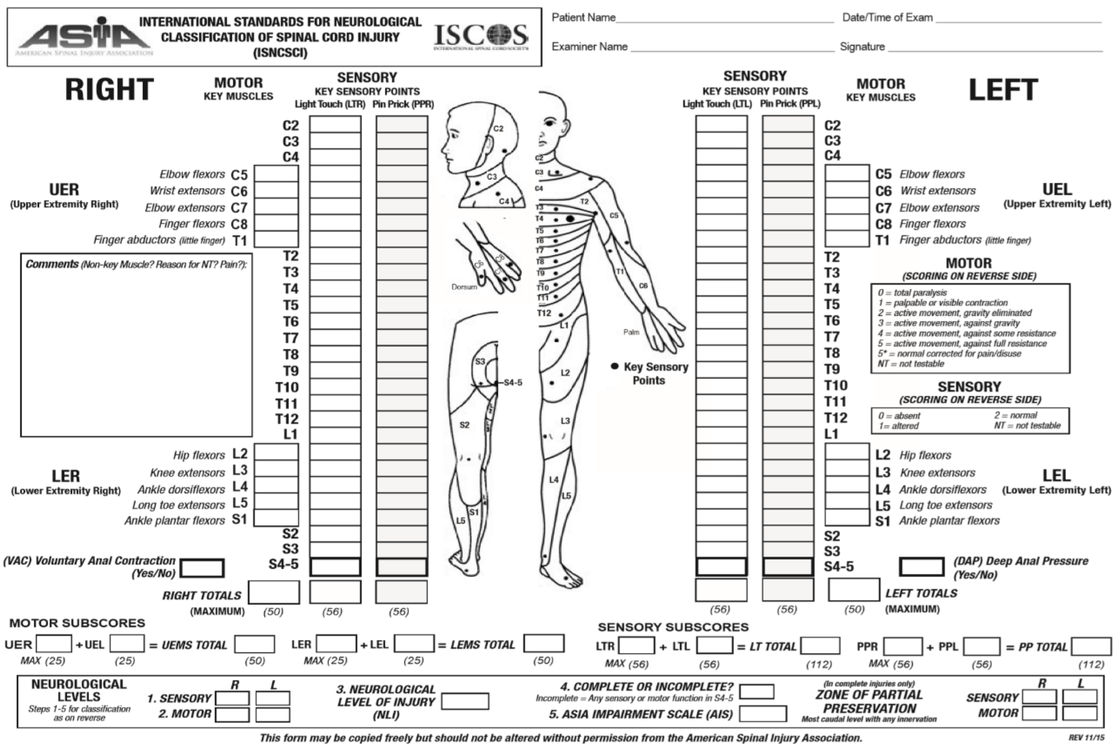

Figure 2.3. A standardised body-map for charting motor and sensory impairments arising from spinal cord injury. (ASIA, 2015)

2.06 Charts and Graphs

Another common type of cognitive artefact used in the practice of medicine are charts and graphs with typical examples being medication and observation charts (see figure 2.4) (Cahill et al., 2011).

Figure 2.4. Standard Adult General Observation Chart Example

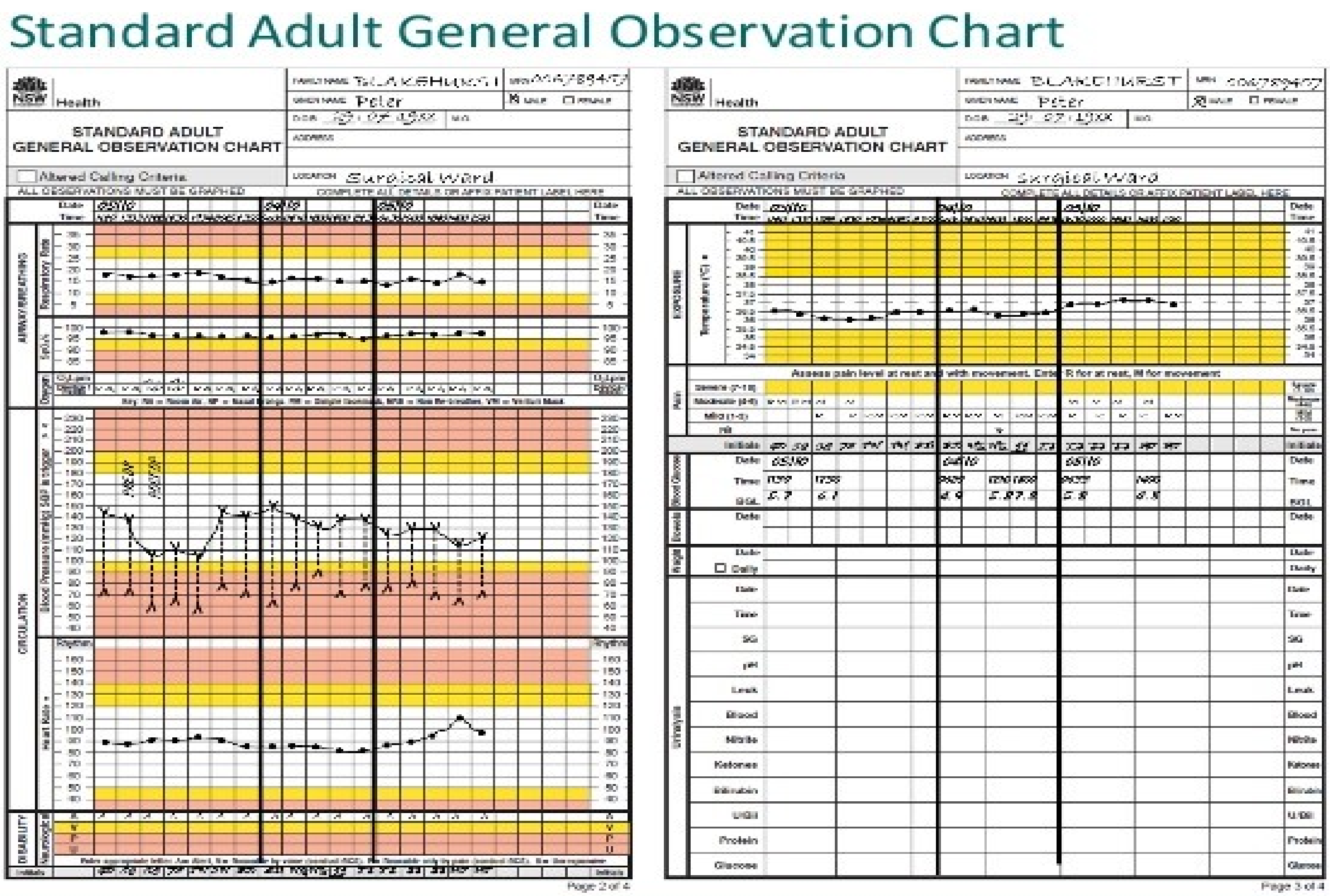

Figure 2.4. Example of a Standard Adult General Observation Chart. This chart shows a chart typically used in the recording and display of patient 'vital signs' such as heart rate, blood pressure, temperature and pulse. Adapted from Hughes, Pain, Braithwaite, and Hillman (2014).

2.07 Letters and Summaries

Extended linguistic cognitive artefacts are frequently encountered in the form of written correspondence such as letters and patient summary documents that provide vehicles for communication that can influence cognitive processes of their recipients as well as serve as a memory aid for future use by its author over time (McConnell, 1999).

2.08 Guidelines

More recently, to provide evidence-based information and treatment recommendations for a range of common conditions there has been considerable development and propagation of practice guidelines developed by expert working groups. This trend for guideline development has been met with mixed success as uptake in real world settings by clinicians may be limited (Gagliardi, 2011). These difficulties suggest the practical limitations of generic guideline documents in meaningfully addressing the complexity of real-world practice.

2.09 Medical Calculators

Increasingly, the practice of medicine exploits statistically driven calculation tools for which computer software programs provide the basis for the cognitive artefact (Bierbrier, Lo, & Wu, 2014). Such tools typically aim to assist the clinician in decision making regarding the risk of either developing a particular medical condition (e.g. diabetes or heart disease) or to assist in decision making about treatment (e.g. atrial fibrillation). Beyond medical calculators, decision support software is increasingly embedded within systems such as electronic prescription tools that prompts the user to consider, for example, drug interactions, that may lead to an adverse outcome. Indeed, with the rise of artificial intelligence in the 1980's, considerable hope was placed in the ability of computer-based decision supports to subsume the role of the physician. However, the initial enthusiasm for artificial intelligence as a panacea for difficult decision making has been moderated considerably with the subsequent appreciation of the complexity of real-world human problem solving (Szolovits, 1982). Considering this, it would appear that humans will continue to play a fundamental role in the often-messy task of cognition in many endeavours (e.g. Medicine) that, in turn, demands an understanding of the tools we use to support it.

Context of Cognitive Artefact Use

2.10 Task Environment Considerations

The above examples of commonly encountered cognitive artefacts in Medicine reflect the needs of their users across a broad range of task environments and contexts of use. For example, the WHO Surgical Safety checklist provides a common focus for a team of clinicians who share the common goal of optimal surgical outcome in a highly constrained spatial and temporal environment (i.e. performing an operation) where the emphasis is on stringent adherence to an unambiguous, predetermined, linear sequence of events. A simple checklist is well suited to this task that is reflected in the representational structure and function of the cognitive artefact in question. As another example, observation charts permit the scheduled accumulation of data over a variable period that may extend over weeks, whilst scales may be administered in minutes but scored, interpreted, repeated and compared over longer durations and locations.

Increasingly, completed cognitive artefacts, like questionnaires are diligently stored as part of the burgeoning systems of information for later use (Bowker, 2005). Characteristically, the cognitive artefacts described above are typically linear in design which provides users with an ordered approach to completion of the cognitive artefact leading to procedural efficiency and standardised, retrievable documentation. Such an approach to the design of cognitive artefacts also reflects the nature of the task being performed for which agreement is often self-evident; people want their operation performed in the correct sequence, or the record of their vital signs to reflect the time sequence in which they occurred. Clinical problem solving and decision making, however, is understood to be sufficiently complex that certain cognitive artefacts may be required that are more ephemeral in nature and less amenable to linear formats (Heath, 2013). To that end, developing a line of cognitive artefacts that are sympathetic to the non-linear and non-deterministic aspects of complex problem solving is essential if an improved understanding of cognitive artefact design and use in Medicine is sought.

The examples of cognitive artefacts described above represent an infinitesimally small number of the available cognitive artefacts used in Medicine for which their users seamlessly switch between, combine, and adapt, to inform complex cognitive practices that underpin clinical work (Nemeth, O'Connor, Klock, & Cook, 2005). Given the degree of specialisation in Medicine, the cognitive artefacts that have been developed to inform and promote such specialisation similarly reflect this and as such their ability to bring together or integrate information across a broad range of cognitive artefacts may be limited.

For many areas of medical practice, however, the role of the practitioner is to integrate information from a variety of cognitive artefacts, that in isolation may not fully inform competent practice (Nemeth et al., 2006). Cognitive artefacts in medicine that strive to achieve this integrative function are therefore necessary.

2.11 Intentionality, Agents and Agency

Implicit in the design of any cognitive artefact is that it will support, in some way, its user’s intentions where intentionality pertains to the idea that certain mental experiences can be characterised as being directed toward an object (Zahavi, 2003, p. 14). For example, one does not simply see, rather we see an object; there is an ‘aboutness’ with which we direct our mental states as agents in the world. In turn, agents capable of generating and realising such intentions display the property of agency. To use the earlier example of the WHO Surgical Safety checklist, a group of agents (i.e. theatre staff) work together using the cognitive artefact to realise the intentions (i.e. agency) of maximising the possibility of a safe surgical outcome. In this example, the cognitive artefact plays an important role in realising a distributed cognitive goal that arises from a distributed moral position (i.e. beliefs and desires) of non-maleficence.

To that end, cognitive artefacts have been recently argued as important components in the realisation of distributed cognitive and moral agency (Heersmink, 2017). The WHO Surgical Safety checklist provides an example of a highly circumscribed act of agency (i.e. surgery) using a cognitive artefact designed to support distributed cognitive and moral agency. The nature of the Surgical Safety checklist, whilst designed to support cognition and an implicit moral perspective, is structured in such a way as to be highly deterministic. In other words, the artefact is designed to move its users step by step from one state to the next when the prior state or question has been satisfactorily addressed. From the viewpoint of an algorithm, this is a simple (yet effective) approach that fits well with the task at hand. There are, however, many circumstances in health and medical practice that do not conform nearly as well to this approach given contextual differences where problems manifest different types of complexity. The essence of these less-ordered types of practice settings has been well described in the work of Schön (1983).

Such areas of medical and health practice do not involve the neatly circumscribed spatial and temporal conditions of a single surgical environment encounter where distributed cognitive and moral intentions are typically well defined. Such ‘messy’ practice environments and the intentional and agentic ambiguities that they reflect are at the crux of this thesis (Schön, 1983).

Cognitive artefact design for such environments demands a high degree of flexibility and integrative capability to reflect the wide range of potential intentional and agentic perspectives and outcomes congruent with modern approaches to clinical practice (Nemeth, Cook, O'Connor, et al., 2004; Nemeth, Cook, & Woods, 2004). Indeed, professions such as Medicine are increasingly aware of the need to respond to evolving concepts of disease, health and wellbeing that continue to undergo radical change to remain relevant. Understanding and practicing in line with concepts such as person-centred care, quality of life, wellbeing, disability, evidence-based medicine, and advocacy principles, are now mainstream expectations in professional curricula that reflect an evolving understanding of health and disease (RACP 2012). Cognitive artefacts that are structured to support the display and organisation of data that reflects the diverse professional roles and responsibilities that contemporary practice demands are likely to be of value into the future as medical practice continues to unfold.

This study seeks to explore a cognitive artefact that is concerned primarily with supporting the ability to integrate, or at the very least, provide a representational structure that can account for the myriad of diverse information and frameworks that inform the practice of Rehabilitation Medicine. The appeal here is to one of 'unspecialisation' that is encapsulated in the Aristotelian notion of phronesis, or practical wisdom (Galvin, 2007). Here, the notion of phronesis refers to the requirement in the caring professions, such as Medicine, for the inseparable application of knowledge, ethics and action that has been threatened by the contemporary fragmentation of knowledge domains (Habermas, 1987).

In that classification systems aim to provide a way in which humans can organise their knowledge of the world they become a useful starting point for exploring the basis of a cognitive artefact that can support the diverse tasks of professional practice. As classifications are frequently not static it is useful at this point to explore further the history of classifications to appreciate their present state of development.

Classifications

This next section provides some additional historical background to the development of scientific and health classifications and the evolution of concepts that inform them.

2.12 A Brief History of Classifications

The earliest systematic approach to classification is thought to date to 3000 B.C with the work of Chinese Emperor Shen Nung who developed a classification of Chinese herbs based on their medicinal properties. This classification became part of an oral tradition in China subsequently documented between 300 B.C and 200 A.D as The Divine Farmers Materia Medica (Yang & Flaws, 1998). Examples of early classificatory work, particularly focusing on biological phenomena, are evident across many cultures (Caraka, 2007) with the earliest written documentation of classification in the western tradition attributed to Aristotle (Aristotle & Balme, 2011).

In the case of Aristotle, this early work proposed for the first time the concepts of genera and species and distinguished animals based on the presence or absence of blood. Aristotle proposed genus as a broad grouping (e.g. animals), with species as more specific (e.g. man). This follows that a genus contains species, so in the above example man (species) is an animal (genus). Significant advances in the approach to classification occurred in the 18th century with the introduction of the hierarchically structured biological classification of Linnaeus (Linné & Deutsche Zoologische, 1894). With the innovative use of a hierarchical structure Linnaeus provided an easily reproducible means by which genera could be grouped into higher order taxa. Taxa are defined as a group of one or more populations of organisms judged to be a unit (Winston, 1999, p.21). Furthermore, taxa are reproducible in the standardisation of language using definitions based on name and rank. The introduction of taxa significantly extended the century's old approach instigated by the earlier work of Aristotle through the aforementioned standardisation of language procedures. Notably, Linnaeus added to genera the higher order categories of order, class and kingdom.

Formal classification systems have continued to develop across many aspects of society and significant systems such as the Dewey decimal system used in library cataloguing, the periodic table of chemical elements, and the Linnaean classification of biology, are familiar to many (Dewey et al., 1989; Levi, 1984; Linné & Deutsche Zoologische, 1894). Classification systems have also developed in the field of health with the western allopathic medicine tradition providing the historical basis of the classificatory systems considered in this thesis.

2.13 The Evolution of Health Classifications: Death, Disease and Disability

Modern day health classifications have origins dating back to a classificatory structure devised by William Farr in 1864 (Lilienfield, 2007) and advanced in Bertillon's Nomenclatures des Maladies (Bertillon, 1900). Indeed, the ongoing basic classificatory structure of ICD remains unchanged from that first proposed by William Farr over 150 years ago. The classifications of Farr and Bertillon are considered precursors to ICD that now, in its eleventh version, has moved from a list of causes of death to include causes of disease.

More recently WHO classifications have been developed that extends the reach of health classification beyond death and disease to incorporate human functioning in the form of the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001). The resulting WHO Family of International Classifications (WHO-FIC) includes ICD and ICF as reference classifications, with a third reference classification under development; the International Classification of Health Interventions (ICHI) (Fortune et al., 2018). In addition to reference classifications, WHO-FIC also comprises several related and derived classifications (Jakob, Üstün, Madden, & Sykes, 2007).

According to WHO, reference classifications are the main classifications on the basic parameters of health whilst derived classifications are based on the reference classifications. These reference and derived classifications have been subject to ratification processes by WHO's governing bodies for international use.

This study explores the nature of the relationship that exists between the WHO reference classifications (i.e. ICD, ICF and ICHI) for the purposes of improved understanding and application to clinical practice. To that end this study does not suggest changes to the current reference classification structure, this study will propose a basic framework from which the reference and derived classifications of WHO can be simultaneously considered during clinical practice.

Together, formal classification systems such as those mentioned above provide large-scale information infrastructures that enable individuals and groups to engage in mutually understood categorical work across time and space (Bowker & Star, 2000). In the context of Rehabilitation Medicine practice with its emphasis on multidisciplinary teams, a practice-oriented classification system serves to provide a unified point of focus from which such mutually understood categorical work can emerge.

Such a system may serve to address the much needed capacity for practitioners to address complexity in health systems that are currently characterised as being organised in ‘silos’ where healthcare delivery can be poorly coordinated due to lack of integration (Tett, 2015). The process of facilitating improved service integration is a current focus of organisations from a ‘top-down’ level, however, such approaches would benefit from parallel approaches at an individual level. A complementary approach at the individual practitioner level would require the development of internally developed cognitive models that facilitate ‘thinking complexly’ (Doll, 2012).

The desire for the improved integration of information across large scale systems in healthcare is a current focus of contemporary classification development and further discussion of this is warranted at this juncture.

2.14 Togetherness: The Ongoing Evolution of the WHO FIC

As suggested above, the WHO FIC has evolved from its historical concern with identifying causes of death, through to the development of disease classifications of the living, and most recently, to consideration of disability in the context of human functioning. These differing approaches stress multiple components of the health puzzle and are informed by different philosophical and cultural perspectives. These differing perspectives are acknowledged in the introductory chapter of the WHO ICF where the perspectives that inform ICD and ICF are dichotomized as being informed by the medical model (for ICD) and the Biopsychosocial model in the case of ICF (WHO, 2001). The request of the WHO for those using the WHO FIC, and the currently available reference classifications, ICD and ICF, is that these classifications be used together, however, how this is to be undertaken is left as an open question.

To that end, further consideration of the idea of 'togetherness' seems to be a basic first step in thinking about how the members of the WHO FIC (i.e. ICD, ICF and ultimately ICHI) can or should be best used together.

In simple terms, togetherness could indicate being used side by side (with no overlap), with some overlap, or with considerable or complete overlap.

For example, when ICF and ICD are separated completely, Health Conditions may be considered before other questions of Human Function and Disability. In some circumstance this may be appropriate, however, it may not in others. At worst, complete separation of ICD and ICF may risk application of one classification not both if the user lacks knowledge and skills in applying both.

Partial overlap between ICD and ICF suggests some common elements or conceptual overlap between the two classifications. Such an approach has been adopted in the current revision of ICD that incorporates consideration of aspects of Human Function as important in the conceptualization of Health Conditions (i.e. diseases and disorders).

Considering the ICD and ICF where there is complete conceptual overlap between the classifications would require a very general ontological stance that assumes a maximally agnostic position toward the concepts of disease, disability, health and function as defined by the WHO. This will be the position that is explored further in this thesis and one that to date has not featured in literature on the WHO FIC.

Adopting such a position is not to suggest that the previous two options do not have a very important place in understanding and intervening in questions of health. However, it should similarly not be assumed that the latter option may not also add value to understanding how we frame and apply our knowledge of fundamental concepts of health and disease. This thesis explores alternatives to the unstated philosophical assumptions about health, functioning, disability and disease that have been reflected in historical and contemporary approaches to the WHO FIC.

Initial approaches to the use of the ICD and ICF took the first approach outlined above where the classifications did not overlap, and this is seen in cognitive artefacts that are available and inform the dominant approach to the use of the ICF in Rehabilitation. In this case the application of ICD and ICF is assumed to occur in series where a known ICD diagnosis then informs subsequent consideration of disability and human function (Steiner et al., 2002). The separateness of ICD and ICF is explicitly made in linking rule recommendations that make clear that there is an unambiguous conceptual divide between disease/health conditions and disability and human function considerations (Cieza, Bickenbach, Prodinger, & Fayed, 2016).

Subsequent efforts have aimed to consider ICF as part of ICD as is the current approach with the recent revision of ICD (Tu et al., 2010). In this approach, diseases are considered to have functional properties.

This approach considers disability from a disease framework or schema which has been a focus of criticism of the WHO FIC approach by disability advocates. The practicalities of populating ICF categories with ICF related content to date appears to be presenting some significant challenges (Selb et al., 2015).

A key issue here is the challenge of dealing with an existing information architecture that significantly curtails they ways in which concepts can be treated, given the infrastructure that exists.

This thesis aims to step outside the historical limitations imposed by an inherited information infrastructure for which our systems remain wedded. Developing novel approaches to classification of health-related information that respect existing infrastructure yet permit treatment of concepts and classifications in novel ways that inform clinical practice is a strong theme of this thesis.

Current WHO FIC Artefacts

In following on from the above theoretical discussion of the WHO-FIC it is relevant to now consider the current state of cognitive artefacts that support the application of the WHO-FIC in practice. This section will consider artefacts that relate particularly to the use of the ICF given the emergence of this new classification over the past decade.

From an early stage following the release of the ICF it was identified by its authors that there would be a need for the development of clinical tools to support use in practice.

Prior to discussion of specific tools, it is appropriate at this point to discuss the ICF diagram (see Figure 2.5) that provides a schematic of major concepts of the ICF that has formed the basis for subsequent tools or artefacts designed for use in clinical practice.

Figure 2.5. ICF Diagram

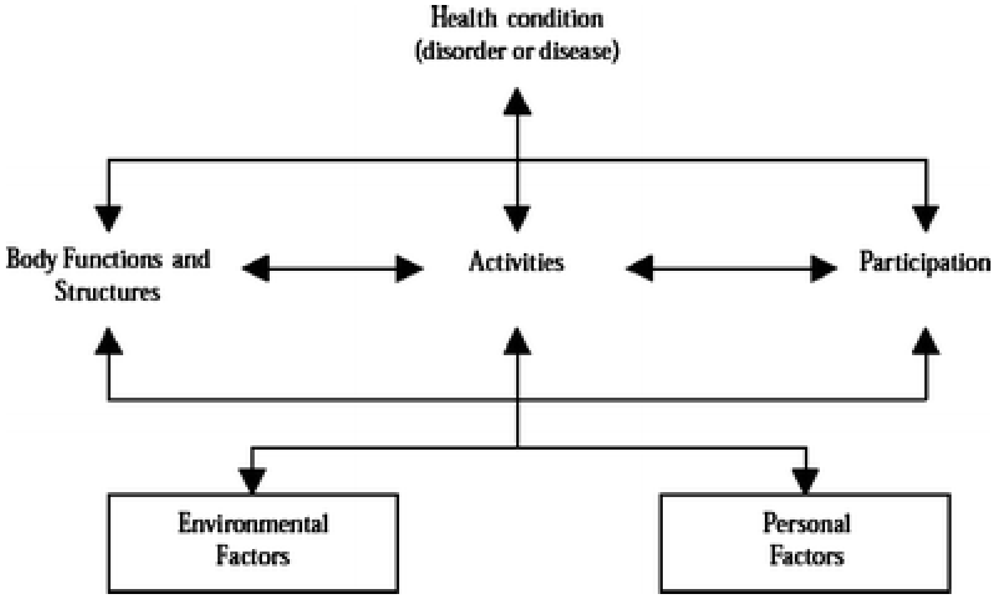

Figure 2.5. The graphical diagram from the ICF shows the dynamic interaction between six interacting components, namely, Health Conditions (coded in ICD), Body Functions and Structures, Activities and Participation, and the contextual factors of the Environment and Personal Factors (WHO, 2001, p. 18).

An early example of such a tool is the Rehabilitation Problem Solving form (RPS) (Steiner et al., 2002) that has been based on the above ICF schematic diagram. It provides users a simple landscape-oriented space upon which the clinician can document information across 3 boxed sections that correspond to the main diagram of the ICF above. Implicit in this approach is the assumption that the user has knowledge of the ICF beyond the major categories presented. The diagram also assumes a single ICD diagnosis in the term Health Condition, rather than the option of the plural term Health Condition/s. The positioning on of the term Health Condition at the top and center of the diagram may also infer a sense of pre-eminent importance of the ICD.

In addition to the RPS form, several other ICF tools have been published that require documentation of detailed categorical information where a goal of standardized reporting appears high on the agenda. The tradeoff for this high premium placed on documentation leads to an administrative burden that may detract from the use of such a tool.

2.15 The ICF Core Sets Approach

The most systematic approach to the development of cognitive artefacts to date has been the core sets approach that target specific conditions and stages of care to make the ICF more contextually relevant to specific user (Bickenbach, 2012). This information is presented in lists that have been generated through consensus processes where a high premium has been placed on internal validity. However, there is little evidence to suggest widespread uptake of the core sets in practice. The generic core set omits significant components of the ICF. Getting the balance right appears to be challenging.

2.16 WHODAS 2

ICF-based screening tools have also been developed of which the WHODAS 2 (Federici, Bracalenti, Meloni, Luciano, & Luciano, 2017; WHO, 2010) is an example. This tool aims to function as a generic instrument to assess health and disability for application in both clinical and general population settings. Multiple versions of WHODAS 2.0 that can be administered in 5-20 minutes aims to capture disability profiles using checklist-style tools to standardise information across six functional domains.

2.17 Linking Tools to ICF

Following the introduction if the ICF considerable effort has been directed toward creating explicit rules for linking the ICF to existing tools (Cieza & Geyh, 2005). As a result, there are several reports of variable concordance of existing clinical assessment scales to the ICF (Darzins, Imms, & Di Stefano, 2017; Madden et al., 2015; Nilsson, Westergren, Carlsson, & Hagell, 2010). Such linkage exercises are useful for evaluating scales against the ICF but, are limited to the study of existing scales that do not attempt to provide integrative alternatives for the combined application of ICF and ICD.

2.18 Additional Tools

Abstract tools that modify the ICF have also been proposed, however, these focus on broad conceptualizations that, as a result, don't appear to be developed for direct application in clinical settings (Heerkens et al., 2018; Jahiel, 2015). Such approaches argue for changes to the basic ICF diagram and for a global revisiting of the ICF scheme.

2.19 Limitations of Current ICF Tools

Despite considerable effort towards implementing the ICF in clinical practice the currently available tools to support application appear to have garnered only a limited amount of traction amongst practicing clinicians (Wiegand et al., 2012). Whilst the reasons for the lack of widespread clinician engagement in the uptake and use of the ICF remain largely uncharacterized, now with more than a decade of experience with the ICF alternate approaches to application appear justified. Furthermore, concerns about the degree to which ICF application has addressed person-centered goals of people with disability has also been questioned where rigid application of the ICF classification has been perceived as "very offensive" in a recent empirical study (Lundälv, Törnbom, Larsson, & Sunnerhagen, 2015, p. 3296)

Having outlined some examples of common cognitive artefacts used in medicine and rehabilitation, including ICF related artefacts, it is helpful to now consider ideas from the cognitive sciences to aid understanding of the design of alternate cognitive artefacts that might better support targeted aspects of cognition in practice. The following discussion is by no means exhaustive, however, it is undertaken with the aim of providing a general orientation to the reader the types of concerns that might need to be addressed when considering the design of cognitive artefacts that can complement and facilitate cognition to the level that is necessary for skillful coping in practice.

Design Considerations for an Integrated Cognitive Artefact for Application in Rehabilitation Medicine

2.20 Integrating ICF, ICD and ICHI

First and foremost, in designing a cognitive artefact for Rehabilitation Medicine practice, the artefact would need to simultaneously address questions pertinent to both function, disease and intervention where such integration appeals to Gestalt theory. The theory of Gestalt explores the relationship between parts and wholes that has been summarised as:

> "The fundamental "formula" of Gestalt theory might be expressed this way:
> There are wholes, the behaviour which is not determined by that of their individual elements, but where the part-processes are themselves determined by the intrinsic nature of the whole". (Wertheimer, 1945, p. 84)

In other words, adopting a Gestalt perspective to artefact design that incorporates ICD, ICF and ICHI, a 'top-down' perspective of the classifications is assumed. To assist here, the concept of a global workspace provides a useful analogy for artefact development where a global workspace provides an environment where data from potentially multiple sources can be explored to support problem solving (Shanahan & Baars, 2006). Such a workspace becomes useful when considering situations where cooperative problem solving is needed to solve problems where a single knowledge source is either inadequate for the task or provides a sub-optimal solution. Arguably, this is the case when considering complex health-related problems where cooperative application of ICD, ICF and ICHI may provide problem solutions unattainable when applying the classifications either singularly or in series. In this way, such a tool would also function as a meta-artefact where information from other tools and artefacts can be imported to inform the global workspace and concurrently address multiple framing perspectives (Goffman, 1974).

2.21 Temporo-spatial Structure

In creating a global workspace, the design of the artefact would benefit from being grounded in an explicit temporo-spatial structure to aid in the efficient organisation of data that reflects real-world experience.

2.22 Simplifying Complexity

Given that part of the role of the Rehabilitation Medicine specialist is to contribute to the management of complexity, it is appropriate therefore for artefacts to be designed to capture and navigate complex scenarios.

2.23 Fast and Frugal

In recognizing that much of human performance relies of the application of heuristics the design of cognitive artefacts that facilitate the application of heuristics is also highly relevant (Gigerenzer, 2011; Kahneman & Tversky, 1982). Here, trade-offs will be necessary where irrelevant detail will be intentionally overlooked or omitted during the active process of problem solving when time is of the essence.

2.24 Easily Accessible and Reproducible

In real-world settings a clinician must have ready and easy access to tools and artefacts to work efficiently and effectively. To that end, the design of an integrated ICF artefact must address this need. Such an approach to design often requires re-consideration of current approaches to re-imagine ways in which artefacts can better support practice. One way this can be accomplished is through the exploration of classification use in practice where emphasis is placed on cognitive artefact design. In this setting, the design and application of deeply personalized artefacts offers the foundation phenomenologically-informed accounts of which methodological considerations will be discussed in the next chapter.

2.25 Summary

This chapter has outlined some of the types of cognitive artefacts that are typically encountered in the practice of Medicine. Following this, a brief outline of Classifications and how these have developed in Health settings under the auspices of the WHO was provided including specific description of WHO-related cognitive artefacts. Subsequently, the limitations of current ICF-related artefacts were outlined leading to discussion of design considerations that might inform novel artefact development. The next chapter outlines methodological considerations for the study.

Chapter 3: Methods

3.01 Positivism in Medicine

It is uncontroversial to suggest that the bulk of medical research has historically presupposed scientific positivism where the experiment is set as the gold standard for the generation and verification of knowledge (Kendall, 2003). Clinical trials are ranked according to their level of rigor based on objective criteria that aims to provide clear, unambiguous guidance to clinicians in practice (Sackett, 1989, p. 47). To that end, the design and reporting of mainstream medical research has typically omitted any reflection and discussion of its underlying philosophical assumptions (i.e. scientific positivism) (Bunge, 2013). Medical research that differs from the implicit use of the scientific positivist approach, as is the case with the current study, therefore requires some description and justification.

In deviating from an empirically-based medical research paradigm in this study, it is important to recognise the contributions of the scientific positivist program and the ongoing role it has for the continued evolution of medical knowledge and practice. On the other hand, however, there remain many open questions in the field of medical practice that, frustratingly, resist the probe of a narrowly defined scientific method. Indeed, the stranglehold that the approaches such as the 'gold standard' Randomised Controlled Trial (RCT) has had on medical research, appears to be loosening, with prominent figures within the field acknowledging the limitations of such approaches to understanding particular questions (Frieden, 2017).

In this study, the questions for consideration elude narrowly defined scientific conceptualisations and consequently their treatment requires deviation from the prototypical, empirically-based testing paradigm. As such, this study makes an appeal to a growing view that strict demarcations between conceptual definitions of science and non-science are too simplified (Hansson, 2016). On this view, science is more fruitfully understood in a broader sense to embrace a wider community of knowledge disciplines that incorporates the natural sciences and the humanities. Adopting this view recognises the close interfaces between traditionally scientific and non-scientific disciplines in settings of practice where strict demarcation becomes problematic. Further, such an approach acknowledges the growing interdependency between disciplines in a complex modern world within which science is a socially embedded activity (Jasanoff, 2004; Latour & Woolgar, 1986). An important requirement for any study then becomes a careful description and justification of the methodological approach that has been chosen and the specific methods employed.

From a methodological perspective, this study draws heavily on the tradition of Philosophy to examine and generate knowledge where the research concerns elude experimental paradigms. In working toward a detailed description of the study methods for this thesis it is first helpful to place the study in a broader context for which some general discussion of Philosophy is warranted.

3.02 What is Philosophy?

Philosophy has been defined by Luciano Floridi as ‘conceptual engineering’ where questions, ‘open to informed reasonable disagreement’, are dealt with by providing new concepts that in turn may be superseded when better solutions are found (Edmonds & Warburton, 2010, p. 16). In that sense, the practice of philosophy involves examining and reconstructing presuppositions about how we know the world, what it is, and how it fits together. For the pre-eminent philosopher Putman, philosophy requires both vision *and* arguments to avoid, on the one hand, erudite yet meaningless displays of argumentation, whilst on the other, avoiding acts of unbridled imagination (Putnam and Conant 1990). This study aspires to the combined attention to both vision and argument where both a creative and rational consideration of the use of health classifications in practice may better inform important aspects of medical practice.

Historically, philosophy has significant Western and Eastern traditions where the classical branches of philosophical inquiry in the West includes consideration of metaphysics (what there is), epistemology (what we can know), morality and ethics (how we should act), logic (reasoning), and aesthetics (sense perception) (Marías, 1967). In binary terms, contemporary Western philosophy is frequently described in terms of analytic and continental traditions where the former focuses primarily on the use of logic whilst the latter permits consideration of the subjective.

In simple terms, it has been proposed that,

> 'Analytic philosophers typically try to solve fairly delineated philosophical problems by reducing them to their parts and to the relations in which these parts stand. Continental philosophers typically address large questions in a synthetic or integrative way, and consider particular issues to be 'parts of the larger unities' and as properly understood and dealt with only when fitted into those unities.' (Prado, 2003, p. 10)

Taking a conciliatory approach, philosophical practice that acknowledges these two broad traditions by combining the strengths of each through respecting the historical awareness of continental philosophy and the rigor of analytic philosophy provides grounds for synthesis where underlying questions will largely determine emphasis of approach (Levy, 2003). Within the broad historical traditions and branches of philosophy a variety of specialised fields of contemporary philosophical enquiry have emerged of which the philosophy of mind is an active example that has relevance to the current study.

3.03 Philosophy of Mind

Philosophy of mind has emerged as a relevant field of contemporary philosophical study where many open questions remain regarding the nature of how we think, experience consciousness and self-etc., where these ideas remain central to our fundamental notions of what it is to be human. Indeed, the desire to understand the human brain led Francis Crick to form the view that, “There is no scientific study more vital to man than the study of his own brain. Our entire view of the universe depends on it.”(Crick, 1979, p. 137)

Interest in philosophy of mind has paralleled the dramatic developments in the study of the human brain that have been possible with the recent development of technologies such as a variety of sophisticated brain imaging techniques (Boden, 2006). To date, however, answers to basic questions about how our brains and minds work remain elusive despite our increasingly advanced technological expertise (Koch, Massimini, Boly, & Tononi, 2016). The conundrums presented by the study of mind and brain have led some to entertain the value of incorporating experiential accounts of mind that challenge traditional scientific positivist notions of objectivity (Gallagher, 2000). The idea of permitting experiential accounts of mind lie at the heart of an ongoing debate about the legitimacy of taking such an approach (Shear & Varela, 1999) .

Proponents who permit experiential accounts as a legitimate way to inform our understanding and knowledge of our minds frequently draw on the philosophical tradition and practices of phenomenology (Gallagher, 2012). As a central methodological approach informing this study the following section will outline something of what phenomenology is and how it can be used to address the concerns of the study.

3.04 What is Phenomenology?

In broad terms, phenomenology can be considered both a philosophical movement and a practice (van Manen, 2014). Understanding first the idea of phenomenology as a movement within philosophy paves the way for understanding current approaches to its practice. As outlined above, the history of western philosophy, now a 2500-year-old tradition originating in ancient Greece, underwent a significant division during the late 19^{th} and early 20^{th} century when, as mentioned earlier, the analytic and continental delineation emerged (Critchley, 1997). The story of phenomenology, which also marks the beginning of the continental movement, begins with Husserl who proposed the value of careful description of the world as it is experienced from the *first person point of view* (Gallagher, 2012, p. 7). For Husserl, this approach aimed to provide a perspective of consciousness that transcended the doctrines and theories of psychology, mathematics, and logic that he saw as fundamentally limiting to understanding structures of conscious experience. In compiling phenomenological accounts, the phenomenologist recognises that the way things appear in conscious experience may differ from reality. However, as our only access to reality *is* through our experience of consciousness, then examining how we experience things is of legitimate concern to the phenomenologist.

In approaching a phenomenological investigation, Husserl outlined several stages that should be addressed that include:

1. The epoche – Husserl argued that in everyday life, whether this be at work or play, we adopt what he suggests is the 'natural attitude' where we take for granted everyday features of our existence and ways of being in the world. Adopting the natural attitude, according to Husserl, limits our capacity to critically reflect on how this attitude plays out in everyday life. Disengagement from the natural attitude - the epoche, or suspension of belief – then provides the necessary starting

point for phenomenological inquiry, for describing the experience of consciousness (Gallagher, 2012, p. 43; Zahavi, 2003, p. 45).

2. The phenomenological reduction – following the suspension of the natural attitude that arises with the epoche, Husserl then proposes we turn to describing how things appear in a certain experience (Gallagher, 2012, p. 47).
3. Eidetic variation – this further step in the phenomenological method relates to the stage of grasping the essence of the phenomenon where the technique involved requires a type of imaginative variation. The principle here is that we use our imagination to change various features of the phenomenon to uncover the eidos, or essence of the set of invariables that characterise the focus of phenomenological investigation (Gallagher, 2012, p. 49).
4. Intentionality – In addition to the 3 stages of a phenomenological investigation outlined above, Husserl also, drawing on prior philosophers, stressed that conscious experience itself always has some quality of directedness or intentionality. In other words, there is always some property of 'aboutness' that is part of the conscious experience. The notion of intentionality is an important one in that it has implications for how we attribute intentionality in ourselves and others regarding concepts such as beliefs and desires (Gallagher, 2012, p. 63; Zahavi, 2003, p. 13).

For example, in this study, the mental states of the clinician and patient, in addition to numerous others, play an important role in delivering and receiving health care. Of specific interest in this study is the experience of intentionality toward particular WHO classifications where the first-person experience of the clinician is the focus of phenomenological description.

The above process for undertaking phenomenological enquiry outlined by Husserl has subsequently been interpreted in numerous ways since its initial description which has led to the publication of a heterogeneous group of phenomenological studies over the past century (van Manen, 2014, p. 113). Numerous methodological approaches to undertaking a phenomenological investigation have been proposed for which lively debate regarding their legitimacy continues (van Manen, 2019; Zahavi, 2019).This wide variation seen in the methodological description and practice of phenomenology has led to significant criticism of phenomenology as lacking sufficient degrees of analytical rigor (Dennett, 1991). Further, early philosophical works in the phenomenological tradition have been criticised for their generally inaccessible language that demands much from the reader to comprehend (Wrathall, 2006). Consequently, despite the significant impact phenomenology has had within philosophy and related disciplines in the humanities, it has struggled to maintain a constant presence in philosophy as a thriving discipline.

More recently, however, there has been a renewed interest in phenomenology as part of the toolkit of the cognitive sciences where, as suggested above, significant research efforts are being directed toward understanding how our minds work (Gallagher, 2012, p. 15). Whilst for many within the cognitive science community the idea of using phenomenology as a research approach remains antithetical, for others it is a legitimate pathway where the appeal is to intersubjective validity (Gallagher & Zahavi, 2012, p. 46).

Given a renewed interest in phenomenology and the historical concerns about an absence of analytical rigor by practitioners, recent efforts have been directed toward being clearer about the types of phenomena people experience. Early work in phenomenology focused largely on perceptual phenomena, however, it has been argued that phenomenological accounts of this nature are too limiting and may omit a wider range of phenomenological experience that might provide useful insights into understanding how our minds work (Kriegel, 2015). Thus, cognitive phenomenology and phenomenology of agency, for example, have been put forward as phenomenological sub-types that enrich the descriptive possibilities for phenomenological investigation (Bayne & Montague, 2011; Nahmias, Morris, & Nadelhoffer, 2004).

Here, the cognitive phenomenology thesis adopts the view that intentionality can be directed toward experiences that are not purely sensory or affective, for example, when grasping a mathematical proof (Chudnoff, 2013). Phenomenology of agency also challenges common conceptions of describable phenomena suggesting that mental states such as deliberation, for example, also contain a unique 'aboutness' for which experiential accounts are warranted (Bayne, 2008).

Thus, in the current study, the idea of the medical practitioner as a problem solver in conjunction with a patient, family, and a variety of team members appeals directly to the description of cognitive phenomena embedded in the context of agency. Such an approach resonates with current cultural shifts in the medical profession that is increasingly concerned with a broadening of professional practice concerns that includes advocacy, person-centeredness, and working in teams amongst others (Ekman et al., 2011; Miles & Mezzich, 2011; Royen et al., 2010). More specifically, consideration of cognitive phenomenology in this study concerns the directedness of intentionality toward the reference classifications of the WHO-FIC (i.e. ICF, ICD and ICHI) where the goal is to gain an improved understanding of complex intellectual experiences, or, 'intellectual gestalts' that arise from integrated application of these classifications in practice (Chudnoff, 2013). Experiential accounts of how these professionally focused concerns are understood in practice by individuals charged with delivering these outcomes are urgently required through which first-person phenomenological accounts may provide some valuable insights.

3.05 Phenomenology of the First Person

In proposing first-person accounts of phenomenology, Husserl and early phenomenologists were seen to have crossed an important line regarding how we can know our world. Indeed, the idea of first-person accounts has led to significant criticism of the phenomenological method led in contemporary times by philosophers of mind such as Daniel Dennett (1991). For Dennett, who recognises a place for phenomenology in providing potential insights into the field, the issue appears to be who is entitled to report it. On Dennett's original view, phenomenology should be divided into 2 distinct categories; autophenomenology and heterophenomenology with the latter being the only legitimate path to reliable phenomenological description (Dennett, 2003). In brief, heterophenomenology requires the objective verification of the phenomenological account by another where as autophenomenology relies on direct reporting of the phenomena by the person who has experienced it. In a reconsideration of his original description of hetero/autophenomenology, Dennett appears to have softened his position somewhat by indicating that nothing in heterophenomenology rules out the use of first person methods, however, he maintains a requirement for the 'second-person gathering of data'. Here, descriptions in the 'second-person' typically, however, include the requirement for two people; an interviewer and interviewee (Olivares, Vargas, Fuentes, Martínez-Pernía, & Canales-Johnson, 2015).

3.06 Legitimate Autophenomenology?

Given Dennett's criticism of autophenomenology it is incumbent upon the author at this juncture to provide some justification for pursuing this line of inquiry. To that end, and drawing on the extended mind thesis (Clark & Chalmers, 1998), an argument could be constructed as follows:

1. Cognitive systems extend beyond the individual brain to include cognitive artefacts.
2. Cognitive artefacts can both arise from, and contribute to, phenomenological experience.
3. Cognitive artefacts are publicly available to both the first-person designer and user, and third parties.
4. Third parties can directly access and evaluate features of the autophenomenologist's cognitive system through their own assessment of the publicly available cognitive artefact.

As alluded to in the above argument, of central importance in this study is the use of cognitive artefacts as a method of accessing and capturing phenomenological experiences that form the basis of Medical practice. The important relationship between phenomenological experience and publicly available artefacts has been highlighted when considering artefact design (Robertson, 2002). With that in mind, brief description of the status of artefacts in philosophy is warranted to further clarify the philosophical positioning of this study.

3.07 Philosophy of Technology

The philosophical study of artefacts is part of the field of Philosophy of Technology where, until recently, much of the fields focus has been on how technology impacts culturally and economically rather than addressing the technology itself. More recently, there has been a shift toward gaining a better understanding of the practice of artefact design and how artefacts contribute to action and decision making (Dourish, 2004; Fransen, Vermaas, Kroes, & Meijers, 2016). In addition to phenomenology and the philosophy of technology, this study also concerns the field of medical philosophy.

3.08 Medical Philosophy

As suggested at the outset of this chapter, philosophical assumptions for much of medical research (and its practice) remain implicit with the philosophy of medical bioethics being a notable exception (Bunge, 2013). More recently, however, implicit assumptions of the value of medical positivism are gradually being challenged where an 'epistemological turn' in medical philosophy is increasingly questioning the value and implications of the randomized controlled trial and the systematic review (Stegenga, Kennedy, Tekin, Jukola, & Bluhm, 2017). In addition to a number of other approaches, medical philosophy has also considered questions of phenomenology that will be considered in the following section.

3.09 Medical Phenomenology

Phenomenological studies in medicine have been limited and typically adhere to the heterophenomenological approach. In examples of published studies, cases tend to focus on phenomenological descriptions of patient experiences of disease, first-person reports of disease experience, or theoretical discussions of phenomenology in medicine (Toombs, 2001). The potential value of phenomenological accounts of medicine from a theoretical and practice perspective has been identified (Waksler, 2001). Whilst phenomenological research in medicine remains limited there has been a distinct focus within the field of psychiatry, with phenomenology also an established research method in non-medical fields of healthcare practice with the nursing being an important example (Matua, 2015; Ratcliffe, 2011; Zahavi & Martiny, 2019).

This study aims to contribute to the medical phenomenological literature with a primary focus on cognitive phenomenology although recognising the relevance of perceptual phenomena and agentic perspectives as essential in providing a holistic account of experience in medical practice. Further, the phenomenological account is strengthened through the use of cognitive artefacts that are central to the phenomenological experience and side-step, to some extent, concerns about the autophenomenological nature of the inquiry. Consequently, the study also aims to contribute to the literature on cognitive artefacts and how they are experienced from the phenomenological perspective. Finally, the study also provides much needed accounts of the lived experience of using health classifications in practice that has implications for not only better understanding the role of classifications in this setting but also as a contribution toward the ongoing theoretical development of classifications themselves.

3.10 A Final Appeal to Phenomenology

Our understanding of how humans construct, engage and incorporate cognitive artefacts into everyday practices continues to develop. For many cognitive artefacts, gaining a detailed level of understanding may not be necessary. However, there are likely many artefacts that would benefit from developing a greater understanding. Such artefacts are those that need to become deeply incorporated into cognition to realise their intended function. In the case of health classification use in practice, cognitive artefacts that strive to facilitate deeply synthesised, integrated cognitive structures of health at a Gestalt level are more likely to benefit from careful design and analysis than those that are designed to address less integrated parts of the overall package or are geared to a more linear, deterministic cognitive approach by its user. Further, when cognitive artefacts are designed where claims are made about deeply synthesised accounts by individuals, methodological approaches for investigation rapidly dwindle to the approach presented in this chapter, i.e. phenomenological inquiry.

3.11 Specific Methods

Following from the above description, the specific methods of this study can be characterised as being that of a phenomenologically-informed, idiographic account of the practical application of the WHO-FIC in Rehabilitation Medicine where the development of a cognitive artefact informs skilled coping. In providing this account, Husserl's classical description of the phenomenological method is employed where the epoche is applied to the WHO-FIC and how it is applied in clinical work. Subsequently a phenomenological reduction is undertaken where the experience of using the WHO-FIC in the context of Rehabilitation Medicine practice is considered with a focus on cognitive artefact development. Eidetic variation is also considered as this applies to the experience of applying the WHO-FIC where emphasis is placed on proposing unifying ontological features of these classifications. To that end, description is the dominant methodological approach, however, the study is not without interpretive analysis where the Heideggerian notion of being-in-the-world as a Rehabilitation Medicine Physician is also considered.

The remaining section outlines the approach to subsequent chapters that provide description and analysis of the phenomenologically-informed investigation. Firstly, a detailed description of the cognitive artefact is provided that was developed iteratively over several months during routine practice as a Rehabilitation Medicine Physician working in a large regional centre with clinical responsibilities at a large tertiary referral hospital in both inpatient and outpatient settings.

In describing the artefact, reference will be made to existing artefacts and classifications that can be viewed as providing the background for the 'natural attitude' to practice that presupposes a particular worldview. The pragmatic need for the development of the novel cognitive artefact provided the necessary conditions that stimulated the epoche, or suspension of the natural attitude, from which the artefact developed.

Following description of the artefact, it is then analysed with reference to theoretical perspective and empirical evidence from the field of cognitive science to support the putative claims of the artefact in supporting the cognitive demands of the Rehabilitation Medicine practice role. With this approach, the study aims to combine the benefits of both the phenomenological approach in orienting the reader to the nature of the experience of designing and using cognitive artefacts in practice whilst also applying a rigorous analytic approach within the limits of techniques available. To that end, it is hoped that the overall product may have some appeal from a philosophical perspective to both analytic and continental traditions whilst also providing some appeal to those from health-related fields who are interested in how individual clinicians make serious attempts to understand and apply classification systems that require effort to synthesise and integrate into medical practice.

3.12 Summary

In summary, this chapter introduces the study's methodological considerations in the setting of scientific positivism as the dominant approach to medical research. In acknowledging the ongoing importance of the positivist approach, the need to explore questions that sit outside the tight constraints of traditional scientific methods remains necessary for which alternate methods are required. The focus then becomes on identifying a suitable methodological approach for the study for which some discussion of philosophy was required. Specific areas of philosophical inquiry including the philosophy of mind, philosophy of technology, and phenomenology have been outlined that together will inform the methodological approach. As a study from the field of medicine, the relative lack of philosophical work in medicine has been highlighted, save for bioethics, with brief discussion of the scant literature available on medical phenomenology discussed. In addition, specific arguments for the use of the first-person approach were made in keeping with the original description of the phenomenological method.

Chapter 4: Artefact Design and Description – Part I

Building the Artefact

The subsequent chapters provide description and analysis of the study artefacts that reflect the phenomenological experience of the author obtained through an iterative process of artefact design and use in the practice of Rehabilitation Medicine. To that end, the section begins with a brief account of the author's context of practice that, in the spirit of phenomenology, will be provided in the first-person.

4.01 Personal Context

As a Medical Practitioner of 22 years, my last 17 years of practice have been in the field of Rehabilitation Medicine with four as a specialist-in-training, and a subsequent 13 years working in the specialist role. In my situation, Rehabilitation Medicine training and practice has taken place in large, University-affiliated, tertiary-care centres where my role has typically spanned clinical settings from critical care through to sub-acute hospital and outpatient care settings. In addition to direct clinical care, like many clinicians employed in government funded health care settings, my role also includes some administrative, educational, and leadership responsibilities. To that end, artefacts derived from health classifications that can inform these broader practice contexts has personal appeal.

Regarding WHO Health Classifications, my initial exposure to ICD began in first year medical school with diagnostic codes referenced in formal learning materials. Whilst this exposure did not aim to provide a comprehensive approach to understanding ICD as a classification in its own right, it did highlight to me the fundamental importance of ICD as a blueprint for medicine. Whilst, like most medical practitioners, I cannot provide a verbatim account of ICD, I am familiar enough with the basic structure, concepts, and language of ICD that I can function effectively as a medical practitioner in the typical sense. In other words, I can organise my knowledge of the world in terms of diseases and disorders in a way that reflects ICD and effectively communicate this knowledge and understanding with other medical practitioners. For all medical practitioners, I suspect, ICD is implicitly, if not explicitly understood (Polanyi, 1966).

It was not until some ten years later, in my first year of Rehabilitation Medicine specialist training, that I was first exposed to ICF which at the time comprised the second of the WHO Health Reference Classifications. Having recently been ratified and endorsed by WHO, the ICF was ushered in as an important classification for use in Rehabilitation Medicine being made part of curriculum learning with, in my case, the Australasian Faculty of Rehabilitation Medicine. As a specialty concerned with topics such as human functioning and disability, the ICF appeared to be a natural fit for informing the basis of understanding important aspects of Rehabilitation Medicine practice.

Subsequent years of training and practice in Rehabilitation Medicine, coupled with WHO's request that ICF be used by 'all clinicians', led to my own iterative learning and application of ICF at a time where there was minimal guidance available for practitioners; the ICF was very new and experience with the classification in real-world practice was minimal. In my experience, attempts at using available ICF tools in practice that were available met with limited success and this necessitated a trial and error process designing and trialing my own artefacts/tools. Initially, these tools where designed to capture information pertaining to the ICF, however, over time, it became apparent that ICF and ICD, whilst both fundamentally informing my practice in Rehabilitation Medicine, were difficult to understand from a common conceptual framework. At least in my own mind, a lack of conceptual integration between ICD and ICF limited my ability to reach a satisfactory phenomenal holism between these two, related, yet very different classifications. In a practice, it was difficult to document data relevant to both understanding disease processes and human function in a common tool.

From a phenomenological perspective, these experiences triggered an ‘epoche’, or setting aside of assumptions about ICD and ICF that, in my circumstance, informed the broad questions of this study; namely, 1) how could I best use the ICF in practice? and, 2) how does ICF fundamentally relate to ICD? As a Rehabilitation Medicine practitioner, these 2 questions are intimately related as the best use of ICF, in my view, requires seamless conceptual integration with ICD for holistic practice frameworks to emerge.

These subsequent chapters report on the resultant process arising from setting-aside assumptions about the world as it is presented to us (in this case in formal health classifications) and exploring, through phenomenologically informed artefacts, the lived experience of using these classifications in practice. Importantly, this study is not in any sense an exclusive claim to the description of a holistic approach to medical practice, nor a claim that the detailed consideration of particular health classifications is the only route to addressing questions of integration and synthesis of health concepts as they apply to practice. Rather the goal, as above, is no more than the exploration of the lived experience of practice.

Fundamental Phenomena

The initial artefact that will be described aims to provide a basic, fundamental framework from which the WHO reference classifications can be subsequently understood, and additional artefacts can be designed and elaborated. In other words, this first artefact constitutes a sort of ontological bedrock – the substrate upon which everything else can subsequently be built – which in the case of Health Classifications, are concepts like disease, disability, and the notion of health itself.

In striving for a basic ontological framework, the primary aims of this first artefact are to address fundamental phenomenological experiences including time, space and matter. At this stage the introduction (and thereby assumptions) about the concepts of disability and disease are put to the side.

4.02 Representing Time

The word 'time' is the most frequently used English language noun and a concept relevant across all cultures (Boroditsky, 2011); time aids our understanding of the world and our place in it (Evans, 2003). Time is not represented in the current WHO ICF schematic diagram (see Figure 2.5) (WHO, 2001) and its absence has been a source of criticism (Wade & Halligan, 2003). Similarly, ICD does not explicitly incorporate time as an underlying construct of its classification (WHO, 1992). As such an artefact that can incorporate time appeals as a construct upon which the concepts of disease, disability, human functioning and health can subsequently rest.

From a practice perspective, representing time in an artefact that purports to assist cognitive processes is essential where the focus of practice is strongly grounded in temporal experience. For example, a patient may ask; 'when will this get better?', 'how long have I got?', 'will I always be disabled?', or, 'what needs to happen next? From the doctor's perspective questions may include; 'what prompted you come to see me today?', 'how long have you been feeling this way?', or, 'what is this person's developmental history?'.

The above questions represent typical questions about temporal events for which doctors attempt to use data about prior experiences to make predictions about the future. In statistics, approaches such as Bayes Theorem temporally related data to help make predictions about the future (Tawfik & Neufeld, 2000).

4.03 Representing Space

Concepts of space provide a primary organisational structure for our experience of the world that ranges from the privileged space occupied by our bodies; both inside and out, through to more abstract spaces such as those found in external representations such as graph and diagrams (Tversky, 2005). Overt reference to space is omitted from the current WHO ICF schematic diagram where, like time, constitutes a fundamental concept when considering issues of health, disability, disease and function. For example, consider the following statements: ‘the patient needs ongoing dialysis and lives 400km from the nearest dialysis machine’, or, ‘it feels like there are ants crawling under my skin’.

4.04 Representing Matter

In addition to the concepts of time and space, the existence of matter constitutes a primary building block for how we understand and know our world. As a basic differentiation of matter a common division is that between body and the environment. This division is reflected in the WHO ICF, however, it is not explicitly stated in ICD. Again, the ability for an artefact to confer a basic distinction between matter (i.e. body and environment) is germane when considering requirements of practice.

4.05 Space, Time and Matter: Putting it together

Given the primary importance of time, space and matter in organising our basic understanding of the world it is necessary to now put these concepts together in constructing an artefact. To assist in artefact construction, it is advantageous to draw on existing representational artefacts. Here, an established artefact can act as a useful analogue where analogy posits ‘a common pattern of relationships amongst elements based on a process of comparison’ (Holyoak, 2012). Analogical reasoning is recognised as an important process in the development of schemas and arguably fundamental to cognition (Hofstadter & Sander, 2013).

To that end, a useful analogue for the development of the initial artefact is that of a Minkowski diagram that incorporates the concept of space-time; a 4-dimensional construct where space comprises three dimensions and time one dimension (Petkov, 2010). Space-time diagrams have their origins in mathematics and physics where the concepts they represent have been instrumental in elucidating theories of relativity (Dafermos, 2008). As indicated above, the concept of space-time requires comprehension of a four-dimensional construct: three dimensions for space and one dimension for time.

Given the difficulty that arises when attempting to visually represent 4 dimensions on a 2-dimensional plane (e.g. a piece of paper), 4-dimensional space-time is frequently represented using 3-dimensional diagrams.

Figure 4.1. 2-Dimensional Flatland Minkowski Spacetime Diagram

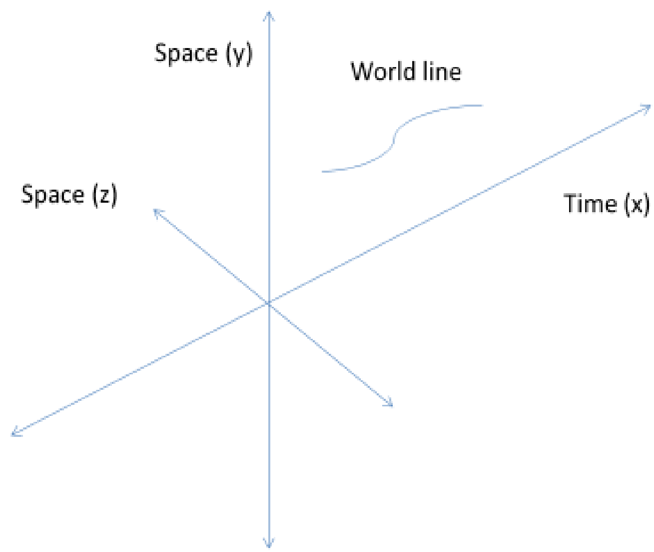

Figure 4.1. The 2-dimensional Flatland Minkowski spacetime diagram shows time on the X axis, and space on the Y and Z axes. A worldline is represented in spacetime.

In this initial artefact, time is represented on a single axis with space occupying two axes. In this sense space is 'compressed' and represented as a 2-dimensional 'flatland' rather than the 3-dimensions in which space is typically conceived (Abbott & Stewart, 2002) (see Figure 4.1). Matter occupies space where the 'environment' can be represented as a 'flatland' field at discrete time points (see Figure 4.2). Contiguous temporal 'slices' of the environment would coalesce to form a 'cylinder'. Additionally, the concept of the 'body' constitutes part of the broader environment are can therefore be logically represented as being contained within the environmental field (see Figure 4.3). In other words, the body is part of the environment.

Figure 4.2. Environment mapping to Flatland Minkowski Diagram

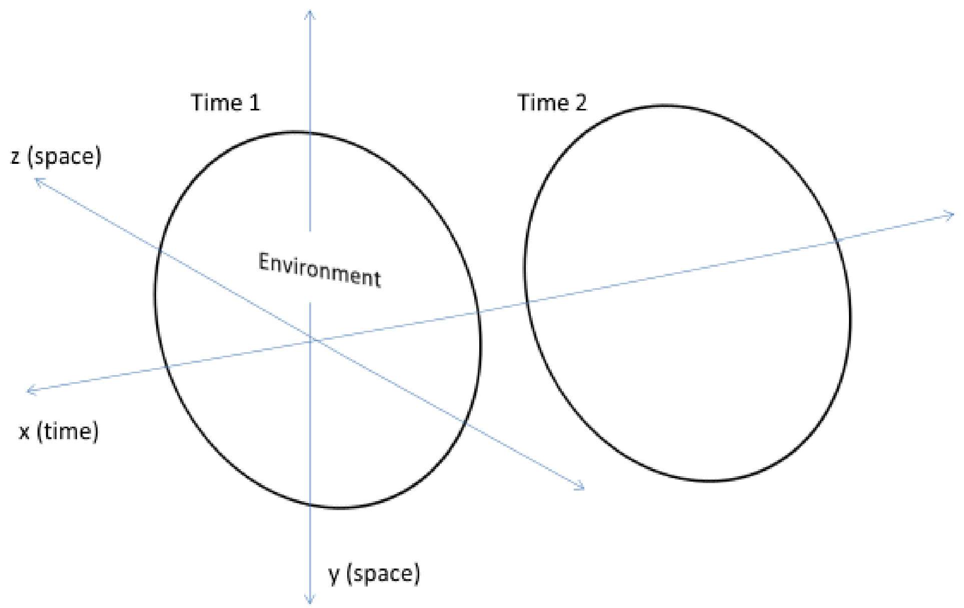

Figure 4.2. ICF Environment component mapped to spatial plane at 2 time points.

Figure 4.3. Environment and Body components mapped to Flatland Minkowski Diagram

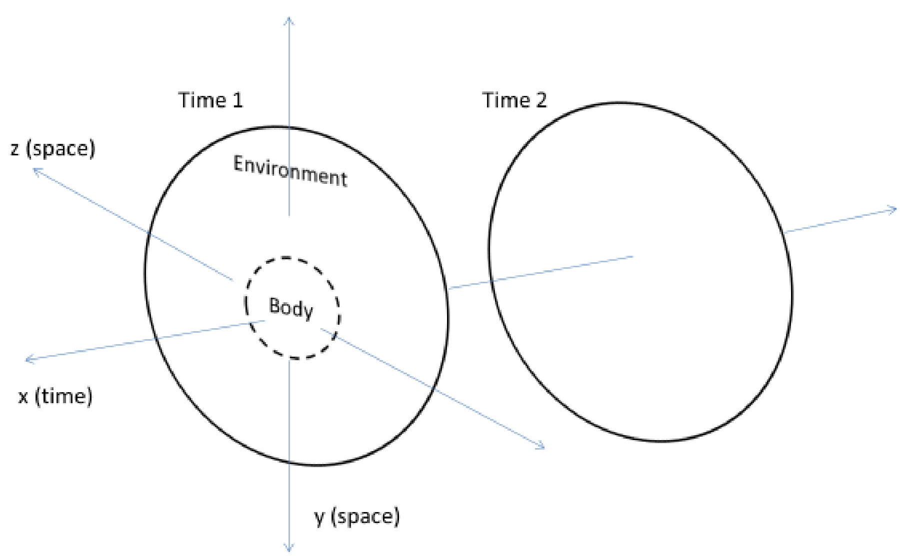

Figure 4.3. ICF Environment and Body components mapped to spatial plane at 2 time points.

4.06 Activity: Body in Motion

In addition to the concepts of time, space, and matter an additional concept is now added to the artefact, namely; Activity, that represent the result of human matter (bodies) in motion. This is conceived of as the product of interaction between a body and the environment within which it is contained (see Figure 4.4).

Figure 4.4. Environment, Activity and Body mapped to Flatland Minkowski Diagram

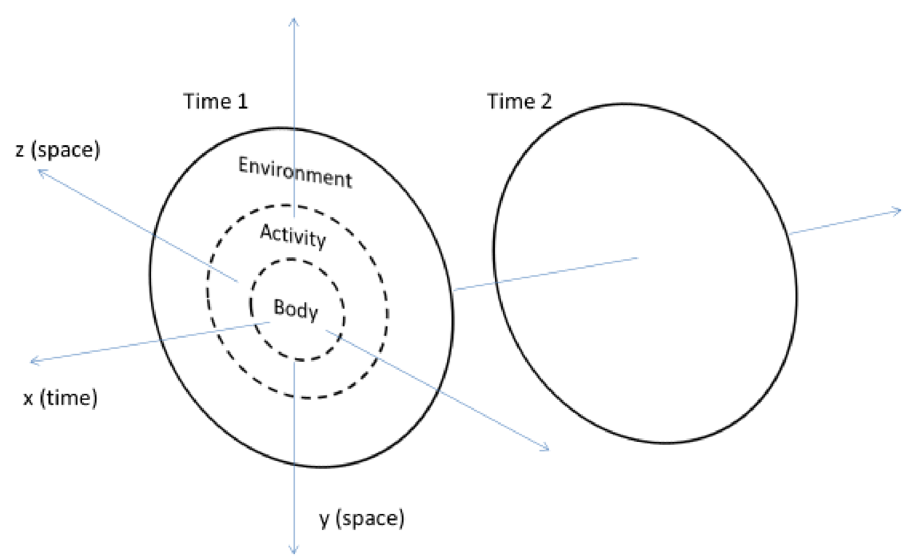

Figure 4.4. Environment, Activity and Body components mapped to spatial plane at 2 time points.

4.07 Leaky Matter

To convey the inherent 'leakiness' of the boundaries between the body and the environment (and the activities that result) the artefact is constructed with dashed lines (see Figure 4.4). Such an approach attests to the difficulty in unambiguously creating a division between the body and the environment. For example, where does the human gut start and end? Are the bacteria in your gut part of you, or are they part of the environment?

4.08 Forces of Nature

Whilst the artefact described is a static drawing it is intended to infer (given movement of matter in space and time) that it is dynamic. With this in mind, the environment can play an important metaphoric role in its interaction with the body whereby it may, for example, in a negative way 'squeeze the life out of a body', or, in a positive sense create a nurturing 'envelope' around a body.

Thus far, the artefact shows an abstract representation of a single body. The addition of subsequent bodies, however, introduces a social component whereby multiple bodies may engage in shared activities (see Figure 4.5).

Figure 4.5. Shared Activity Between 2 Bodies

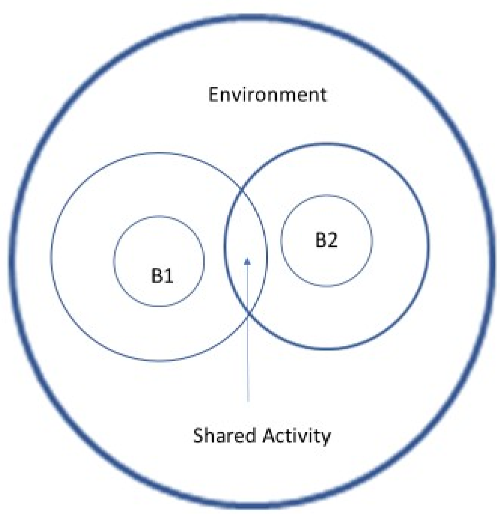

Figure 4.5. Two bodies engage in shared activities within the environmental field.

Figure 4.6. Contrasting Activity Levels Between Bodies

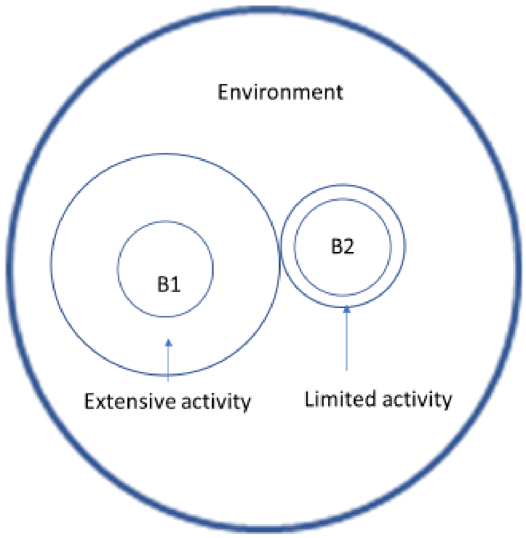

Figure 4.6. Two bodies are represented that exhibit varying activity within the environmental field.

Thus far, the artefact described employs the concepts of time, space, and matter (in the form of bodies and the environment) that together interact to produce activity. Activities can be both social or individual and vary in degree between people (see Figure 4.6). The artefact exploits recognised diagrammatic approaches to representing the concepts of space and time (Kessell, 2011) and suggests metaphoric roles of the environment as a positive, neutral or negative force that has implications for bodies and their ability to generate activity.

The representation of concepts in this initial artefact is sympathetic to theories that postulate the fundamental role of image schemas in cognition and language (Lakoff, 1987; Lakoff & Johnson, 1980) where schemas can be defined as 'knowledge structures that represent objects or events and provide default assumptions about their characteristics, relationships, and entailments under conditions of incomplete information' (DiMaggio, 1997, p. 269). As such, schemas function both as a mechanism for knowledge representation and information processing.

Such schemas provide a conceptual domain from which we draw metaphorical expressions to understand another conceptual domain known as the source domain. In other words, according to Conceptual Metaphor Theory, our understanding of concepts and language is derived from basic image schemas as reflected in imagistic, pre-linguistic concepts such as; containers, pathways, trajectories, and spatial relationships for example, inside, outside, between, and below. These basic imagistic relationships can then provide the basis for mapping to other higher order concepts such as; emotion, desire, morality, thought, society, politics, economy, health, human relationships, communication, etc. In the case of this initial artefact, a *container* (representing the environment), *envelopes* the body that together interacts to generate activity along a *pathway* across time and space mapped onto the basic structure of a Minkowski Flatland diagram.

At this point the schema remains agnostic regarding higher order concepts or specific frame perspectives where the overriding goal is to set up an initial state where the practitioner is maximally unbiased when encountering clinical situations. Such an unbiased perspective is essential to avoid application of unsuitable frame perspectives for the problem at hand. For example, a disease/ICD framework is applied when the problem at hand relates to a non-disease domain of human experience. Equally, a frame perspective considering issues of disability may neglect important disease-frame considerations.

4.09 Reducing Complex Relations

In addition to the creation of a maximally agnostic schema, the minimal use of concepts in this initial artefact has the advantage of reducing cognitive demands on the user when considering important cognitive functions such as working memory. For example, when problem solving ‘online’ in the human brain the number of interacting variables is limited to around four (Halford et al., 1998; Halford, Wilson, & Phillips, 2010). Beyond this number, information is needed to be combined in larger 'chunks' to continue to process relational information effectively. In the artefact presented relations are limited to 3 initial concepts of body, activity and environment. These concepts give rise to the following binary relationships:

1. Body – Activity
2. Body - Environment
3. Activity - Environment

Such an approach contrasts with the schematic model diagram in the ICF (see Figure 2.5) that comprises the following binary relations:

1. Body – activity
2. Body – participation
3. Body – Health Conditions
4. Body – Environmental factors
5. Body – Personal factors
6. Activity – Participation
7. Activity – Health Conditions
8. Activity – Environmental factors
9. Activity – Personal factors
10. Participation – Health conditions
11. Participation – Environmental factors
12. Participation – Personal factors
13. Environmental Factors – Health Conditions
14. Environmental Factors – Personal factors
15. Health Condition – Personal factors

As can be seen, the existing schematic diagram from the ICF (that links to ICD through the concepts of Health Conditions) comprises a cognitively overwhelming number of basic binary conceptual relations that, in addition, makes pre-commitments to frame perspectives (i.e. disease) in this initial schema. In addition, the lack of reference to time and space in the ICF diagram further reduces its utility for users interested in inducing cognitive schemas anchored to these concepts.

4.10 Reducing the ICF Diagram to Smaller Conceptual Chunks

Whilst the ICF diagram comprises many basic interactions as listed above, these concepts can be further reduced, as outlined in the ICF, to the primary concepts of Health Condition, Function (comprising Body structure and function, Activities, and Participation), and Contextual Factors (Environment and Personal Factors). As such, these three concepts – Health Condition, Function, and Contextual Factors – do provide a manageable number of concepts to address limited cognitive capacity for working memory demands. However, the question remains whether these are the most ideal concepts with which to categorise health information in clinical practice.

Firstly, unlike the novel model presented in this chapter, the 3 major ICF concepts of Health Condition, Function, and Contextual Factors lack any equivalent temporal and spatial representation thereby limiting this model in conveying a dynamic visual schema. To that end, this lack of temporal and spatial representation between these concepts makes it difficult for users to understand how these concepts are related in space and time. Further, at this basic level of interaction the notion of a Health Condition (i.e. disease) is already crystallised, which is often contrary to the experience of clinical practice where the objective of an interaction may be to establish what the Health Condition in fact is. For the clinician, beginning with the Health Condition effectively puts the 'cart before the horse'. This approach contrasts with, for example, the role of the coder, who benefits from an encapsulated statement about the Health Condition, that is, a clear diagnosis.

In the ICF model, there is a need to specify the concept of Contextual Factors as the concepts of Health Condition – reflected as a taxonomy of diseases in ICD – are effectively de-contextualised. In the proposed model, however, the need to specify Context becomes *redundant* given the holistic nature of the 3-dimensional schema. In other words, the enveloping nature of the Environment within which Activities and the Body are always contained and related creates an ever-present contextual backdrop for understanding human function. Importantly, the proposed model omits specific reference to Personal factors, however, an appreciation of Personal Factors such as 'age' can reasonably be inferred from the passage of a body through time as depicted in Figure 4.4. Further, bodily interaction as depicted in Figure 4.5 also suggests the emergence of 'culture' as another Personal factor where, for example, bodily interaction may take the form of a culturally informed greeting such as a handshake, or the side of the path one walks down depending on cultural norms. In addition, the omission of both Health Conditions and Participation will be discussed later in the thesis.

4.11 Summary

This chapter provides description and analysis of a preliminary artefact designed to support an integrated understanding of ICD and ICF in practice. The basis of the artefact is a schematic diagram that highlights the fundamental fabric of space and time as a structure for the dynamic interplay between the body, activity and the environment. The minimalist nature of the artefact - as an induction schema for the subsequent development of health-related concepts - appeals directly to known cognitive constraints (e.g. processing limits) and avoids pre-commitment to health-specific framing perspectives.

Through the simple organisation of manageable conceptual 'chunks', this initial artefact sets the stage for the development of subsequent artefacts whereby these minimal conceptual 'chunks' can be elaborated and 'unpacked' into finer grained concepts that reflect specific frame perspectives. These subsequent artefacts are described in the following chapter.

Chapter 5: Artefact Design and Description: Part II

Expanding the Artefact

This chapter builds on the schema outlined in the previous chapter that highlighted the concepts of Body, Activity and Environment as dynamically interacting components across time and space. In this next section, concepts introduced in the initial schema are expanded with the goal of creating a practical artefact designed to support the core cognitive tasks of Rehabilitation Medicine practice (see Figure 5.01). To help convey the intended function of the artefact the analogy of 'cognition as computation' will be developed later in the chapter.

5.01 Developing the Schema

In summary, the previous chapter presented an imagistic schema modelled on a Flatland Minkowski diagram that incorporates the dynamically interacting concepts of Body, Activity, and Environment (see Figure 4.4). This initial schema, given its rudimentary nature, appeals to the capacity-limited cognitive functions of attention and working memory (Halford et al., 1998) that provide a potential framework for channeling and organising information from 'outside' to 'inside' the brain. Such a broad-brush approach, however, does not address the level of detail that is necessary to address problems of practice and, as such, further development of the schema to support information processing at a more fine-grained level of detail is important. The next section outlines the structural changes of the proposed schema that are required to accommodate the finer degree of detail to support real-world problem solving in practice.

Figure 5.01. Developing the Schema

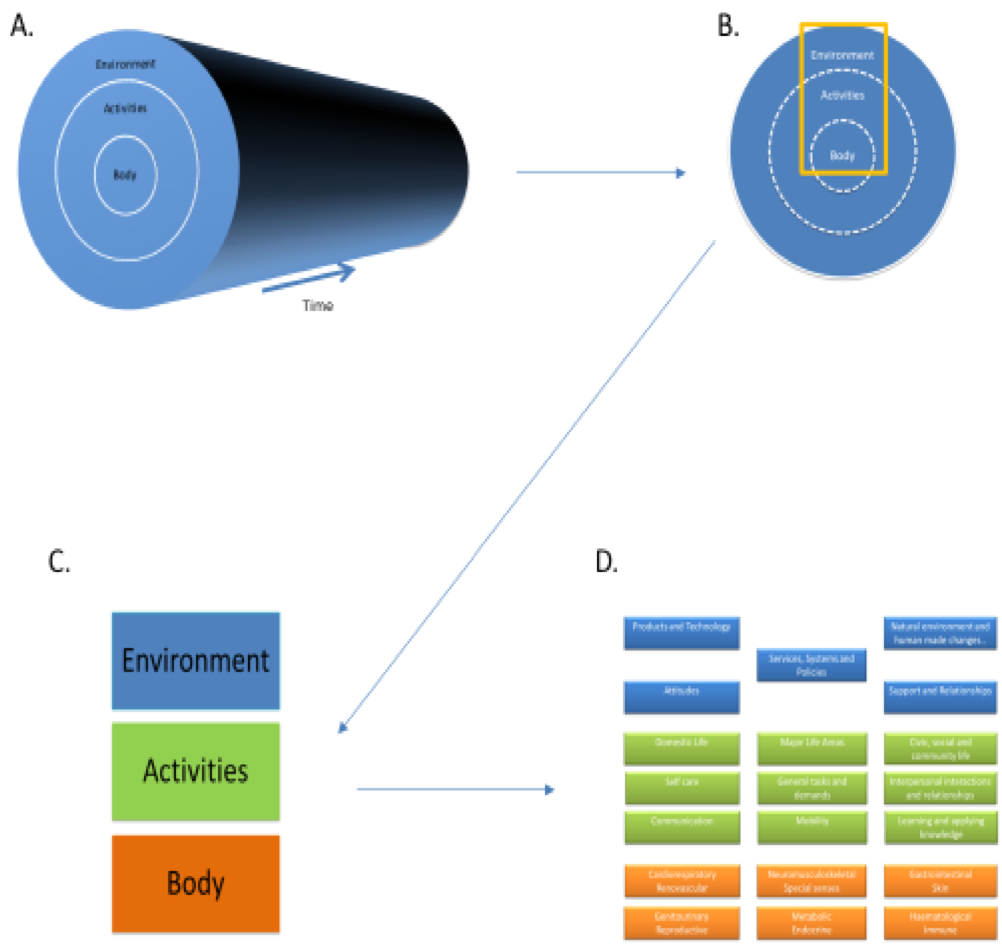

Figure 5.1. This figure provides a flowchart of schema development that will be outlined in this chapter.The cylinder outlined in the previous chapter (**A**) is rotated end on to show a ‘slice’ of the cylinder (**B**) from which a rectangle is ‘cut’ revealing the vertically oriented Environment, Activities, Body schema (**C**). This structure is further divided into a more detailed array based on the chapter heading of the ICF (**D**).

Figure 5.02. **Body, Activity, Environment Container**

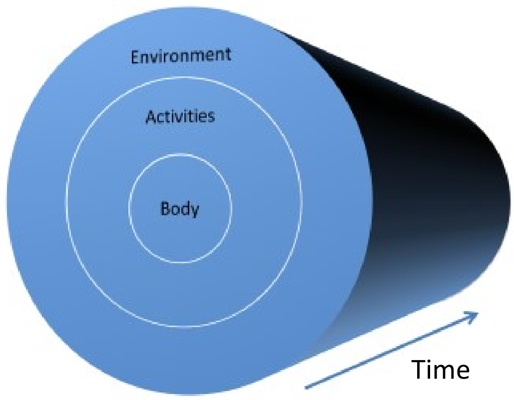

Figure 5.02. This diagram depicts the structural relationship between the Environment that contains within it the Body with Activities forming an interface between the two. An arrow represents the temporal unfolding of the Body, Activities and the Environment.

The next step in building upon this schema involves mentally rotating the container 'end-on' from which a 'slice' is cut leading to a portrait-oriented rectangle (i.e. A4 portrait page) that, from top-to-bottom, comprises three cells representing the concepts of Environment, Activity, and Body (see Figure 5.03).

Figure 5.03. Container 'slice' Reconfigured as a Simple Array

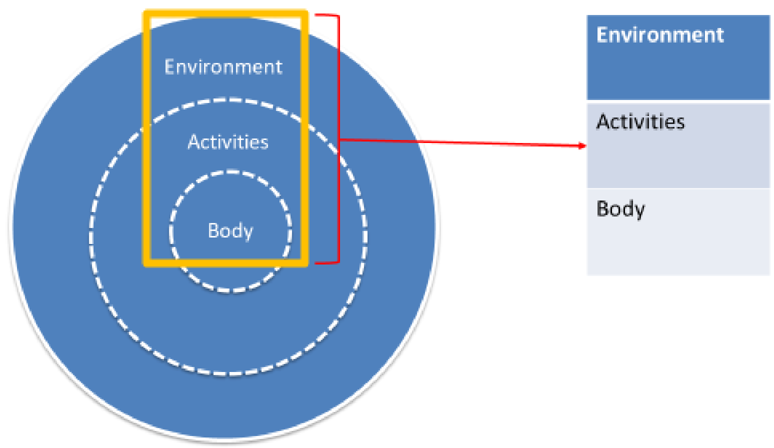

Figure 5.03. This diagram shows an end on view or 'slice' of the Environment 'container' from which the Body, Activity and Environment components are reconfigured in a simple vertical array comprising 3 cells.

As these cells represent a 'slice' from the original 'container', they also represent a distinct point in time that can be designated as t1, t2 etc. (see Figure 5.04).

Figure 5.04. Cellular Array Across 3 Discrete Time Points

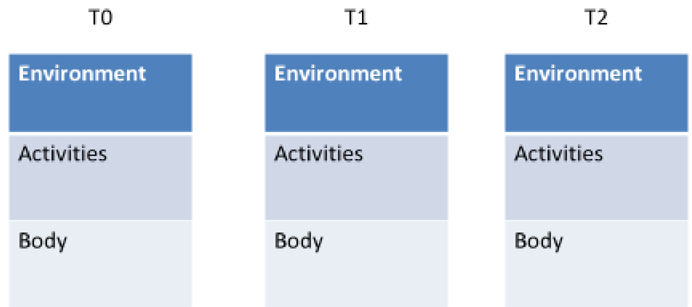

Figure 5.04. This diagram shows the 3-cell vertical array across three discrete time points designated as T0, T1 and T2.

In other words, multiple consecutive ‘slices’ across linear time add together to build the ‘container’ from which concepts like past, present and future arise. From here, additional detail can be added to the three cells that form the vertically-oriented array using concepts taken from the WHO ICF.

5.02 Environment Cell

To begin, the five chapter headings pertaining to the Environment chapter of the WHO ICF are arranged in a ‘tic-tac-toe’ formation within a 3x3 grid structure (see Figure 5.05).

Figure 5.05. Environmental Cell Expansion

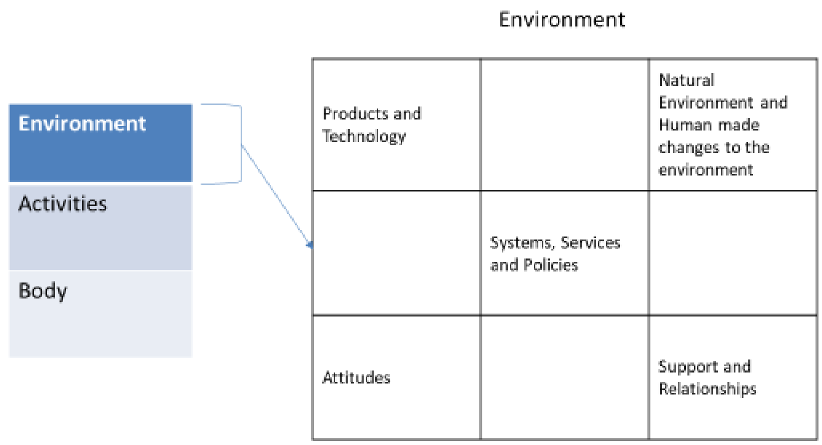

Figure 5.05. The Environment cell from the 3-cell vertical array is expanded to a 9-cell array with five active, populated cells, namely; 1) Products and Technology, 2) Natural Environment and Human Made Changes to the Environment, 3) Systems, Services and Policies, 4) Attitudes, and 5) Support and Relationships.

In this arrangement, systems, services and policies are located centrally highlighting the pivotal, coordinating role these concepts reflect in the organisation of human affairs. Attitudes, and Support and Relationships are placed at the edge of the cell that adjoins the Activities cell. This direct interface with the Activity cell is meant to infer the inherently social qualities that both Support and Relationships, and Attitudes, have on human activity; there is a quintessential humanness about these notions.

In contrast, the concepts of Products and Technology, and Natural Environment are positioned peripherally. In this way, the contents and position of each concept can be more easily recalled as 3 vertically oriented components i.e. a bottom layer (Attitudes and Supports and Relationships), a middle layer and central component (Systems, Services and Policies), and a top layer (Products and Technology and Natural Environment) (see Figure 5.06). Such an approach affords the opportunity to chunk the information in this cell into three groupings thereby minimising issues of cognitive load as additional detail is added to the schema.

Figure 5.06. Environment Array Arranged in Levels

Environment

Level 3 'non-human'	Products and Technology		Natural Environment and Human made changes to the environment
Level 2 'systems'		Systems, Services and Policies	
Level 1 'human'	Attitudes		Support and Relationships

Figure 5.06. The Environment array is arranged in 3 vertical levels corresponding to; 1) immediate 'human' considerations (i.e. Attitudes, Support and Relationships), 2) Systems level, and 3) 'non-human' considerations (i.e. Products and Technology, and Natural/Human made Environmental changes.

Further, the hub-like nature of the central cell (Systems, Services and Policies) asserts a coordinating function with radial connections to the remaining four cells in this grid (see Figure 5.07).

Figure 5.07. Systems, Services and Policies as a Central 'hub'

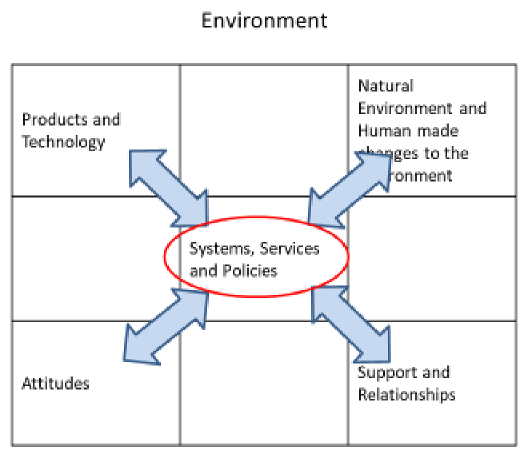

Figure 5.07. The Systems, Services and Policies cell is centrally located in the Environment array functioning as a coordinating hub.

5.03 Activity Cell

Like the Environment cell, the Activity cell is divided into a 3x3 array with each cell corresponding to one of the nine chapter headings of the 'Activity and Participation' chapter headings of the ICF (N.B. In the ICF a clear distinction between the concepts of Activity and Participation are not made and, as an appeal to simplicity, the concept of Participation is bracketed at this stage of the phenomenological description) (see Figure 5.08).

Figure 5.08. Expanded Activity Cell Shown as a 9-cell Array

Activities

Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge

Figure 5.08. The Activity cell from the 3-cell vertical array has been expanded to include the 9 Activity and Participation Chapter headings from the ICF. These cells are considered to be hierarchically arranged from the 'bottom-up' where the higher-levels (e.g. Domestic Life) reflect compositional output from lower-level interaction.

In arranging the Activity Chapter headings, the cells are, in this case, arranged hierarchically from the 'bottom-up' where the concepts of Communication, Mobility, and Learning and Applying Knowledge are taken to be the fundamental building-blocks of human activity from which more complex activities can emerge. As such, the second layer comprises Self-care, Interpersonal Interactions and Relationships, and, General Tasks and Demands. For example, to engage in the Interpersonal Interaction of 'shaking hands' this activity can be viewed compositionally as a dynamic, interwoven expression of Communication, Mobility and, Learning and Applying Knowledge. In the third tier, the most complex expression of human activities can be envisioned in Domestic Life, Major Life Areas, and Civic, Social and Community Life domains.

5.04 Body Cell

The remaining 'Body' cell is also divided into a more detailed array of concepts; in this case, a 3x2 array (see Figure 5.09). Taking this approach, the Body Structure and Function Chapter Headings from the ICF are integrated into paired groupings that share functional and/or structural relationships. Specifically, the Cardiorespiratory system component is paired in a cell with the Renovascular system where these systems share close physiological coupling (Husain-Syed et al., 2015). Next, the Neuromusculoskeletal system is paired with Special Senses given their structural and functional extension from the Neuromusculoskeletal system. Similarly, the skin and gastrointestinal systems are coupled together given their function as crucial interface organs with the environment (O'Neill, Paus, Monteleone, McLaughlin, & Paus, 2016). The Genitourinary and Reproductive systems share close structural relationship (Woodhouse, 1994) with the endocrine and metabolic systems intimately related from a functional perspective (Lavin, 2019). Lastly, the Haematological and immunological systems share considerable overlap (Gargani, 2015). Using this approach, the 18 Chapter headings from the ICF pertaining to the 'Body' are pragmatically reduced to 12 paired items occupying six cells. The human genome has not been explicitly represented in the matrix of body components, however, there is no reason that this should not be the case and , for example, could be located with the metabolic system given the fundamental role our genetic material has in the control of growth and regulation in a broad sense.

Figure 5.09. Expanded Body Cell Shown as a 6-cell Array

Body

Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 5.09. The Body Cell from the 3-cell vertical array has been expanded to 6 cells that contain pairings of related body systems. These 12 paired items represent a pragmatic reduction of the 18 Structure and Function Chapter headings from the ICF.

With this approach, the term ‘body’ is used to provide some consistency with the ICF. However, the term ‘Body’ in this study is also considered synonymous with a variety of related terms that include; person, human being, client, patient, person with a disability, carer etc.

5.05 Putting the Cells Together

In all, the three vertically oriented cells (i.e. Body, Activity and Environment) are expanded to give 20 populated cells derived from the chapter headings contained in the ICF (see Figure 5.10).

Figure 5.10. Populated Cells of ICF-derived Cellular Array

Products and Technology		Natural Environment and Human made changes to the environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 5.10. The 3 cells of the simple vertical array have been expanded to include 20 active cells. The 20-cell array forms the basis of the cognitive artefact used in practice.

Thus far, the schema provides a gradual unpacking of concepts from a single chunk (container) that contains the concepts of Environment, Body and Activity that can be further unpacked into a deliberately arranged fixed-array of concepts that reflect slices of space-time.

From Structure to 'Processing on Representation'

The current schema provides an essential component required as the basis for computation, i.e. representation, where computation can be conceptualised as 'processing on representation' where ‘thinking can best be understood in terms of representational structures in the mind and computational procedures that operate on those structures’ (Thagard, 2012). For the schema to more authentically appeal to this notion of computation, consideration of processing is required where the concept of a cellular automata provides a useful analogy for understanding both representation and processing.

5.06 Cellular Automata

Cellular Automata provide a non-traditional example of computation that has been chosen as a useful analogy for the artefact that is the focus of this study (Mitchell, 1998). The basic idea of a cellular automata (CA) is that of a cellular grid or lattice where each cell occupies a particular ‘state’ (e.g. ‘on’ or ‘off’) where the current state of a cell is determined by the state of neighbouring cells based on processing ‘rules’(Berto, 2012). In more complex simulation’s cells occupying a grid may have multiple potential states. Cells in the grid change state at discrete time steps giving rise to parallel-processing computers of simple construction (Wolfram, 2002). The most common ‘neighbourhoods’ for two-dimensional CA are outlined in Figure 5.11 (Janssen, 2010). The concept of a Cellular Automata was first described in the 1950’s (von Neumann, 1951) with CA now considered to be a core subject in the sciences of complexity where modelling phenomena present in the physical world is a typical research goal (Gowers, 2008, p. 836; Hoekstra, Kroc, & Sloot, 2010).

Figure 5.11. Types of Cellular Automata

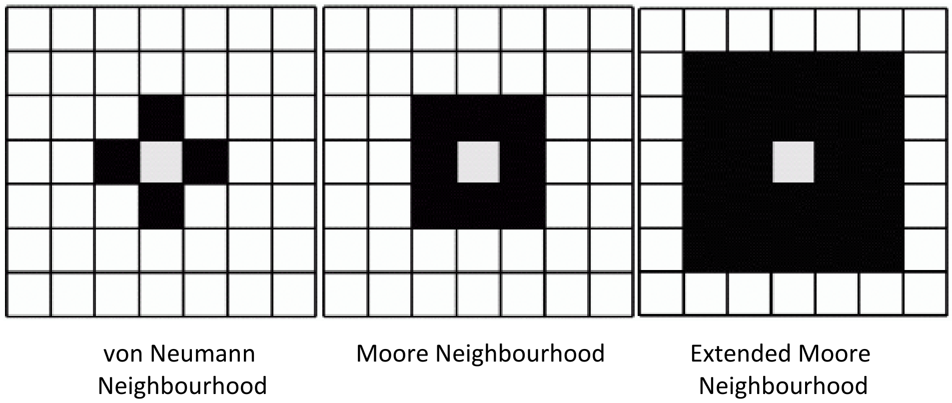

Figure 5.11. Three types of 2-dimensional cellular automata are shown. The state of the central cell in each of the three automata types are determined by the state of surrounding black cells. Adapted from Janssen (2010).

5.07 Modelling the World of Rehabilitation Medicine

Using the analogy of a cellular automata, the artefact outlined so-far could be viewed as a CA-like tool upon which information relevant to 'computation' of information during Rehabilitation Medicine problem solving could be considered. In their most simple form, the components of Body, Activity and the Environment could be considered, in an abstract sense, to be a neighbourhood of 3 adjacent cells that update at discrete time intervals to create past and present states as well as potentially future states. As a simple example, the cells may update according to the following rule; that the Environment cell needs to be 'on' for the 'Body' and 'Activity' cells to be 'on'. If, for example, the 'Environment' cell was 'off', say in the event that there was no oxygen in the earth's atmosphere, then, correspondingly the 'Body' and 'Activity' cells would also be 'off'.

5.08 The Combinatorial Explosion

Whilst on the surface the use of only 20 cells in an array may appear to be an overly simplistic approach to framing problems encountered in Rehabilitation Medicine practice, the potential complexity of relationships that can arise from these cells can quickly become overwhelming when varieties of combinations and permutations of cell states are considered. For example, combinations of 4 cells across a 20-cell array give rise to a potential 4845 combinations. Such a large number of combinations has been described as both the ‘combinatorial explosion’, and ‘immense numbers’ by luminaries in the field of complexity research (Bertalanffy, 1969; Simon, 1962).

The confronting mathematical reality that arises from this so-called combinatorial explosion is further amplified when considering the actualities of practice where many finer-grained levels of detail are required as inputs for complex problem solving in actual cases. These finer-grained levels of detail operate within each of the 20 cells represented in the array.

For example, the cell entitled ‘Products and Technology’, would reasonably include ‘aids that support walking’ where this concept would include an additional range of products, say, ‘lower limb prosthetics’ (Seymour, 2002). Lower limb prosthetics can be further divided into categories based on the part of the lower limb they are designed to act on, for example; the foot, ankle/foot, knee/ankle/foot orthoses etc. Alternatively, adopting a disease frame, ‘Products and Technology’ might include ‘Pharmaceutical products’ within which the sub-category of ‘antibiotics’ is a well-known example that can be further categorised based on antibiotic classes such as penicillins, macrolides, quinolones etc. (Yount, 2005).

5.09 Permutations: Where Order Matters

The above example of combinations operating on the cellular array suggest the degree of complexity that can arise from relatively few variables operating across it. The concept of combinations does not require consideration of order or sequence, however, in clinical practice the requirement for the sequential ordering of certain processes is essential and such processes can be considered as permutations. For example, if the self-care cell is required to achieve a particular level of activity for successful functioning i.e. to be in the 'on' state, then this may be dependent upon, in the case of certain disabilities or developmental states, a requirement for support (e.g. a carer), that in turn may be dependent on the existence of a service or system who can provide the required carer. So, in this example the order or sequence required to move the self-care cell to the 'on' state requires firstly, the availability of a service, and then secondly, the employment and training by this service of a carer. In practice, a service may need to be accessed that provides funding for a subsequent service who is then responsible for providing a carer to assist in the performance of self-care with a client.

From a mathematical perspective consideration of permutations operating on the array significantly increases the complexity that arises. For example, permutations of just three cells on a 20-cell array generates 6840 possible permutations. In the scenario that four cells required activation in a sequence – for example if a change in the attitudinal environment was required to initiate the previous sequence (i.e. service, support, self-care) – then the theoretical permutations involving four cells generates 116280 possibilities. Many of these theoretical permutations would be either non-sensical sequences, or, sequences that occurred with very low frequency. Astonishingly, the complexity of combinations and permutations described occurs at the apparently very simple level of the ICF chapter headings.

5.10 Additional Complexity: Beyond Chapter Headings

Thus far, the mathematical complexity theoretically arising from the array has been considered when considering only 20 cells that represent a modified arrangement of ICF chapter headings. In practice, these cells can be further unpacked into much finer detail that is outlined in the ICF beyond the chapter-level headings, namely, in levels 2,3 and 4 of the classification. Indeed, practice settings demand consideration of detail well beyond the floor of these ICF levels where a critical finer-level detail may determine the overall state of the cell. It is in this setting that the full-force of the combinatorial explosion can begin to be appreciated. It is in environments of complexity, as seen in expert medical practice, that the human brain continues to outstrip current AI efforts and lies at the centre of fundamental and fascinating questions about how our brains work (Braga & Logan, 2017).

5.11 Hidden Layers

As suggested above, the use of 20 cells in an array provides a surface view of the possible relational complexities that inform an understanding of human function, disability and health. Beneath these cells, however, exist multiple deep 'hidden layers' that are not explicitly visible in the array (see Figure 5.12). When considering the ICF, these layers are present in the hierarchically organised levels of the classification and a working knowledge of these levels (and beyond) is inferred in the use of artefact.

The following diagram illustrates the concept of deeper layers that act beneath the surface level of the artefact as it is presented in the form of 20 active cells immediately beneath the primary layer; the 3-main conceptual 'chunks' of Environment, Activity and Body.

In this setting expertise in Rehabilitation Medicine practice could be defined as an ability to make accurate inferences about relational connections between information at multiple levels of granularity where inferential abilities are informed by multiple frame perspectives (Goffman, 1974). The importance of multiple frame perspectives in Rehabilitation Practice are discussed in the next section.

Figure 5.12. Cognitive Artefact Layered Granularity

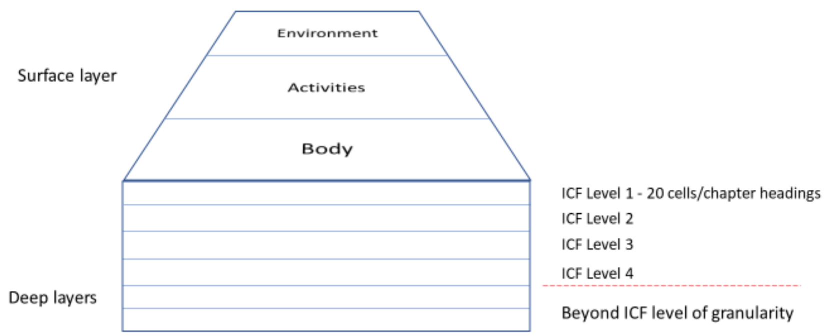

Figure 5.12. The Cognitive Artefact comprises a coarsely granular superficial layer comprising Body, Activity and Environment. Underneath this lies the expanded 20-cell array derived from the ICF Chapter headings. Below the 20-cell layer lie additional levels of granularity (e.g. ICF level 3 and 4 items) as well as additional finer-grain layers of granularity that are required to inform Rehabilitation Medicine Practice.

Alternate Frame Perspectives

5.12 Developing Frame Perspectives Beyond ICF

The construction of the schema to date has drawn solely, with some modification, on concepts contained in the ICF that was not designed with the purpose of understanding of disease. Indeed, concepts at or below the cellular level are explicitly overlooked in the ICF. This next section will, however, present preliminary arguments for how the ICF concepts, as outlined in the above schema, could be used to adequately provide a framework for describing and understanding disease states.

5.13 A Common Array for Multiple Frame Perspectives

As stated earlier, a major challenge in Rehabilitation Medicine practice is the adoption of multiple frame perspectives (e.g. disability, disease, function etc.) and the integration of these frame perspectives into a meaningful whole. The following 2x2 table explores the concepts of disease and disability giving rise to four theoretical states where disability and disease are either present or absent.

Figure 5.13. Disease and Disability 2x2 Table

		Disability +	Disability -
Disease	+	Disability and Disease present	Disability absent Disease present
	-	Disease absent Disability Present	Disease absent Disability absent

Figure 5.13. Theoretical table outlining possible relationships between disease and disability states. Coupled states of disease and disability require consideration of multiple frame perspectives in practice settings.

States of disability and disease, designated as either present or absent, give rise to the theoretical states where disease and disability are either co-existent, both absent, or decoupled from one another (see Figure 5.13). These four theoretical states provide a logical approach to considering frame perspectives that may be applied to the use of the artefact that has been outlined in the current chapter. In considering these four conditions, disability as a stand-alone state in the absence of disease is debatable. There are situations, however, where a person's primary goal may be to attain a state of what may be considered 'disability' as in Body Identity Integrity Disorder. In this situation the person's desire may be, for example, amputation of a functioning limb where it has been argued that such requests reflect human diversity and not an underlying mental health disorder (Barrow & Oyebode, 2018). There are also common situations where a person may experience disability in the absence of disease with pregnancy being an obvious example. Additionally, the lack of appropriate educational opportunities, such as learning to read and write, provides another example where circumstances without the presence of disease may create conditions for the experience of disability. As such, the next chapter will be to systematically consider three of these four states using examples of each to demonstrate the use of the artefact where an understanding of all states has relevance to Rehabilitation Medicine practice.

5.14 Summary

This chapter outlines a 2-dimensional 20-cell array that expands the Body, Activity, Environment model described in the previous chapter where the array provides a finer level of detail upon which real-world problems pertaining to the practice of Rehabilitation Medicine can be represented and explored. To convey the dynamic nature of the cellular array components an analogy is drawn with Cellular Automata (CA) where CA serve as an abstract prototype for representing complex computational problems such as those encountered in Rehabilitation Medicine practice.

Further to this, theoretical framing perspectives are proposed based on the presence or absence of disease and disability, either alone, in the case of disease, or in combination, that serve a logical basis for description and analysis of the artefact in subsequent chapters.

Chapter 6: Applying the Artefact- Four Examples

The aim of this chapter is to provide examples of how the study artefact can be used to support an understanding of clinical problems relevant to the practice of Rehabilitation Medicine. As clinical problems encountered in Rehabilitation Medicine span both disease and disability, examples of each will be provided. In all, four contrasting examples will be presented with a goal of demonstrating both the breadth and the integrative capacity of the study artefact. To that end, the first example focuses on a prototypical medical disease; myocardial infarction, where the aim is to demonstrate a mapping of this (ICD) condition on to the (ICF-derived) study artefact.

Next, the clinical scenario of fever in a critically unwell patient following traumatic brain injury (TBI) is described where the study artefact, as in the first example, is used to facilitate an understanding of diagnosis and management considerations from a 'disease' frame, or, the ICD perspective. In this example, two diseases/disorders as the potential cause for the underlying fever (i.e. sepsis and paroxysmal sympathetic hyperactivity) are contrasted.

Thirdly, a hypothetical scenario outlines the approach to the management of distress in a young woman with intellectual disability admitted to hospital for management of an ankle fracture following a fall. This final example highlights the way in which the artefact can represent multiple-frame perspectives (e.g. disease and disability) and how this may result in different approaches to care.

Lastly, a fictitious case typical of the author's clinical practice is used to show a completed template and subsequent consultation letter based on the template.

The chapter concludes with a discussion of the value of the study artefact in supporting cognition in Rehabilitation Medicine practice through exploration of the examples provided.

Example 1: Myocardial Infarction

As a prototypical medical disease, myocardial infarction provides a useful example of a condition that could be applied to the study artefact to explore the artefact's potential to map disease states (i.e. ICD content). Restating this as a question: can 'ICD' (i.e. disease states like myocardial infarction) be mapped on to 'ICF' (the ICF-derived study artefact)? Importantly, such an approach reflects a *reverse* mapping that contrasts with current efforts exploring ICF and ICD relationships where ICF components have been mapped to ICD (Selb et al., 2015).

6.01 Relevance of Myocardial Infarction to Rehabilitation Medicine

Myocardial infarction is a major cause of death and disability worldwide (Thygesen et al., 2012) and is used as an example of a prototype disease in describing the current revision of ICD (WHO, 2011). In medical practice, a working knowledge of MI; its typical causes, diagnosis and treatment, are considered a core practice competency. In other words, all medical doctors practicing in clinical settings need to know something about 'heart attack'. For a subset of Rehabilitation Medicine physicians, a more detailed approach to the knowledge and management of MI may be required, for example, those working in the field of Cardiac Rehabilitation (B. Rauch et al., 2016). Further, a patient with a history of MI will inform the delivery of Rehabilitation care regardless of the reason for the current Rehabilitation encounter.

6.02 The ICD 11 Content Model: A structured Approach to Describing Disease

In approaching a mapping process of disease (e.g. MI) on to the ICF-derived study artefact, it is useful to undertake this using an organised structure for which the Content Model of ICD provides a relevant framework (WHO, 2011). The Content Model of ICD 11 aims to, 'define the ICD categories in a systematic way and represent the classification knowledge to allow processing within computer systems' (WHO, 2011, p. 4). Specifically, the Content Model makes provision for 13 main parameters which are outlined in Table 6.1 below.

6.03 Content Model Parameters

Table 6.1. The 13-Component Content Model of ICD-11

1.	ICD Entity Title, e.g. Myocardial Infarction
2.	Classification Properties, e.g. ICD coding data
3.	Terms, e.g. Signs and Symptoms
4.	Textual Definitions, e.g. Detailed text definition of Myocardial Infarction
5.	Body Systems/Structural Description, e.g. Cardiovascular system, coronary artery
6.	Temporal Properties, e.g. acute
7.	Severity of Subtype properties, e.g. Size of Myocardial Infarction
8.	Manifestation Properties, e.g. Chest pain
9.	Causal Properties, e.g. Smoking, hypertension
10.	Functioning properties, e.g. Mobility limitation
11.	Specific Condition Properties, e.g. Adult Male
12.	Treatment Properties, e.g. thrombolysis
13.	Diagnostic Criteria, e.g. ST elevation on ECG

6.04 ICF definition of Disease

In all, these parameters inform the concept of disease that in the current ICD revision process is defined as;

> ‘a set of dysfunction(s) in any of the body systems defined by;
>
> 1. Symptomatology: manifestations: known pattern of signs, symptoms and related findings
> 2. Aetiology: an underlying explanatory mechanism
> 3. Course and outcome: a distinct pattern of development over time
> 4. Treatment response: a known pattern of response to interventions
> 5. Linkage to genetic factors: e.g., genotypes, patterns of gene expression
> 6. Linkage to interacting environmental factors’ (WHO, 2011, p. 4)’

Of fundamental interest to this study and the ensuing mapping process, is the basic assumption that disease is viewed as an expression of (dys)*function*, thereby endorsing (at least at a theoretical level) the potential for disease to be mapped to a classification of *function* (i.e. ICF) where ICF describes potential states of function on a spectrum from positive to negative (i.e. full function to dysfunction) (Salvador-Carulla & Garcia-Gutierrez, 2011).

Whilst the above definition specifies that dysfunction occurs at the level of Body systems, it acknowledges explicitly the role of the interacting Environment, the implicit potential for Activity-level Aetiological contributions, as well as a temporal component. As such, the basic components of the study artefact models proposed in earlier chapters, (i.e. Body, Activity, Environment concepts structurally arranged in a spatio-temporal cylinder and an automata-like array), foreshadow a potentially logical, simple, yet robust framework on which 'disease' could be mapped.

6.05 Unpacking the Content Model

To demonstrate the utility of the study artefact to map disease, a systematic consideration of the Content Model parameters will now be undertaken using MI as the disease example. The populated study artefact/array outlined in the previous chapter is reproduced (see Figure 6.01) and upon which the mapping process will be undertaken. At each stage of the mapping process and for subsequent examples the artefact populated with Chapter Headings is reproduced below the mapping example on each page to reduce the cognitive burden on the reader.

Figure 6.01. 20-Cell Array

Products and Technology		Natural Environment and Human made changes to the environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.01. 20-Cell Array populated with adapted ICF Chapter Headings for mapping to ICD Content Model.

1. ICD Entity: In this case the ICD Entity refers to the condition, i.e. Myocardial Infarction, that, if known can be noted in the corresponding body structure and system cell designated Cardiorespiratory and Renovascular (see Figure 6.02).

Figure 6.02. ICD Entity 'Myocardial Infarction'

'MI'		

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

2. Classification Properties: this item refers to the collective properties of Disease or disorder, signs and symptoms, external causes, injury and reason for encounter and will be addressed individually in subsequent items of the content model below.
3. Textual definitions: these refer to definitions of conditions, signs and symptoms and diagnostic criteria for the disease. For example, 'Myocardial infarction occurs due to an ischemia - lack of oxygen in the heart muscle, which may lead to the death of myocardial tissue. This generally happens due to interruption of the blood supply of the heart when a coronary artery is blocked. Underlying this blockage is generally a collection of lipids and atherosclerotic plaques.'(WHO, 2011, p. 19), where, 'Myocardial infarction occurs with sudden chest pain, palpitations and sometimes without symptoms. An electrocardiogram may show pathologic Q waves or ST segment elevation and blood tests for creatine kinase may indicate rapid rise or troponin T levels may fall.'(WHO, 2011, p. 20)

Figure 6.03 maps the textual definition of MI onto the corresponding cells with 'oxygen' arising from the 'Natural environment' cell that, when interrupted to heart muscle through the sequential steps of plaque rupture and coronary occlusion leads to reduced blood (and oxygen) supply and resultant myocardial ischaemia.

Figure 6.03. Myocardial Infarction Example Textual Definitions - A

		Oxygen
Atheroma/Plaque rupture Coronary occlusion Reduced blood supply Myocardial ischaemia		

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

In turn, Figure 6.04 shows the effect of myocardial ischaemia on the development of signs and symptoms of MI such as palpitations and chest pain (a neurologically mediated experience) with diagnostic 'products and technologies' (i.e. ECG machines and cardiac enzyme assays) utilised to assist in confirming a diagnosis of MI based on characteristic changes.

Figure 6.04. Myocardial Infarction Example Textual Definitions - B

ECG changes, cardiac enzyme assays (e.g. CK, troponin)		
Myocardial ischaemia Palpitations	Chest pain	

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

4. Index terms: these refer to synonyms and further discussion is not relevant to the current mapping process.

5. Body System/Structure Definition: this item refers to body systems, structures and morphological characteristics (e.g. histopathologic features) that are relevant when considering the disease. As shown above MI occurs in the Cardiorespiratory/Renovascular system of the artefact where specific structures may be further specified such as individual coronary arteries (e.g. proximal left anterior descending artery (LAD)) and where specific morphological features may be evident that may include histopathological findings such as atherosclerotic plaque rupture, coronary artery dissection, vasculitis and myocardial infarction. These morphological changes reflect micro and macroscopic alterations located within the Cardiovascular system that reflect dysfunction of these structures where dysfunction is seen as the hallmark of disease (WHO, 2011, p. 4).

   Figure 6.05 shows a specific body part (proximal left anterior descending artery) with a specific morphological feature (coronary artery dissection) mapped to a specific system/cell (Cardiovascular) located in the cellular array.

Figure 6.05. Myocardial Infarction Example Body System/Structure Definition

Proximal LAD dissection		

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

6. Temporal properties: this item refers to the age-related and development course properties of the disease.

Here, the spatio-temporal model outlined earlier (see chapter 4) that is used as the basis for developing the clinical tool is considered with reference to myocardial infarction. Figure 6.06 below shows the developmental spectrum from birth to death where examples of underlying causal mechanisms for the development of MI are mapped to the typical developmental stages in which they occur.

For example, 1) perinatal asphyxia may lead to a critical lack of oxygen to the myocardium at birth leading to MI, 2) Kawasaki disease where inflammation of the coronary arteries may lead to MI with this condition typically affecting children under 5, 3) cocaine induced MI in younger adults, and, 4) Atherosclerotic disease typically causing MI in adults from their 40's and beyond (see Figure 6.06) (Morrow, 2017; Papneja, Chan, Mondal, & Paes, 2017).

Figure 6.06. Myocardial Infarction Example Temporal Properties

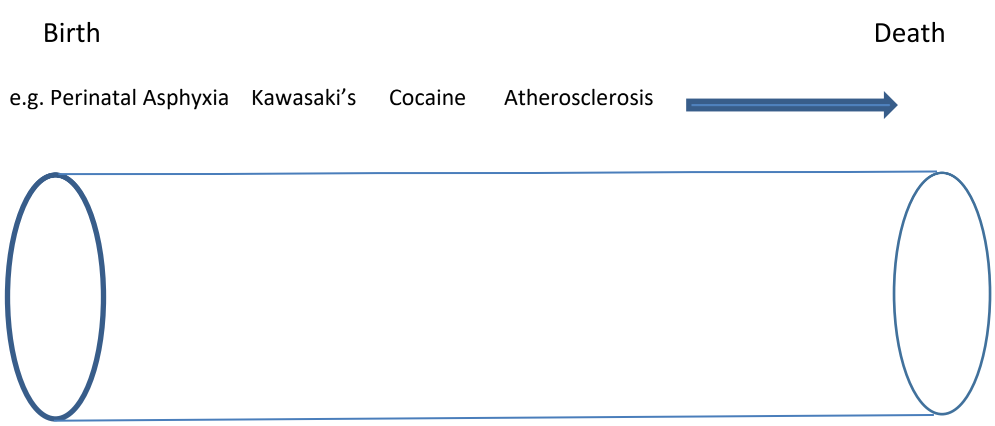

Figure 6.06. Typical aetiological factors for Myocardial Infarction differ across the human lifespan.

Further, temporal properties refer to the developmental course of a disease that may be acute, sub-acute or chronic. Whilst MI is typically understood to be an acute event, the developmental process that leads to its final expression may differ significantly in a temporal context, for example, the effects of cocaine on the caliber of coronary arteries are immediate, whilst the time course for the development of established atherosclerosis typically occurs over decades.

7. Severity of subtypes: refers to the severity of a disease e.g. mild, moderate or severe. This item will not be discussed in relation to the mapping process.

8. Manifestation properties: these items refer to disease properties like signs and symptoms, and investigation findings (e.g. laboratory and imaging).
   Figure 6.07 below shows the range of typical signs and symptoms of MI that might be experienced. Typical investigations that are used in the diagnosis of MI were outlined earlier in the diagram outlining textual definitions (i.e. ECG and Cardiac enzymes).

Figure 6.07. Myocardial Infarction Example Manifestation Properties

	Reduced exercise tolerance	
Palpitations Shortness of breath	Chest, neck, jaw, arm pain Lightheaded, fatigued	Sweaty Nausea, indigestion

Products and Technology		Natural and Human Made Changes to the Environment
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Domestic Life	Major Life Areas	Community, Civic and Social Life
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9. Causal Properties: this item refers to factors that contribute to the cause of the disease and include concepts such as aetiology, causal agents and mechanisms, genomic links and risk factors.

   For example, overweight and obesity is known to be a causal link for the development of MI (Thomsen & Nordestgaard, 2014) where minimal exercise and high caloric diets are implicated in the development of the former. In turn, environmental and other activity and participation-related factors are plausibly linked to these states (i.e. low exercise, high caloric diets) that can be described in the study artefact (see Figure 6.08).

Figure 6.08. Myocardial Infarction Example Causal Properties

Advertising High calorie foods		
	Food regulation policy Food production services Information systems Education systems	
Attitudes to obesity		
Overeating Looking after one's health		
	Reduced mobility	Learning and applying knowledge of obesity and CV risk
MI		Obesity
	Genetic influence on metabolism	

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
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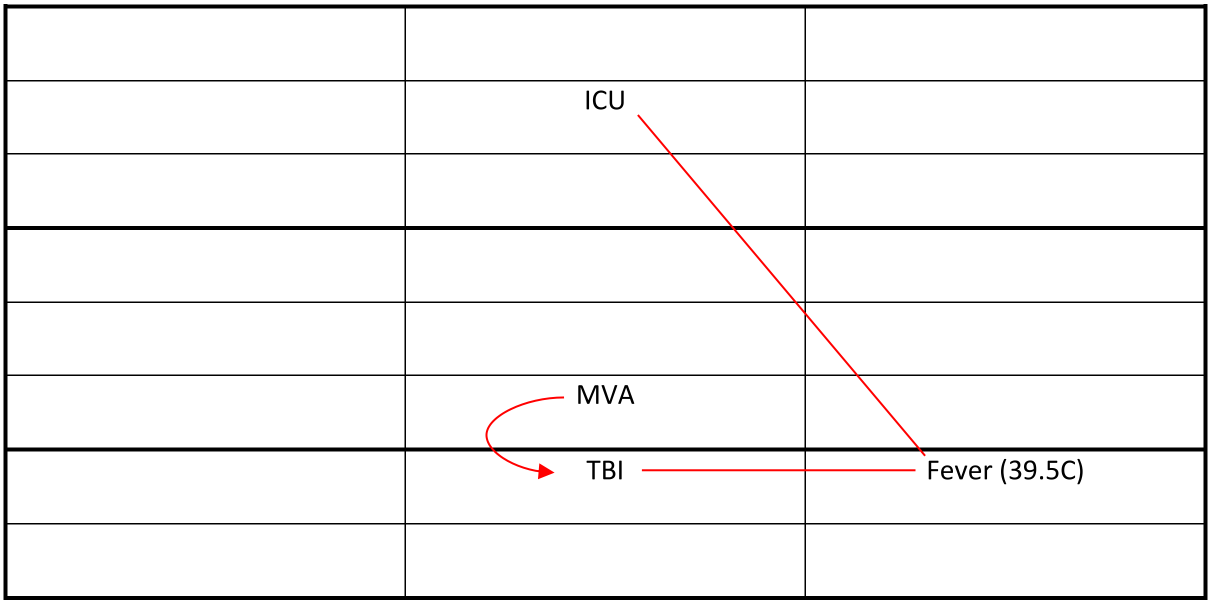
Example 2: Fever in the ICU

John is a 27-year-old male who sustained a severe traumatic brain injury seven days ago following a high-speed motor vehicle accident. He remains in a coma in Intensive Care and has begun to develop significant fevers up to 39.5 degrees Celsius (see Figure 6.09).

Figure 6.09. Fever in the Setting of Traumatic Brain Injury



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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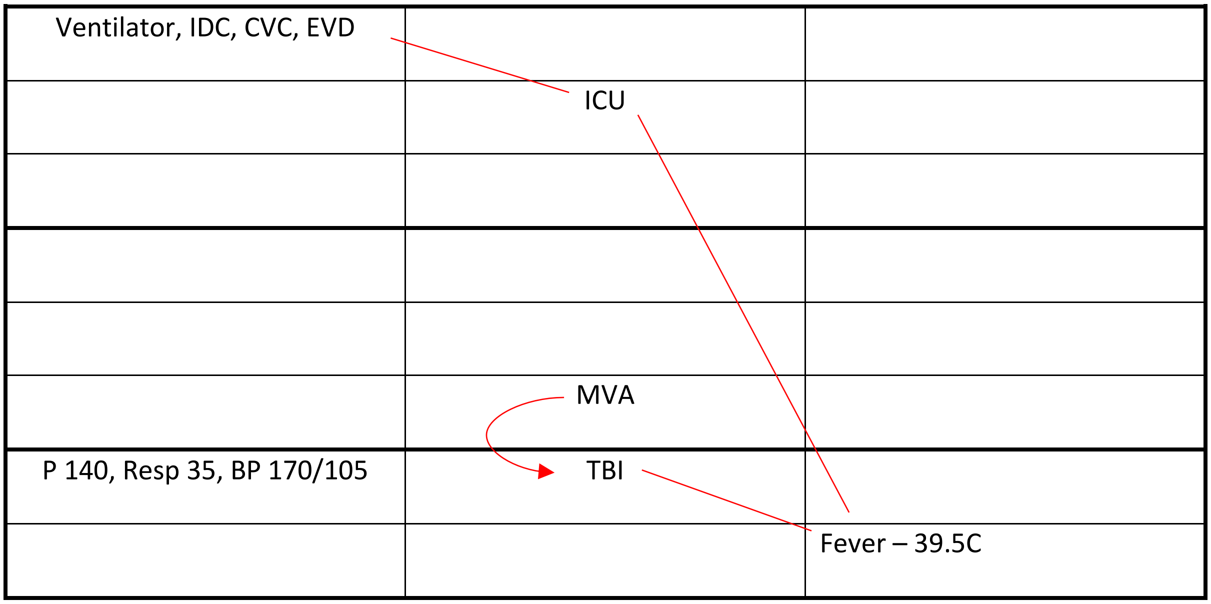
As is typical of TBI management in critical care settings, John is being managed with several products and technologies that include endotracheal ventilation, a central venous catheter, indwelling urinary catheter, and an extra ventricular drain. In this setting, all these invasive products serve as potential sources for bacterial entry into the body from the outside world that, coupled with physiological stress and immobility heighten the risk of infection for which fever is a cardinal sign (see Figure 6.10). In John's case, the potential for infection arising from the urinary tract (IDC), bloodstream (CVC), respiratory system (ventilator) or central nervous system (EVD) all need to be considered. Here, these environmental products can all be explicitly linked to various body structures as potential aetiological sources (see Figure 6.11). In response to this potential for infection from these sources arrange of investigations can be instigated including sampling of fluids from these sites to identify an offending bacterial source: blood, urine, sputum and cerebrospinal fluid are all obtained for culture, a chest x-ray is performed looking for signs of pneumonia and biochemical tests for inflammation that can infer systemic infection are sent. In many cases such as John's empirical antibiotic treatment is commenced given the potentially fatal outcomes from bacterial sepsis if treatment is delayed (see Figure 6.12).

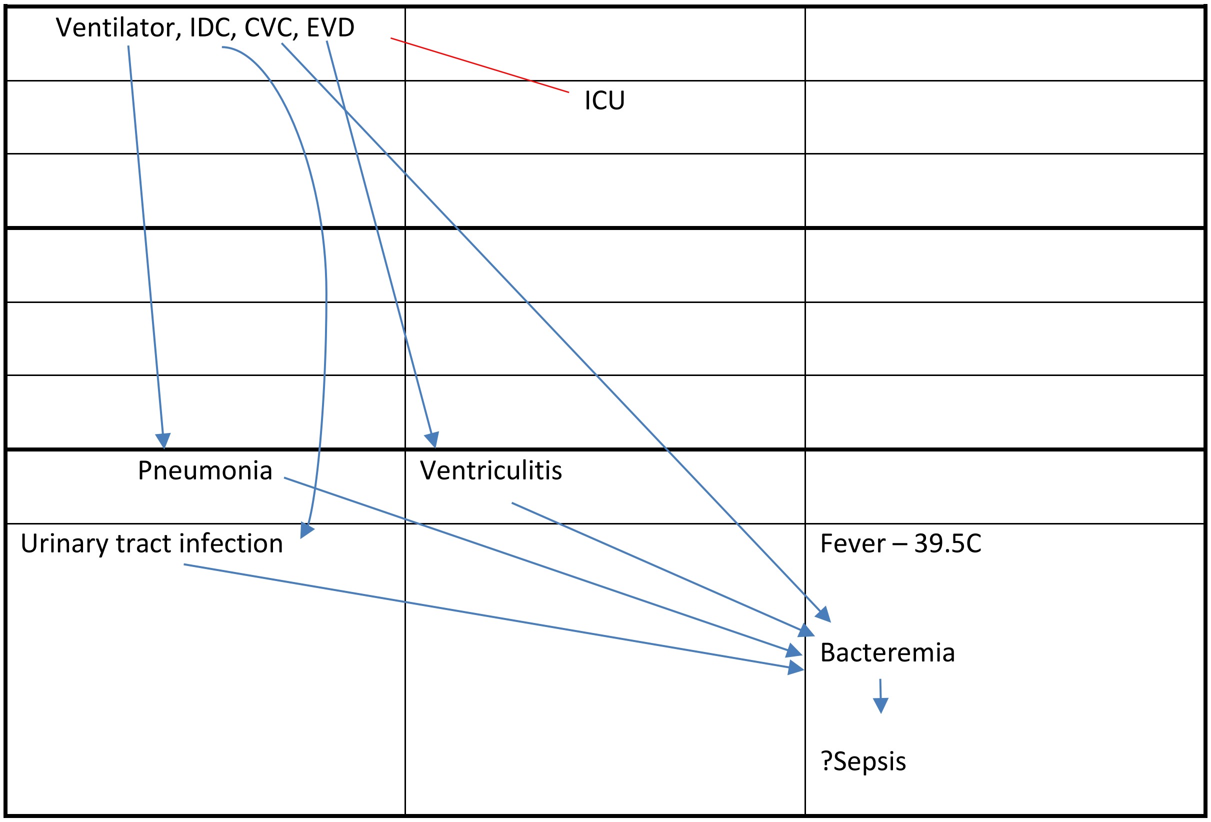
Beyond the presence of significant fever, additional 'vital signs' also provide information to better understand what process might be contributing to John's significantly elevated temperature. In his case, John has an abnormally elevated heart rate, respiratory rate and blood pressure that reflect the current functional state of the cardiorespiratory and vascular systems (see Figure 6.10).

Figure 6.10. Context of Fever – Vital Signs and Invasive Devices



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.11. Potential Aetiological Factors and Health Conditions to Explain Fever



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.12. Potential Investigation Options to Confirm Sepsis

Sputum sample, Instigate tests (e.g. CXR, Blood tests), empirical antibiotics		
Sputum sample	CSF sample	
Urine sample	Metabolic response e.g. CRP, procalcitonin, lactate	? Sepsis Blood culture and antibiotics

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
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In John's case, it is noted that his blood pressure is significantly elevated which contrasts with the typical response of the body to sepsis where hypotension is usually seen (see Figure 6.13). For the clinician experienced in the assessment of traumatic brain injury in critical care settings, this deviation from the usual pattern of vital signs in sepsis prompts consideration of an alternate diagnosis based on autonomic nervous system dysfunction directly attributable to the traumatic brain injury (see Figure 6.14). Here, clues to the alternate diagnosis of paroxysmal sympathetic hyperactivity may be evident with signs elicited following, for example, changes in body position by staff (e.g. being turned in bed), or other provocative stimuli such as endotracheal suctioning. In that case, efforts may be directed toward minimising interventions that may needlessly stimulate sympathetic hyperactivity. In addition, pharmacological interventions may be directed toward modulating the response of the sympathetic nervous system response (see Figure 6.15).

Figure 6.13. Relevance of Hypertension in Guiding Clinical Problem Solving Pathway

	ICU	
	MVA	
170/105mmHg	TBI	Fever (39.5C)

Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
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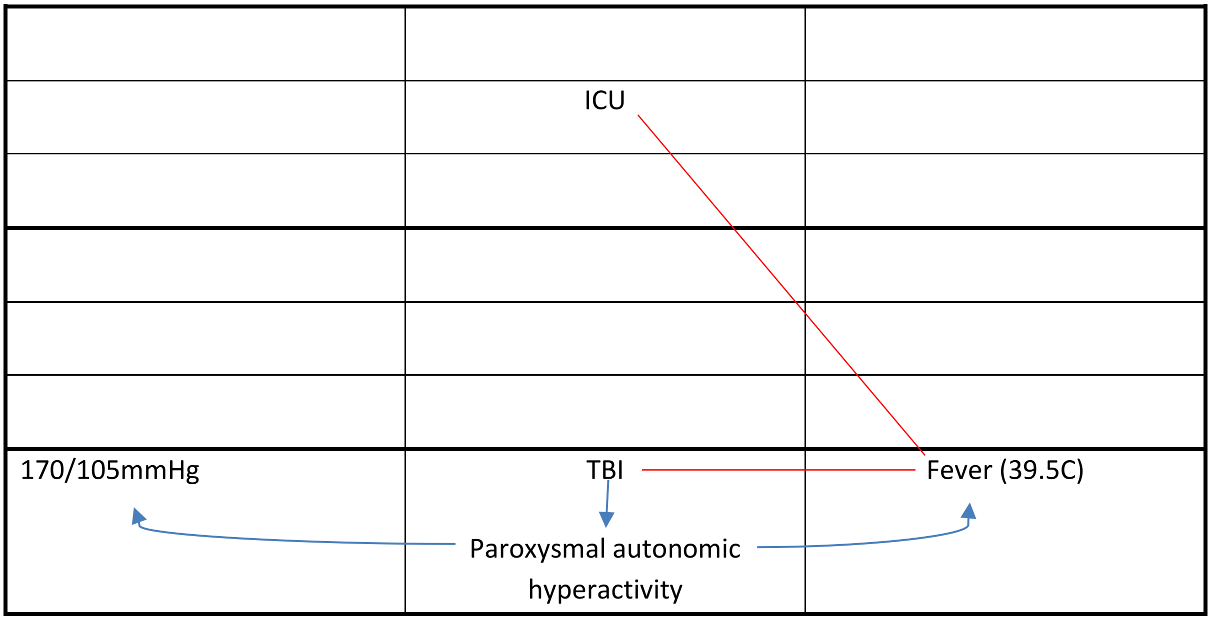
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.14. Possible Aetiological Mechanism to Explain Hypertension in Context of Fever



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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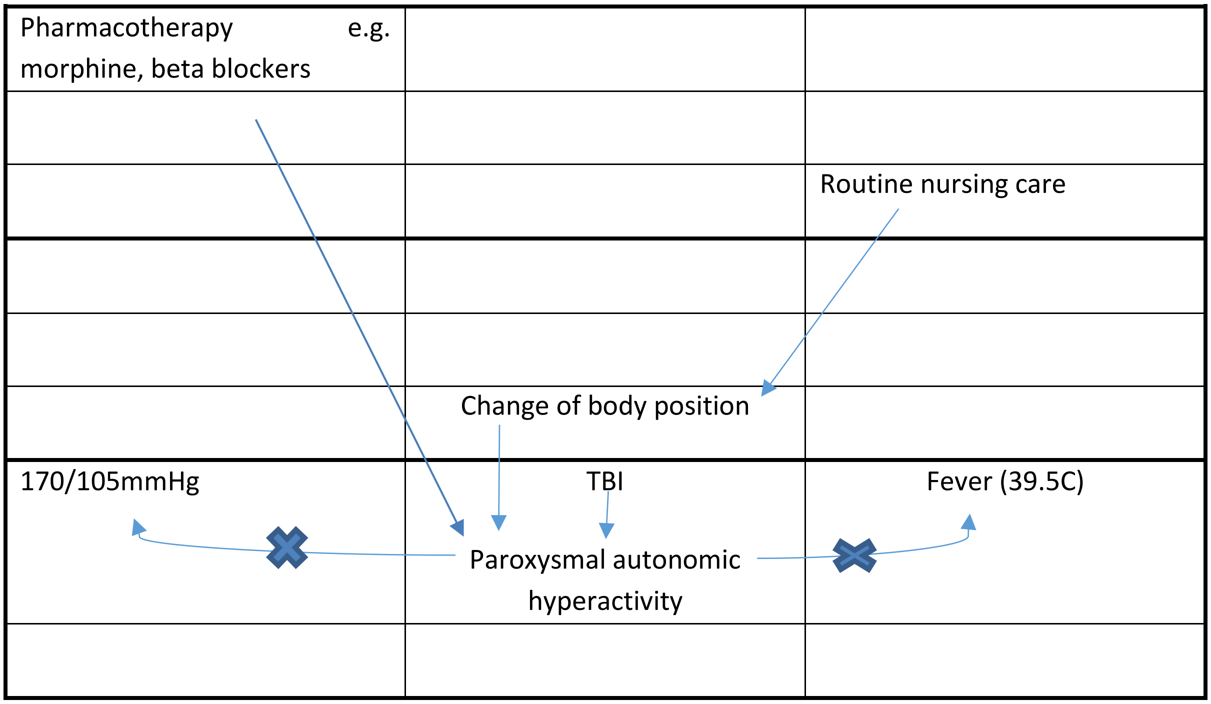
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.15. Potential Management Strategies for Paroxysmal Autonomic Hyperactivity



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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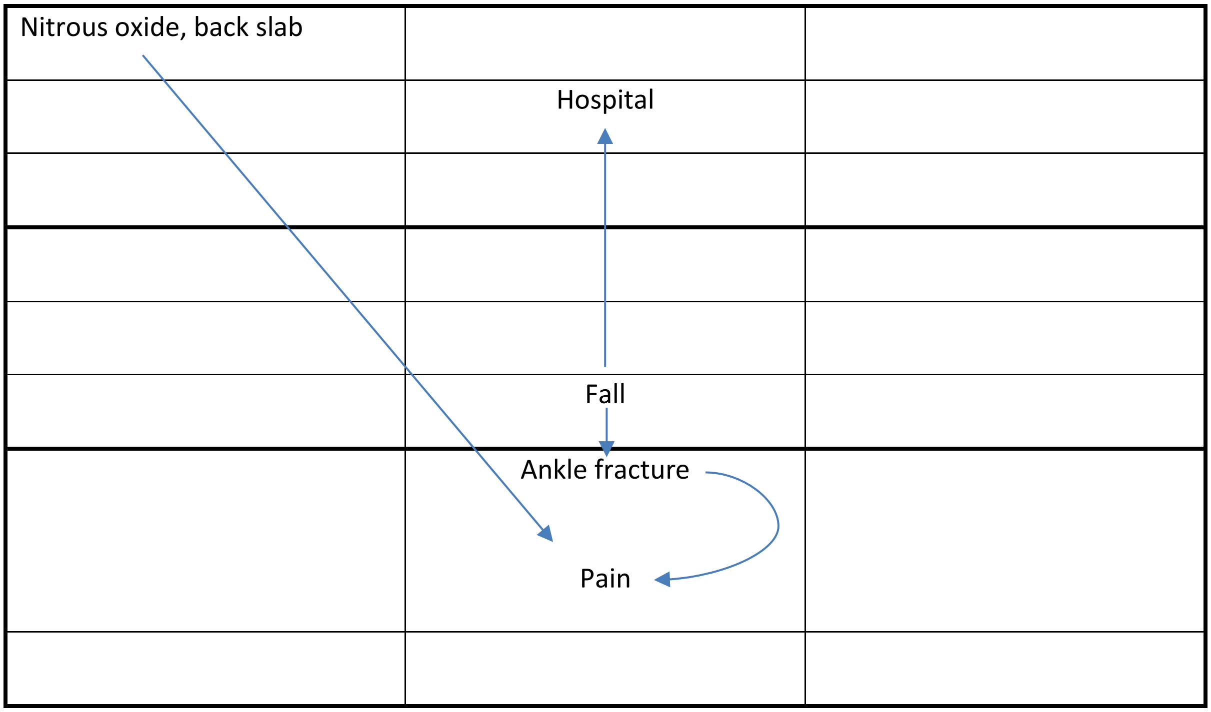
Example 3: Anna’s Broken Ankle

Anna is a 32-year-old female with Down’s Syndrome who lives a group home where she receives 24-hour care and support. Following a fall down a driveway whilst visiting a friend, Anna sustains an ankle fracture and is taken to hospital. Unfortunately, Anna needed to be transported to hospital without a carer as staff were required to remain at the group home to care for the other residents. In the emergency department Anna was able to use nitrous oxide (laughing gas) whilst a back slab was applied to her leg and she was then transferred to the ward as her reduced mobility precluded immediate transfer back to the group home (see Figure 6.16).

Figure 6.16. Initial Pain Management Intervention in Hospital for Ankle Fracture



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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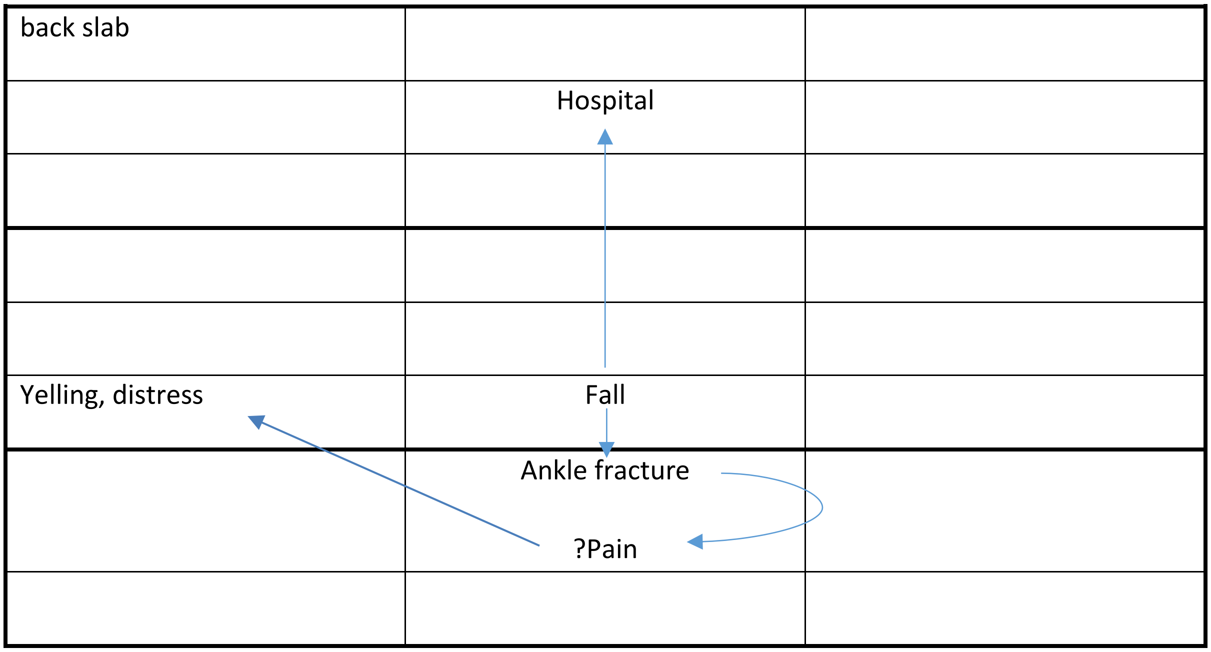
Shortly after arriving on the ward Anna becomes distressed evidenced by yelling out to 'go home' and shaking on the hospital bed rails. The orthopaedic resident is called to review Anna, who, after brief discussion with the orthopaedic registrar in theatre concludes that Anna's distress likely relates to inadequately managed acute pain (see Figure 6.17) and prescribes an oral short acting opioid (see Figure 6.18). When attempting to administer the resident's prescription, Anna spits out the tablets and her agitation increases. As a result, hospital security staff are called who assist in physically restraining Anna so that an intramuscular injection of morphine can be given to manage her presumed acute pain. The short acting parenteral opiate causes Anna to become sedated and she soon falls asleep for approximately 45 minutes.

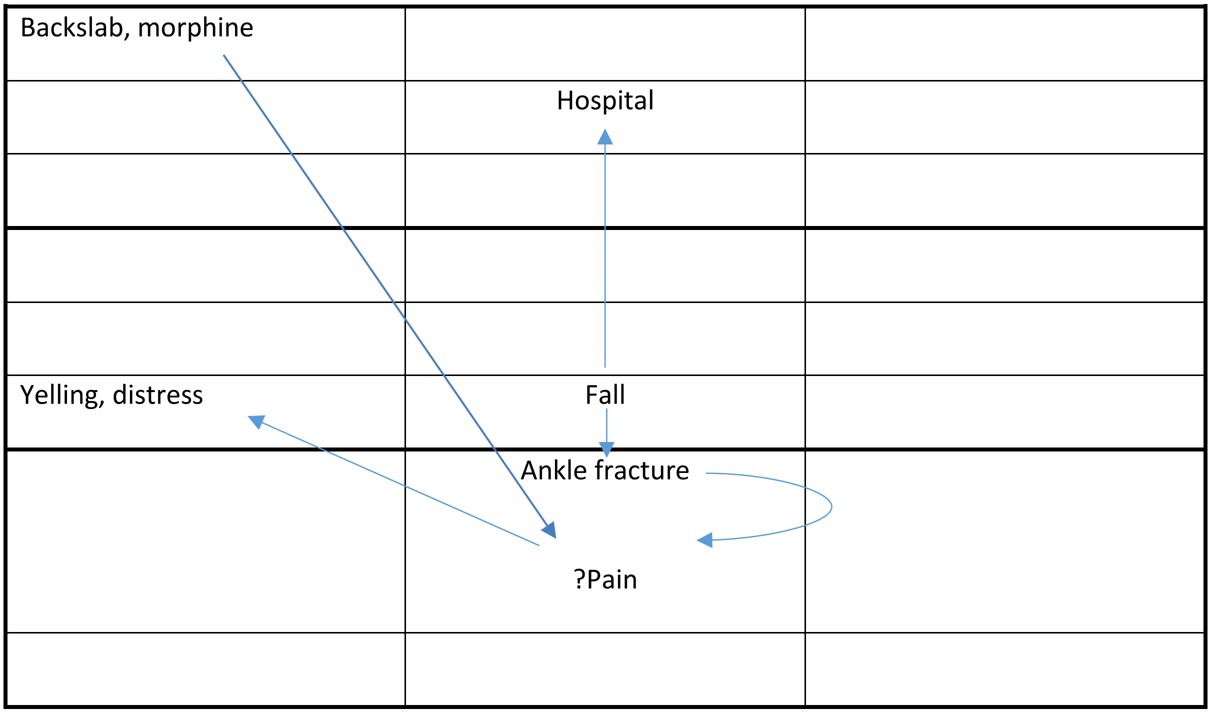
Upon waking, and still with no carer available from the group home, Anna again becomes distressed calling out to 'go home' and shaking her bed rails. At this point the ward resident has had an opportunity to look through Anna's correspondence from the group home that lists her hobbies as 'singing and karaoke – especially Elvis'. Questioning whether acute pain is in fact the cause of Anna's distress, the resident phones the staff at the group home to get a better understanding of how to best manage Anna's current distress. The resident spends some time talking with Anna's long-standing carer who, via speaker phone talks to Anna which helps calm her down. Meanwhile, the resident contacts the Arts and Music therapist currently on the adjacent children's ward who agrees to see if she can engage Anna and further reduce her distress. After a short introduction to the music therapist, facilitated by Anna's carer over the phone, Anna is soon enthusiastically singing Elvis Presley covers with the resident, nursing staff and the music therapist on the ward (see Figure 6.19). Anna agrees to take paracetamol tablets which adequately manages her residual ankle discomfort. After a few hours, Anna's attendant care provider has allocated a staff member to assist with her management on the ward and by the following day Anna and her carers have received instruction on safe mobility and self-care strategies from the ward physiotherapist and occupational therapist and Anna is transferred back to her group home for ongoing care.

Figure 6.17. Pain as Possible Cause for Ongoing Distress Following Ankle Fracture



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.18. Morphine as Treatment for Presumed Pain Leading to Distress



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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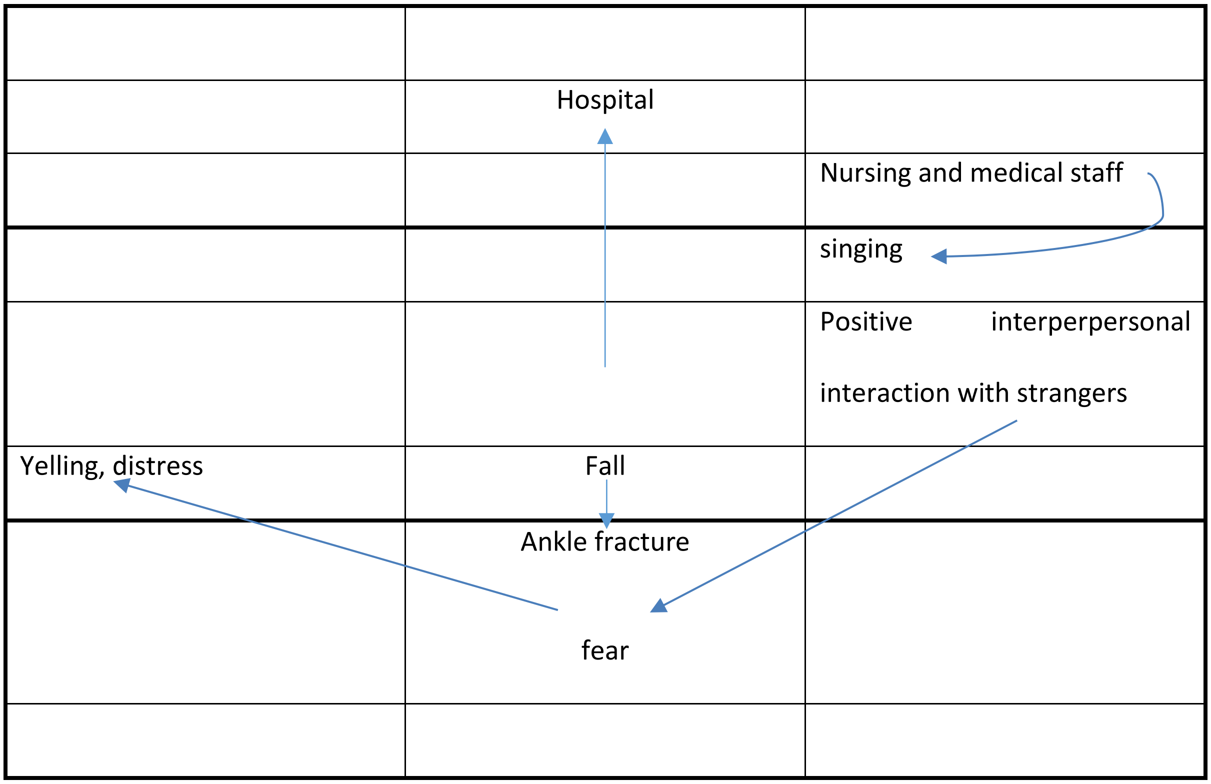
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Figure 6.19. Staff Intervention to Address Fear as Alternate Explanation for Anna's Distress



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
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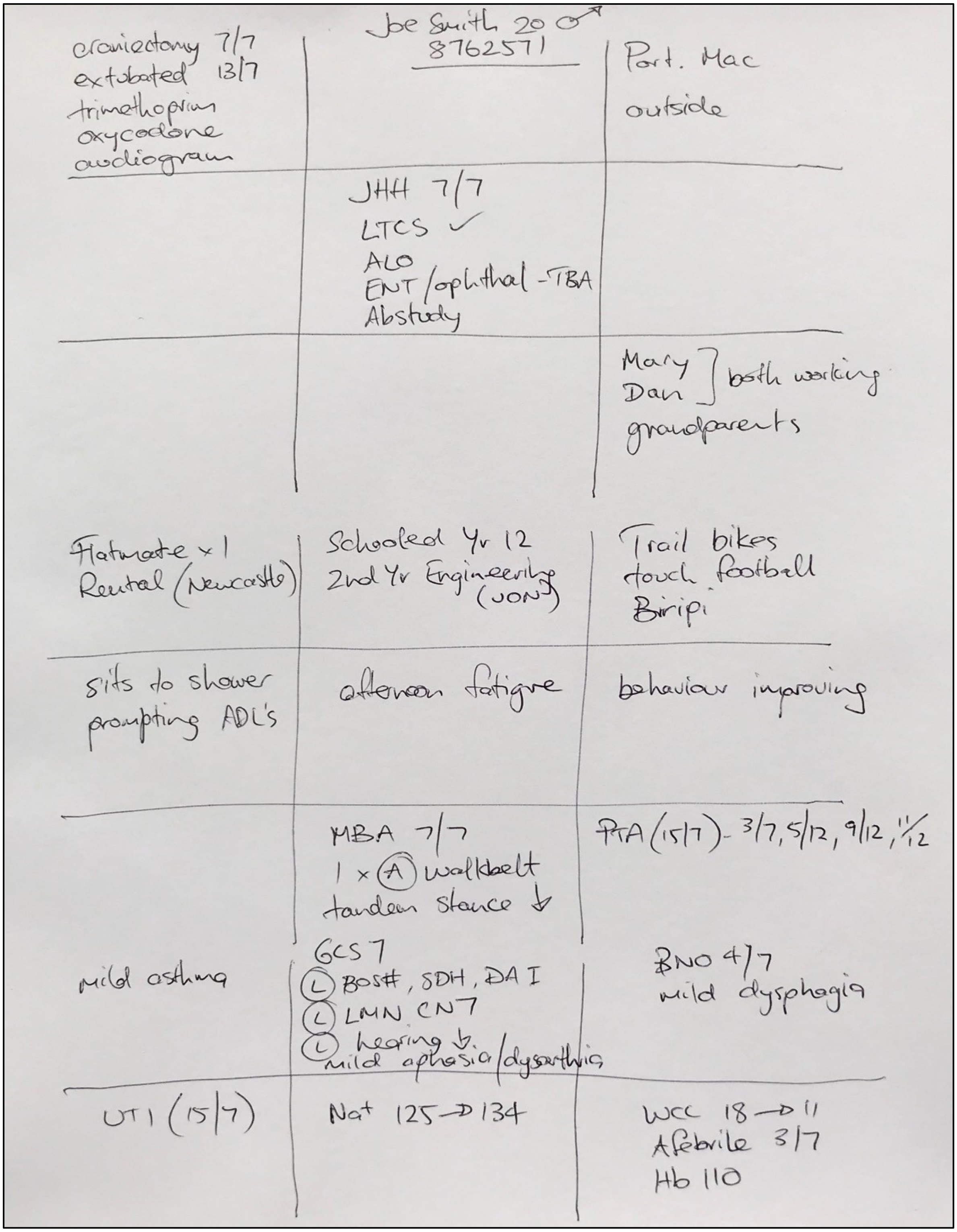
Example 4: Application to practice – a fictitious case

The final example in this chapter outlines a completed artefact template based on a fictitious patient case. Following presentation of the completed artefact, this section is followed with a consultation letter that has been generated based on information derived from the completed artefact. The assessment is typical of the types of assessment undertaken by the author using the clinical artefact described in the study.

6.06 Artefact completion procedure

In undertaking the assessment, the template is constructed freehand using a blank piece of A4 paper and pen. The process of drawing the template manually provides an initial orientation that acts as a reminder of the global workspace to be covered during the consultation. Initial entry of some data on to the artefact typically occurs prior to the formal consultation with the patient where access to patient notes provides information about the course of care to date. In addition to patient progress notes, other forms of information located in the ward environment are also used to populate the artefact that may include imaging and pathology reports and verbal information supplied by team members involved in the patients care. Data may be subsequently added at the patient bedside (see Figure 6.20).

Figure 6.20. Completed Artefact based on a fictitious case



In completing the template, the order in which data is entered is not fixed. Given that, demographic data is usually added initially and located at the top corner of the template outside the active ‘cells’, namely; age, hospital record number, and patient name. Following this the nature of the initial event, in this case, a Motor Bike Accident (MBA), and date and place of admission to the hospital (i.e. ‘JHH’) are usually recorded next. Completion of the template is done so using key words and abbreviations that provides information supporting a more formal entry into the hospital progress notes or, in the example provided, a consultation letter (see Figure 6.21) sent to the referring surgeon. The example letter provided includes highlighted words, terms, and concepts from the completed artefact that informs the letters narrative. In this way, the artefact supports a transient function of organizing information obtained from distributed sources over a relatively short period of time (typically minutes). The artefact itself is transient being disposed of after the consultation period ends and information is transcribed into more traditional formats (e.g. progress notes, letters).

6.07 Fictitious Case illustration

This case in involves the Rehabilitation Medicine assessment of a fictitious patient, a 20 year old male (‘Joe Smith’), who is currently being managed on an acute neurosurgical ward of a tertiary-level hospital (‘JHH’) in Australia. Joe had sustained a traumatic brain injury 11 days earlier (‘MVA 7/7’) and underwent hospital admission and surgery (‘craniectomy’) the same day. He was intubated and ventilated in Intensive Care and subsequently extubated on 13/7. His subsequent course in hospital includes the development of a urinary tract infection (‘UTI’) managed with antibiotics (‘trimethoprim’), constipation (‘BNO 4/7’), changes in sodium level (‘125>134’) and white cell count (‘WCC 18>11’), and pain management decisions (‘oxycodone’), amongst other issues. This data is documented using typical abbreviations and acronyms. Additionally, information regarding current functioning (e.g. balance, walking, hearing, facial weakness, swallow, speech, language, self-care, and behaviour) are also documented. Information regarding Joe’s pre-injury role as a student studying in Newcastle and his supportive family context are outlined as well as social and cultural factors (e.g. Aboriginality, sporting interests, parental supports). The document also includes key information about Joe’s immediate goal of getting outside in addition to other medical short term medical assessment and intervention goals (e.g. ENT and ophthalmology review, and audiogram assessment). Regarding Joe’s short term goal of spending time outside, it could be inferred that this preference may reflect cultural factors where the provision of suitable outdoor environments for Aboriginal patient populations has been identified as important(SAHMRI, 2017). Longer term organizational goals such as involvement of a formal support service that in this case is a government funded insurance scheme named Lifetime Care and Support (LTCS). In this example, the ‘attitudes’ cell has not been filled out, however, it may be inferred from the corresponding letter (Figure 6.21) that there are a number of attitudinal factors that are at work in Joe’s case. For example, the corresponding letter identifies the positive attitude that Joe’s parents are displaying toward their role as supports in his ongoing care.

Figure 6.21. Clinical letter based on completed artefact

Dr John Jones 18/07/19

Department of Neurosurgery, **JHH**

Dear John

Thanks for requesting a Rehabilitation Medicine assessment on **Joe** following a motor bike accident (**MBA**) on 7/7/19. I met with **Joe** and his parents, **Mary and Dan** today on ward G2.

Now day 11 post injury, Joe is showing encouraging signs of early recovery from a severe TBI (initial **GCS 7**, ongoing **PTA**, **Left SDH**, **BOS #,** and **DAI** on imaging). The **craniectomy** wound is healing well and I understand the plan is for autologous cranioplasty in 2 weeks. A protective helmet is being used with Joe requiring prompts to wear this. **Prompting** is also required for most **self-care** tasks at this stage. Mary and Dan are actively involved with Joe's care on the ward and have been instrumental in managing his resolving **challenging behaviours** (impulsivity and verbal aggression). **Mobility** is currently with a **walk belt** and **1 person** given persisting **balance impairment**. Joe is very keen to go **outside,** and I would encourage this with the use of a wheelchair with his parents supervising.

Joe continues to emerge from the post traumatic amnesia state (**PTA**) scoring **11/12** on the Westmead scale today. He is beginning to understand his current situation, however, overestimates his functional ability. Despite some mild word finding difficulty and dysarthria today, Joe was able to provide a reasonably accurate autobiographical history. **Fatigue** is prominent in the **afternoons**, and Joe's parents are appropriately limiting visitors to avoid overstimulation.

From the acute medical perspective, **hyponatraemia** has resolved and there has been a good clinical response to **trimethoprim** for management of **UTI**. **Left-sided hearing impairment** was evident today on screening as were signs of delayed **LMN CN7 palsy** (House Backmann grade 3) that has become apparent on waking today according to family. I have spoken to your resident who will arrange urgent **Ophthalmology** and **ENT** review, in addition to an **audiogram**. I have also suggested addition of aperients in the context of **constipation**. Pain seems to be well managed on low dose **oxycodone**.

Mary and Dan are staying in Joe's **rental property** here in **Newcastle** where he has been studying **Engineering** at **UoN**. **Dan's parents** are managing any issues that arise back in their home town of **Port Macquarie**. Mary is taking indefinite leave from **work** to support Joe, and application to the Lifetime Care and Support scheme (**LTCS**) has been made. Joe and Dan are part of the **Biripi** community of the Mid North Coast and the Aboriginal liaison (**ALO**) service has been providing inputs on the ward. Mary and Dan are aware Joe will be unable to complete this current semester of study and have requested letters to provide to the University and Centrelink (**Abstudy**) regarding his current medical condition.

I anticipate that Joe could transfer to the inpatient rehabilitation ward in the next few days to continue his Brain Injury rehabilitation prior to returning for cranioplasty in a fortnight. Joe and his parents are aware of the Brain Injury rehabilitation pathways into the future that may include inputs from services in both **Newcastle** and **Port Macquarie** depending on evolving rehabilitation goals. Thanks again for the referral.

Kind regards

David

Discussion

The examples above aim to show the utility of the study artefact when considering a range of clinical conditions and scenarios that may be encountered during Rehabilitation Medicine clinical practice. The first example demonstrates the utility of the study artefact – based on the ICF – to map a common medical disease, Myocardial Infarction.

The second example also adopts a traditional biomedical frame perspective with the clinical problem being fever in a critically ill patient following TBI. In this example, the 2 differential diagnostic possibilities were sepsis and paroxysmal sympathetic hyperactivity with a key factor in understanding the different presentations being the patients' blood pressure with blood pressure typically low in sepsis and raised in PSH. In this example the study artefact functions as a global workspace upon which numerous variables can be considered that are relevant to the case. The key variable in this example, i.e. blood pressure, demonstrates the effect a single variable can have on the state of the entire array in terms of subsequent investigation and management despite other parameters being equal (e.g. pulse, respiratory rate, fever).

The ability to organise information pertinent to medical diagnosis on the artefact demonstrates the potential for the ICF framework to lend itself to appreciating the underlying structural and functional processes that collectively inform our concepts of disease.

Such an approach deviates from the intended function of the ICF where consideration of disease is dealt with using ICD alone. This example expands the potential for ICF to provide a platform for unpacking the variables that, in differing states, constitutes what we understand to be disease or health conditions.

In this example, two diseases or 'health conditions' – sepsis and PSH – are considered from the biomedical framing perspective and as such this example reflects what could be referred to as an 'intra-frame' problem. This example contrasts with the third example where the management of distress in the setting of acute trauma is considered initially from a biomedical perspective (i.e. acute nociceptive pain management) followed by a shifting frame perspective where psychosocial factors in the context of disability successfully informed management. In other words, this example highlights the 'inter-frame' nature of the problem encountered whereby the cause of human distress was interpreted from both a medical frame (unsuccessfully) and a disability frame (successfully) after trial and error. Again, in this third example the study artefact was used to provide a global workspace for the description of both frame perspectives following which an adequate solution to the problem was achieved.

The fourth and final example provides a practical illustration of artefact use in a fictitious patient scenario where the transient nature of the artefacts use is highlighted as part of the assessment procedure. In this example, the completed template highlights the compression of temporally extended information onto a single 2-dimensional page. Here, information is arranged based on the spatial relationship of abstract categories rather than temporal relationships. In other words, it is up to the user to know that Joe's asthma, for example, is an old, currently inactive problem, and that the motor bike accident is a more contemporary one. To assist with this data temporal information may be provided next to data entries, for example, the date of the MVA, hospital admission date ('JHH) and date of surgery ('craniectomy') are all indicated as '7/7'. Personal Factors, such as Culture, are inferred through reference to Joe's identification as 'Biripi' which is an Australian Aboriginal group that informs a part of Joe's Community, Civic and Social Life. Through the dynamic interaction of the templates cells a narrative of Joe's Participatory life also emerges including the simple interventions that may support this beginning with Joe and his parents desire to spend time outside of the hospital ward. For example, Joe's short-term goal of '**outsideness**' begins with, a) his desire to attain this state which occurs at the level of the **body** (i.e. mental functions), followed by, b) Joe's ability to **communicate** his desire that is subsequently, c) appraised within the **attitudinal** environment for which, d) **supports** are forthcoming based on relationships (e.g. parents and Doctor) that are, e) subsequently endorsed by involved **services** and facilitated by the use of appropriate **products** (i.e. a wheelchair). Whilst the completed template does not explicitly convey the above relationships between cellular array states, the subsequent letter derived from it provides a narrative based on the data that has been partially, and transiently, organised on the artefact. In this case, information collated on the artefact template is done so based on a particular structural form that is then modified to an alternate structural form (i.e. a letter) where the functional goals of the two formats differ. In the former, the goal is to permit free-form exploration of an abstract spatial map to inform problem identification and solving, whereas the goal of the latter is to provide written communication. As such, these differing structural formats highlight their contrasting function (Kemp & Tenenbaum, 2008). Further, the artefact only provides a sketch of important issues that may be subsequently elaborated in subsequent communication. For example, in Joe's case, the artefact notes 'LMN CN7', that in the subsequent letter is elaborated to further describe the extent of this clinical finding based on a common grading scale i.e. Bachman-House grade.

Together, the examples presented in this chapter reflect, to varying degrees the ill-structured nature of problems that are typical of clinical work where numerous causal pathways may potentially underpin the problem that is being encountered. As such, the ability to consider simultaneously the potential roots of ill-structured problems from multiple and often interacting frame-perspectives is demonstrated.

Importantly, application of the artefact in the scenarios outlined above does not attempt in any way to replace other artefacts or information sources that contribute to a problem, rather, the artefact provides a pragmatic space for systematically organising information relevant to a problem where numerous framing perspectives can be considered. Lastly, in the cases presented both disease and functional frames can be considered in addition to related information directed toward intervention thereby creating a link to ICHI. For instance, in Example 1 (Myocardial Infarction), numerous intervention strategies are highlighted including diagnostic interventions such as ECG findings and pathology investigations (e.g. cardiac enzyme assays) that aid in the diagnosis of Myocardial Infarction. Treatment interventions such as thrombolysis in the acute setting as well as prevention strategies both at the level of individuals and populations (e.g. smoking cessation, and obesity management) are also considered. Here, the artefact highlights the intertwined relationship between concepts of disease and their management through various interventions and different stages of the disease process from prevention to diagnosis and treatment of established conditions. Further, interventions directed toward disability that may be associated with Health Conditions also incorporates ICHI-related perspectives. For example, in the case of myocardial infarction this may lead to the endorsement of a disability parking permit in the setting of mobility limitation that may be an ongoing consequence of this injury. In Example 2 (Fever in the ICU), numerous interventions are described including services (e.g. ICU) and products and technologies (e.g. ventilator, imaging and pathology testing, and pharmacotherapy treatment). Similarly, Example 3 (Anna's broken ankle) highlights interventions such as health services (e.g. hospital), support and accommodation services (e.g. group home), medical treatments ('back slab'), as well as novel interventional approaches such as singing (Batt-Rawden & Storlien, 2019). Lastly, Example 4 similarly provides numerous examples of interventions pertaining to pre-injury social welfare support services of human function in education (e.g. Abstudy) through to interventions for the acute hospital-based management of neurotrauma (e.g. craniectomy) as well as longer term intervention to provide support for ongoing disability (e.g. LTCS).

Chapter 7: Self-Reference: Physician and Artefact

This chapter discusses phenomenological concerns that move beyond the immediate, practical use of the artefact in front-line clinical work by positioning the role of the doctor as an actor/agent within the artefact itself (i.e. self-reference). The potential value of this self-referential approach is considered from the perspective of empathy and moral agency. Further, the philosophically interesting notion of the ICF being represented within itself is also proposed and discussed.

Physician Self-Reference

7.01 The ICF is About All people

The introductory chapter of the ICF stresses that the ICF "is about *all people*" (WHO, 2001, p. 7),. To that end, this chapter focuses on human function in the *absence of both disability and health conditions* where the functional activity of interest is learning and applying knowledge of the ICF in Rehabilitation Medicine practice. Such an approach extends the intended boundaries of the ICF where the ICF explicitly states that a Health Condition needs to be present. However, given that the experience of human function for 'all people' extends beyond considerations of health and disability, it seems justifiable, not the least interesting, to explore the ICF from a functional perspective alone. Indeed, it is the letter *F* for *F*unction that has trumped the *D* in *D*isability and the *H* in *H*ealth to inform the classifications abbreviated title; the IC*F*. So, first and foremost, the ICF provides a structure for organising information about human function from which descriptions of Disability and Health Conditions (with ICD) can be made.

7.02 Self-Experience in Learning

Educational science recognises that significant learning occurs if facts have personal relevance (Pope & Gilbert, 1983). Further, reflective practices both during and outside the domain of immediate clinical practice are recognised as important methods that inform learning in professional practice (Kellett, 2013; Schön, 1983). To that end, it seems reasonable to propose that important learning about the ICF might arise by adopting a personal, self-reflective approach to this classification.

7.03 Self-Reference as a Window to Personal Learning

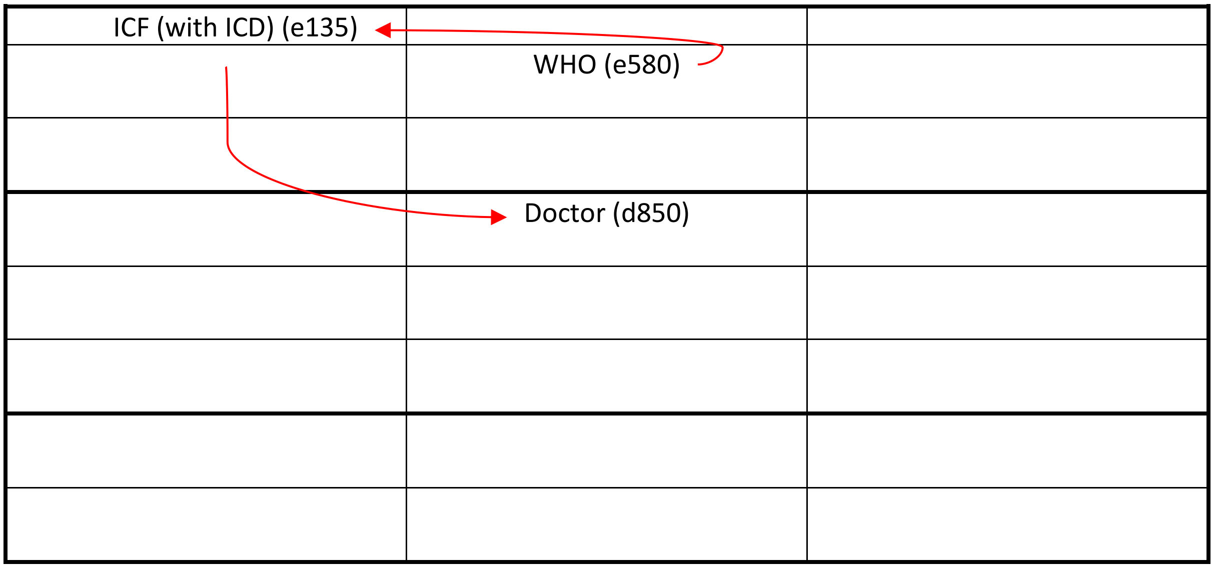
In approaching the task of learning the ICF the idea of self-reference is one perspective that can be applied to create a sense of personal relevance in this process. The concept of self-reference has a long tradition that has been a topic of interest in the fields of philosophy and mathematics (Bolander, 2015; Hofstadter, 1979) and remains of interest in the field of cognitive science where the importance of self-reference, or, introspection in the context of agent learning is highlighted;

> 'agents need introspection in order to understand their own role in social contexts….to reason about how you can help other agents to achieve their goals. Another motivation is that introspection is essential in learning: realising the shortcomings of one's own knowledge and routines is required for a deliberate, goal-directed approach to gaining new knowledge and improve one's problem-solving skills.' (Bolanger, 2014)

Here, the ICF serves as a potential system to assist doctors (in this case myself) to better understand one's own social role where the ultimate goal is to assist other agents (e.g. patients) to achieve their own goals. In the context of medical practice, doctors' function as agents as part of an extended agent network comprising many roles (e.g. patients, carers, health professionals) and artefacts. The current study examines how the ICF can be applied by agents (e.g. a doctor) in social contexts (e.g. medical practice) to help other agents (e.g. patients) achieve their goals in the context of health conditions and disability in the broader context of human functioning with the aid of artefacts. As such, self-reflective or introspective examination of the ICF from a personal context may inform this understanding of role in the social context of work as a Medical Practitioner. To that end, the cognitive artefact discussed in earlier chapters will be used as a vehicle to help describe the role of the doctor within the ICF where applying the ICF in practice is the goal.

Figure 7.1 outlines a directional relationship between the World Health Organisation (e580 – Health Service) who, in 2001 released a product (e135), i.e. ICF, that, in conjunction with an existing WHO product (ICD), was requested to be used in remunerative employment (d850) by health professionals (e.g. doctors). In the case of this study, the specific area of medical practice is Rehabilitation Medicine.

Figure 7.1. Initial Conditions for Basis of Study



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

In addressing the request of the WHO to use ICD and ICF together, the doctor is required to engage in a process of Learning and Applying Knowledge that is, in turn, highly dependent upon, Mental Functions of which a number are relevant. Table 7.1 outlines these following possible mental functions:

Table 7.1. Mental Functions that Support Learning and Applying Knowledge of ICF and ICD Together

ICF code	Description	Example
B1264	Openness to experience	Where an inquisitive, experience-seeking, curious approach is required when confronted with a novel learning request i.e. please use the ICF with ICD.
B1265	Optimism	A hopeful disposition that trying to learn to use the ICF with ICD is meaningful/worthwhile.
B1300	Motivation	Being appropriately driven to engage in a learning task as requested by the WHO.
B114	Memory	The ability to represent information about the ICF and ICD in short term memory, and to store and retrieve relevant long-term memory in relation to these classifications.
B1641	Organisation and Planning	Where using ICD and ICF together requires coordination of parts into a whole.
B1646	Problem Solving	Where using ICD and ICF together requires the identification, analysing, and integration of incongruent or conflicting information into a solution.
B16701	Reception of written language	Where the meaning of the ICF and ICD require decoding of written information to obtain meaning.
B16712	Expression of written language	Where writing forms the basis of producing meaningful messages about ICD and ICF.
B1672	Integrative language functions	Where the organisation of semantic and symbolic meaning of ICD and ICF contents informs production of messages.

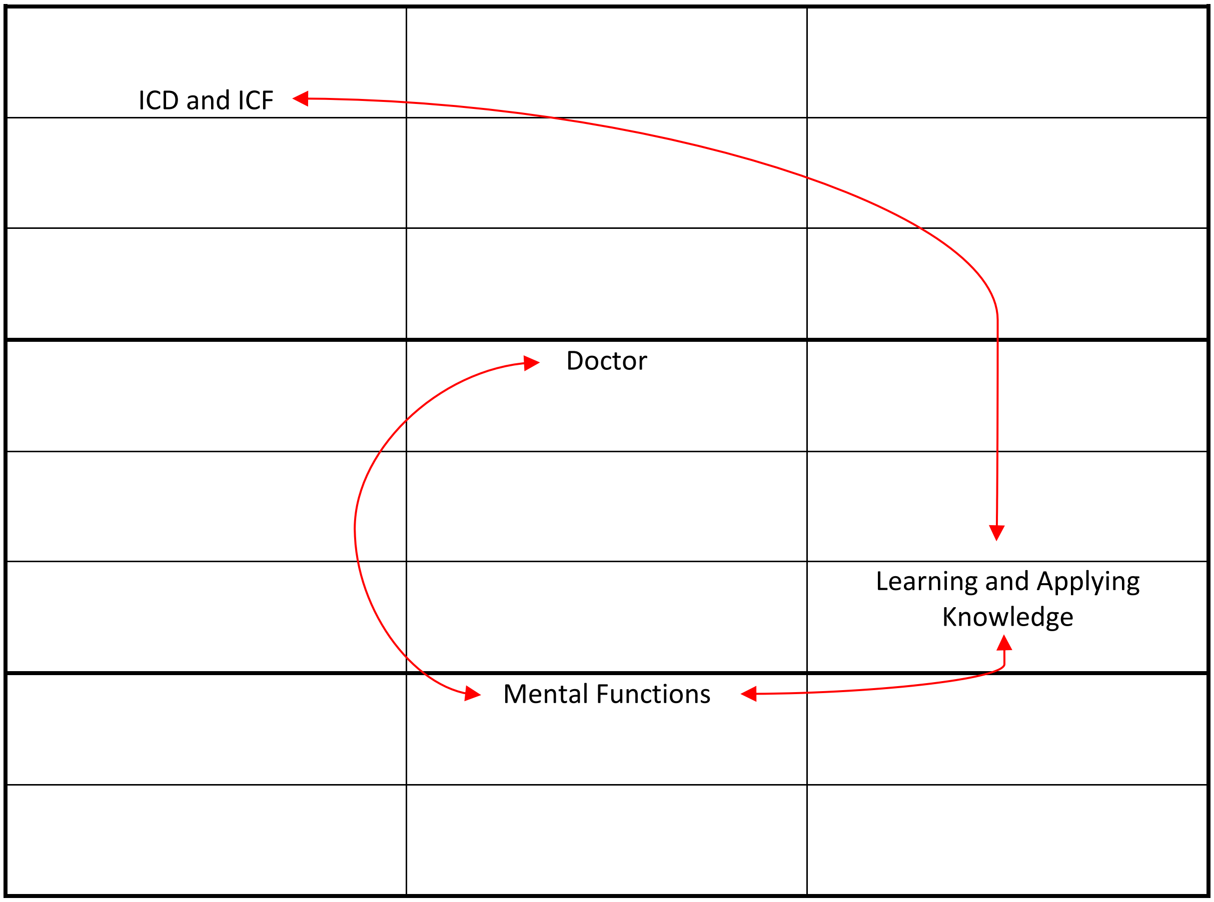
Furthermore, Learning and Application of Knowledge regarding the use of ICD and ICF together involves an iterative combination of the following outlined in Table 7.2:

Table 7.2. Activities Related to Learning and Applying Knowledge of ICD and ICF Together

ICF Code	Description	Example
D166	Reading	Reading the ICF
D163	Thinking	Forming and manipulating ideas, concepts and images about how the ICF and ICD can be used together in Rehabilitation Medicine practice.
D175	Solving problems	In relation to how the ICF and ICD can be used together and when applying the ICF and ICD in real-world practice.
D117	Making decisions	Choosing how to use the ICF and ICD together.

Figure 7.2 attempts to show the dynamic and iterative relationship between the doctor and the ICF/ICD where the availability of the ICF and ICD as products in the environment serve as a stimulus for the Doctor to utilise a variety of Mental Functions (as outlined above) to Learn and Apply Knowledge about the ICF and ICD over time.

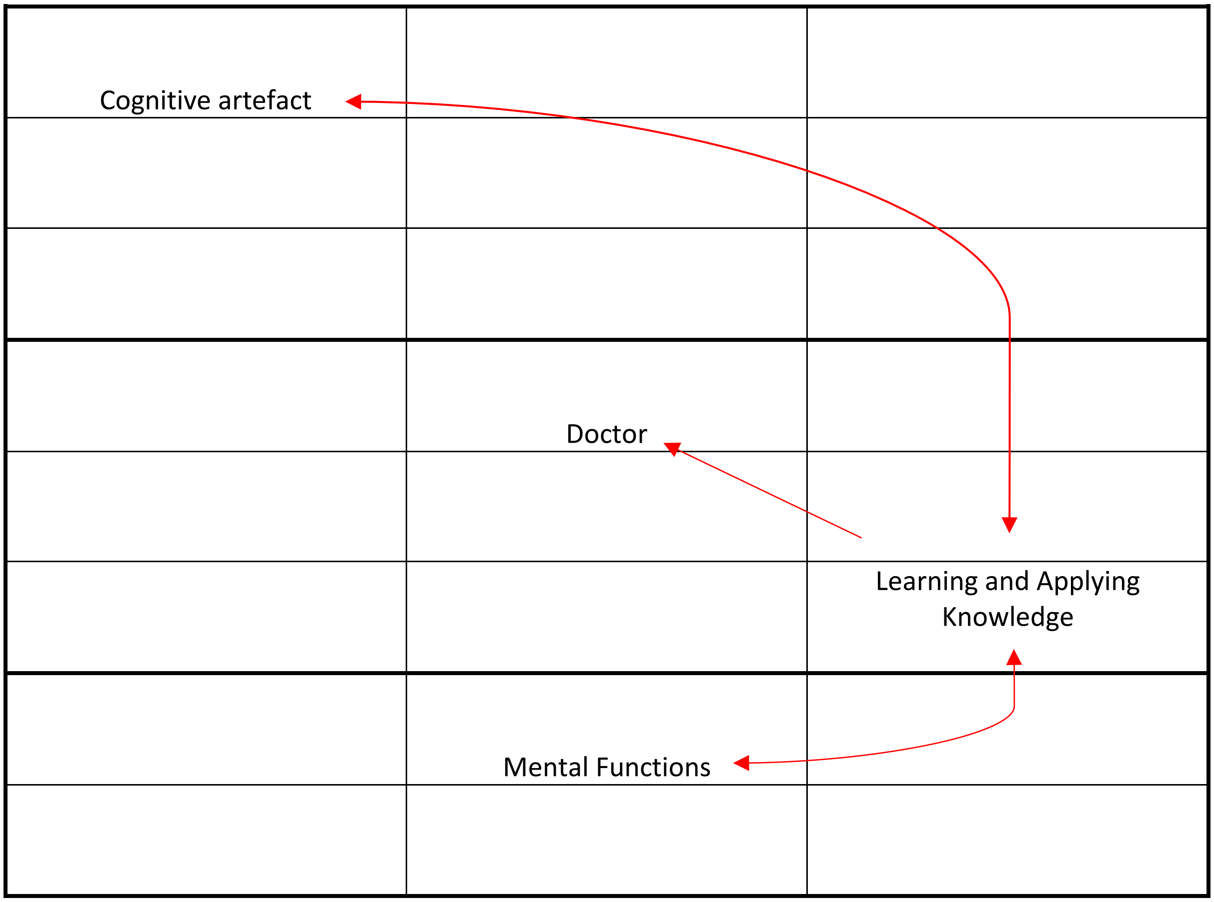
Figure 7.2. Mental Functions Support Learning and Application of Knowledge about ICD and ICF



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

In this study, this iterative process has led to the design and use of an individualised learning and application process that sees the use of an ICF-derived Product used during employment (e135) i.e. cognitive artefact. Here, a cognitive artefact facilitates the Learning and application process of work as a doctor (including descriptions of working as a doctor) that is Mental-Function dependent (see Figure 7.3).

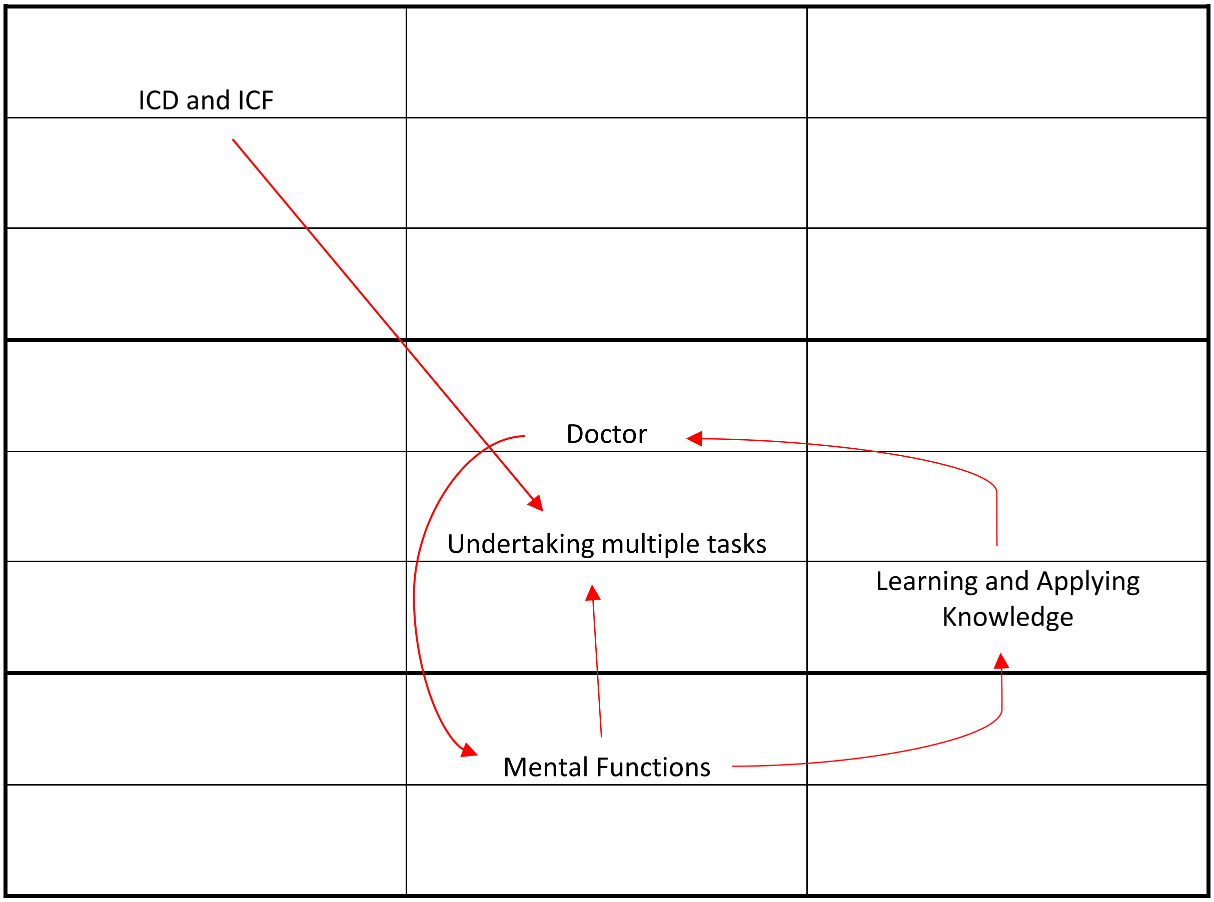
Figure 7.3. Cognitive Artefacts inform Learning and Knowledge Application



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Of special interest in this study is the use ICF and ICD together that reflects the doctor's requirement to Undertake multiple tasks (d220) where executing tasks relating to the application of ICD and ICF take place both individually and within broader groups (d2202, d2203). Again, Mental Functions expressed through the Learning and application of knowledge support this multiple-task activity (see Figure 7.4).

Figure 7.4. Using ICF and ICD Together is a Multiple Task Dependent on Particular Mental Functions

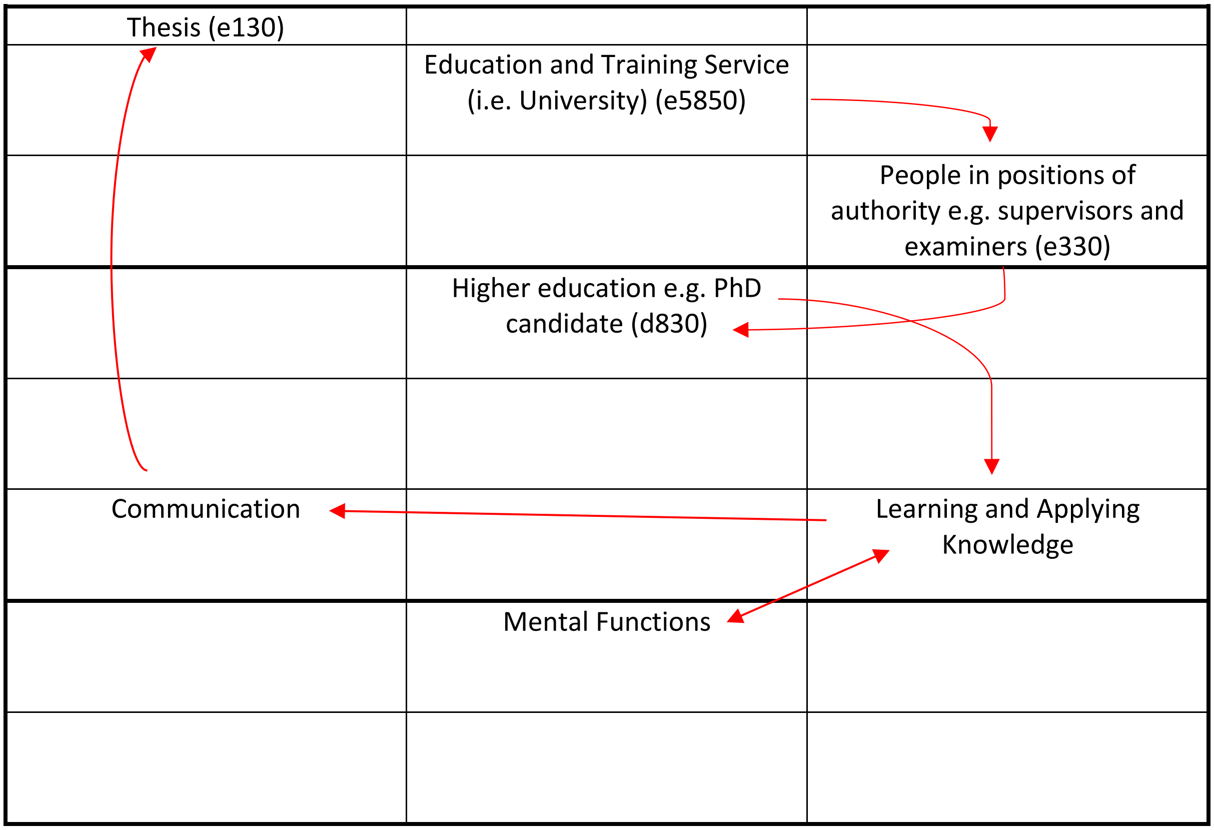


Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Indeed, the notion of using the ICF and ICD together exposes to the crux of this study where interpretations of the concept of togetherness will inform approaches to use; for some, using ICF and ICD in combination suggests a sequential relationship where Health Conditions are first determined and addressed with ICD, then Functional considerations of Disability and other Health-related states are considered using ICF. This study assumes states of togetherness that are inter-related and therefore evolve dynamically and in parallel.

In terms of the study itself, the process can be summarised as the activity of learning and applying knowledge in the formalised setting of Higher Education where the Educational Service is concerned (i.e. the University), amongst other functions, with the provision of the necessary support and relationships to the student (e.g. PhD candidate). In the case of PhD candidature, the goal is communication of original knowledge in the form of an academic educational product i.e. the thesis (see Figure 7.5).

Figure 7.5. Interacting Body, Activity, and Environment Factors That Inform Thesis Production



Products and Technology		Natural and Human Made Changes to the Environment
	Systems, Services and Policies	
Attitudes		Support and Relationships
Domestic Life	Major Life Areas	Community, Civic and Social Life
Self Care	General Tasks and Demands	Interpersonal Interactions and Relationships
Communication	Mobility	Learning and Applying Knowledge
Cardiorespiratory Renovascular	Neuromusculoskeletal Special Senses	Gastrointestinal Skin
Genitourinary Reproductive	Endocrine Metabolic	Haematological Immunological

Additionally, the thesis reports on a process of self-awareness where the experience of self in relation to one's own thoughts is encompassed in the concepts of phenomenology and metacognition (Quirk, 2006).

7.04 Moving From Self to Other

The above example of self-reference using the ICF artefact demonstrates its utility in describing human functional activity in the absence of disease and disability. Specifically, the example highlights the dynamic interaction between Body, Activity and Environment in the expression of life roles (e.g. both in remunerative employment as a doctor and as a student) and provides the basis for self-referential learning about the artefact that may then be generalised to other states of human function experienced by others. In this sense, we all occupy the same page of Human Function where individual life stories and experiences constitute variations on a theme.

Such a statement does not imply that a non-disabled person can share the same experience as a person with a disability or a Health Condition, rather, knowledge of the common building blocks of human function provides a 'foot in the door' to understanding a range of human functional states that might include Health Conditions and Disability. For example, the importance of high-quality educational services and associated supports are of equal relevance to both a PhD candidate studying at University as they are to a child with intellectual disability studying in secondary school. Furthermore, the provision of suitable products and technology to support a doctor to accomplish the general tasks and demands of their workday mirrors the same requirement, albeit with important differences, to a hospitalised patient who also relies on appropriate products and technology to accomplish the general tasks and demands of their day.

In that way, the self-referential application of the ICF, as reflected in the study's artefact, provides a basis for understanding human function in a way that may help inform an understanding of others through stressing the commonality of human experiences. The potential for classifications such as the ICF to inform an understanding of others infers a moral application of the ICF in medical practice where the ability to empathise with others is viewed as an increasingly important ability in the provision of person-centred care (Cox, 2011). The concept of empathy is also of considerable interest in the field of cognitive science where empathy forms an important basis for the expression of social cognition (Decety & Grèzes, 2006; Shamay-Tsoory, 2011; Vollm et al., 2005). The question of whether cognitive artefacts have moral status has also been raised where, 'rather than simply passive instruments, technical artefacts may actively influence their users, changing the way they perceive the world, the way they act in the world and the way they interact with each other '(Kroes & Verbeek, 2014).

Artefact Self- Reference

To conclude this chapter the interesting philosophical notion of the ICF containing itself is proposed where the ICF is explicitly shown as a Product and Technology (see Figure 7.1). Whilst the ICF is not explicitly mentioned in the ICF it is reasonable to think of it as such.

7.05 The ICF Inside the ICF

First and foremost, for Health practitioners, the WHO have produced the ICF as a product for use in employment (e135), e.g. clinical practice. More broadly, however, the ICF is itself a system where the goal of the system is the organisation of information pertaining to human function. Here the ICF functions as an organisational mechanism for information established by a recognised authority i.e. the WHO. Either way, whether as a mere product, or a more abstract system, the ICF arguably contains itself.

7.06 So What?

In proposing that the ICF is represented in itself, some consideration of why this is of interest is important. Concepts of self-reference have been of fundamental interest in the fields of philosophy and mathematics throughout history that continue today (Hofstadter, 1979). Numerous varieties of self-reference have been described that include the fields of Information Theory and General Systems Theory where interest in 'how the components of a system possess the identity they do as a function of the system as a whole' is a focus (Bartlett & Suber, 1987, p. 22). To that end, if the ICF is considered as a system that organises information about human function (i.e. the ICF) then there exists a depth and richness to the ICF that is not similarly reflected in the ICD where 'a classification of disease' is not included as a category within the ICD. In other words, ICD does not refer to itself.

Such a statement draws a sharp distinction between the ICF and ICD whereby the former classification can be viewed as holding self-referential properties whereas the latter does not. In other words, the ICD does not contain a category that relates to 'classifications of disease'. Such a difference highlights the potential value of ICF in understanding the complexity of human function where self-reference has been argued to be a principal indicator of complexity (Hempel, Pineda, & Smith, 2011). This is not to suggest that 'disease' processes themselves are devoid of complexity, rather, that classifications that describe them are limited in their complexity.

Furthermore, the strong hierarchical nesting characteristics incorporated into the design of the ICF may better lend itself to integration with ICD (rather than the other way around) given the potential advantages of nested structures in describing complexity (Allen & Starr, 2017).

7.07 Summary

This chapter has outlined an atypical approach to using the ICF whereby Human Function in the absence of Disease or Disability is considered in the context of ICF application in Medical practice. Specifically, a self-referential approach is adopted using the authors own experience of learning and applying knowledge of the ICF. This process of self-organised ICF learning and self-reflection on professional practice is considered from the perspective of moral agency where the ICF functions to accommodate an agent-network perspective of which the doctor is part. Considering oneself as 'part-of' the ICF creates a platform for beginning to appreciate the place of others within the ICF where variations on a theme form the basis of the rich biopsychosocial diversity experienced by human beings that includes functional states that we describe in terms of health conditions and disability.

Further, the chapter extends the self-reference theme proposing the self-referential nature of the ICF itself from which a contrasting position with ICD is suggested. This position of contrast between the ICF and ICD based on the property of self-reference suggests the inherent complexity that embodies the former classification.

Chapter 8: Summary and Conclusions

Study Overview: Restatement of Aims, Motivation, Current Practice Gaps and Methodological Considerations

8.01 Restatement of Aims

This study set out to provide an account of medical cognition where negotiation of applied complex problems is assumed to be a key task of the medical practitioner. In doing so, the study conceptualises the process of medical cognition as a manifestation of cognitive systems, broadly conceived, within which cognitive artefacts play an important yet underexamined role. To that end a cognitive artefact designed to support medical cognition in the field of Rehabilitation Medicine is described and analysed from a first-person phenomenological perspective.

8.02 Motivation

The motivation for the study arose following the introduction of the WHO ICF and the practical challenge of application highlighted by WHO's request for clinicians to use the ICF and ICD 'together'. As reference classifications of the WHO FIC, ICF, ICHI and ICD reflect different framing perspectives of health-related issues that have developed in response to evolving conceptualisations of health and disease over time. Importantly, as the classifications of the WHO-FIC were not designed together, the ability to seamlessly integrate these classifications both at a theoretical level and in applied settings of practice, poses a significant challenge. At its heart, the integrated use of these classifications in the clinical setting represents a problem where potential solutions appeal directly to the study of medical cognition: how does the medical practitioner approach the WHO-FIC together at a cognitive-level? As a medical practitioner working in the field of Rehabilitation Medicine where both ICD, ICHI and ICF frameworks pointedly inform practice, the requirement for solutions to integrate these classifications constituted a pragmatic need that demanded new learning and adaptation of (my) existing medical cognition.

8.03 Current Practice Gaps

Whilst approaches to the problem outlined above have been developed and described, at an individual level of practice, these approaches were inadequate in addressing the level of integration to which a combined use of the WHO FIC, in my view, should aspire. Further, available applications for practice lacked an ecological authenticity when considering the dynamic and concurrent application of ICD and ICF in my own lived experience of real-world practice in Rehabilitation Medicine.

Whilst current efforts are being directed toward an improved integration of ICD and ICF, such approaches are significantly constrained by highly formalised methods of classification development that are grounded in embedded information infrastructures. For the individual practitioner, however, these challenges are more easily circumvented in real-world settings where whole-scale re-writing of classifications in a formal sense is not a requirement. In practice, a ‘fast and loose’ approach to integrated classification use reflects a pragmatic reality of practice.

8.04 Methodological Considerations

In this context, the current study makes an appeal to the potential value of examining the lived experience (i.e. phenomenology) of individual practice where efforts have been directed toward practical integration of the WHO-FIC in the field of Rehabilitation Medicine. In taking the first-person phenomenological perspective the aim of the study has been to take a ‘deep dive’ into aspects of cognition that inform the applied integration of the WHO FIC where dynamic problem solving of variable complexity is a hallmark of practice. Such an aim by no means implies a monopoly on medical complexity by Rehabilitation

Medicine, rather, that an integrated view of the WHO FIC is particularly meaningful when considering the type of complexity encountered in Rehabilitation Medicine practice. Otherwise, complexity is represented in many different forms in a wide variety medical fields for which a highly integrated approach to the WHO FIC may or may not be a priority.

Key Findings

The study reported on the phenomenology of practice in medicine with a focus on cognitive artefacts where key features of the cognitive artefact included the following:

8.05 Temporospatial Grounding

A key feature of the phenomenological experience of Rehabilitation Medicine in this study is the cognitive ability to represent and understand events in time and space. To that end, the flatland Minkowski spacetime diagram is used as the starting point for the development of a cognitive artefact from which a working artefact for practice is ultimately derived.

8.06 Generic Problem Space

In representing the cognitive artefact as a spatial structure, e.g. a combined array, the artefact functions as a global space for which a variety of problems can be represented regardless of their framing perspective. In that way the cognitive artefact provides a generic problem space where pre-determined commitment to a particular framing perspective is not obligatory. Such an approach champions a level of agnosticism when approaching real-world problems where multiple frame perspectives may inform different aspects of a problem for which alternative approaches to solutions may be entertained.

8.07 Relational Complexity

Understanding problems in Rehabilitation Medicine, as in life more broadly, involves creating meaning through the relationships 'things' (people, places, products, culture, events etc.) have with one another. In this study, the cognitive artefact is constructed in such a way as to permit an understanding of relationships beginning with small numbers of foundational concepts (i.e. body, activity, environment) from which more complex relationships can be considered (i.e. combinatorics using a 20-cell array). Using this approach problems can be progressively 'chunked' and 'unchunked' to allow both an overall Gestalt perspective when considering primary, foundational concepts whilst incorporating relational information from a more granular perspective that informs both problem-framing and solutions. In other words, the artefact permits fine grain details to be superimposed on an ever-present basic structure upon which problems pertaining to health, broadly conceived, can be considered.

8.08 Framing Integration

The ability to consider simultaneous framing perspectives on a common basic structure (i.e. body, activity and environment) provides the potential for the user to better integrate aspects of problems that may otherwise be considered from different frame perspectives. Acting simultaneously on the 20-cell array multiple framing perspectives can be more easily understood as integrated processes that may encourage the user to avoid a silo-based approach to consideration of issues, rather, problems of health, disease, disability and human function are inherently and intimately intertwined.

8.09 The Bayesian Perspective

An important role of the medical practitioner and rehabilitation physician is to make predictions about the future: when will I be able to leave hospital, when will I get back to work, when can I drive again, will I walk again, how long will I need to take this medication? Our models of the world created through our past experiences and continually updated knowledge provide us with useful information with which to make these predictions. Cognitive artefacts that facilitate the organisation of information about the world that may facilitate prediction are therefore important. In this study, the basic temporo-spatial structure that informs the cognitive artefact provides a useful model that aligns with characteristics of prediction approaches such as Bayes theorem (Holyoak & Morrison, 2005). In short, Bayes theorem incorporates information about the past ('priors') along with information about the present ('new evidence') with which we can make inferences about the current state of the world to make informed predictions about the future ('likelihoods'). In making real-world predictions about real-world human beings in the broader context of human functioning, knowledge of disease states will of course be important, however, there are many other factors outside a narrow view of disease that will inform future states. To that end, models such as the ICF become relevant for complementing the predictive ability of our models of disease particularly in situations where the active disease component may be small or non-existent or where uncertainty surrounds diagnosis.

8.10 Value Adding

Whilst the motivation for the development and application of ICD is grounded in a strong moral position, i.e. the desire to classify disease as the starting point for designing meaningful treatment to alleviate human suffering, ICD content itself, however, is largely objective. In other words, diseases are presented as logical objective entities for which no value-based interpretation of how their approach to investigation and treatment should proceed. In real-world practice, however, the diagnosis and treatment of disease, and our response to states of disability occurs in the context of values: the patient, doctor, family, society etc. To that end, the availability of ICF provides a classificatory language from which a discussion of values-based decision making regarding health, disease and disability can proceed. This is not to suggest that there are many other ways in which a clinician may approach consideration of values in decision making, rather, it speaks to the potential for ICF to provide a complementary language with which a wide range of values can be considered. For example, when considering the ICF in relation to values-based problem solving and decision making very practical questions may come to mind that may pertain to questions at the level of the body, activity and the environment. For example, a person's values in relation to activities such as self-care, mobility, domestic-life situation, work, social-life will all potentially inform decisions about treatment, rehabilitation and care. Equally, environmental attitudes and policies reflect individual and community values. Of note, however, whilst the ICF provides a language that promotes the consideration of values in the cognitive process of the clinician, the ICF itself does so in a neutral sense. In other words, the ICF does not offer moral prescriptions regarding the adoption of certain values, rather a framework upon which values-based positions may be considered and elaborated.

8.11 Beyond the WHO FIC: Additional Values Perspectives

In providing a framework for which both ICD, ICF and ICHI perspectives can be simultaneously considered, the cognitive artefact also opens itself to the consideration of additional framing perspectives that, unlike these classifications, explicitly adopt a values perspective. Such values-based framing perspectives may include the Capabilities Approach of Nussbaum and Sen (2010). With origins in philosophical ethics the Capabilities approach champions 'the moral significance of individuals' capability of achieving the kinds of lives they have reason to value'. In an extension of this work Nussbaum has proposed a list of ten 'Central human capabilities' (Nussbaum, 2006) that, for example, could be considered in relation to the study artefact to assist in working through values-based questions. For example, in her list, Nussbaum cites the concept of Affiliation that incorporates the notion of 'being able to live with and towards others, to recognise and show concern for other human beings'. The extent to which a person can achieve this state could be described using the ICF concepts and language of domestic life e.g. assisting others, Interpersonal interactions and relationships e.g. forming relationships, maintaining social space etc. In this way, the ICF-based cognitive artefact lends itself to consideration of explicit values-based frameworks such as the capabilities approach to help inform person-centred approaches to care. Taking this perspective of the ICF as a values-neutral language and framework upon which a values-based philosophical theory of justice (e.g. the Capabilities Approach) can operate is a potentially useful way to understand these two approaches that have been difficult to reconcile to date in the literature.

8.12 Self-Reflective Positioning

In additional to providing a framework within which the WHO FIC, and potentially other approaches to health conceptualisation, may be integrated, the study artefact also permits positioning of the doctor within the framework. Such a positioning has the potential for the user (i.e. doctor) to better understand the position of their patient given the universal nature of the human function framework that underpins the ICF-derived artefact. In other words, the ICF applies to all people of which doctors and patients are equal players. For doctors to be able to reflect broadly on their own human function using the artefact, to place themselves in this scene, provides a potentially powerful learning opportunity from which appreciation of a patient's human functional experience may emerge. Historically, doctors have been charged with being aloof and detached when addressing (or failing to address) their patients concerns, and part of this difficulty may be the absence of schemas in medical training that do not integrate conceptualisations of disease and medicine with broader patient concerns of human function. Integrative schemas that allow self-reflection of one's own human function may go some way to promote this integration in practice.

Limitations

All studies have limitations. In this study, limitations can be considered in 2 broad arenas; namely, the study method and the limitations of the artefact itself.

8.13 Methodological Limitations

The major limitation of this study is its sole reliance on the philosophical method. To that end, many may reject the approach entirely as a legitimate path to acquiring knowledge. For those who adopt this position (and I accept this view) my appeal is to the potential value of better understanding problematic phenomena using philosophical inquiry that may later inform more traditional methods of scientific study. In other words, the study is one of 'up-front' phenomenology. As such, the current study can be viewed as a window into contemporary issues that inform the applied use of classifications in medical practice that, at the very least, has value at the level of discourse.

Beyond the limitation of using philosophy as the study method, the specific choice of the phenomenological approach, where the goal of capturing the lived experience is the purported claim, also constitutes a limitation of the study. Again, for some, the ability to reliably comment on one's own experience is a fundamentally flawed proposition and I also accept this as a legitimate stance to take. However, as with philosophy more broadly, phenomenology propels us into a world of ideas and experiences that remains, in many cases, beyond the reach of our current scientific probes. For cognitive science, the concept of first-person experience remains something of a thorn in the side of the discipline that exposes conflict between deeply held positions in the traditional camps of science and philosophy.

Digging deeper still into the methodological limitations of the study, the use of an autophenomenological approach also requires discussion. To recapitulate, autophenomenology pertains to the direct, first-person account of a phenomena as opposed to the concept of heterophenomenology where the first-person account is relayed to another for consideration and a non-first-person account is made. For some, a heterophenomenologocal approach applies a level of rigor, with a nod to the scientific approach, where the thorny issue of phenomenology can achieve an improved level of legitimacy. In this study an attempt is made to circumvent the limitations of a purely autophenomenological approach through the availability of a cognitive artefact that aims to provide a publicly available component of an extended cognitive system. In other words, the artefact provides a shared window into aspects of the phenomena in question.

Furthermore, the interpretation of the phenomenological approach taken in this study may be viewed by some as insufficiently ‘tight’ and this speaks to the ongoing challenge of the phenomenological project more broadly. In this study, a particular challenge in capturing the phenomenological experience related to the nature of the phenomenon in question and the way in which the development of the cognitive artefact evolved dynamically over a prolonged period of practice to inform a particular intellectual gestalt. Indeed, for some, the study may be interpreted as a phenomenologically informed project rather than a ‘pure’ phenomenological description. Either way, it is hoped that the spirit of imaginative inquiry prompted by real-world problems of classification use is conveyed in the thesis.

In considering the limitations of the study it is appropriate to reflect on ways in which these limitations could have been avoided or mitigated. Given the subject matter of the study it is reasonable to have conceived several alternate methodological approaches focusing on different aspects of the problem. In the end, and despite its limitations, the chosen methodological approach was primarily driven by an internal motivation to describe my lived experience of the phenomena in question.

Beyond limitations of method, the artefact itself also has limitations that will now be described.

8.14 Artefact Limitations

Whilst the WHO have requested for all clinicians to use the ICF and ICD together in practice, the artefact described in the study is derived from the experience of a single Rehabilitation Medicine practitioner thereby significantly limiting any generalisability beyond the single study subject. Again, the goal of the study is the description of experience of applied cognition when considering application of WHO classifications thereby recognising a contemporary issue that is relevant to all clinicians – to a greater or lesser extent.

8.15 Artefact Inferences

In considering the artefact, several limitations are evident that pertain to a potential user's ability to infer how to use it in practice. In this study it has been possible only to provide a limited description of how it is conceptualised and applied and, therefore, relies much on the user's ability to make suitable inferences about how it is used. In other words, the artefact as described provides a basic structural layout at a course level of granularity with limited processing instructions for the user.

From a structural perspective, the artefact is limited to the explicit description and labelling of 20 cells whereas, in practice, data at a much finer level of granularity is used to inform the problem solving and decision-making process. Some of this finer-level detail is available in ICF and ICD and a myriad of other knowledge sources from which expert medical practitioners accumulate knowledge over the course of practice. When considering the artefact, the data gathering and synthesis process; it's initiation, progress and termination, are left to the discretion of the user. To use an analogy with computation, the process is one of non-determinism that is dynamically and organically pursued through the interaction between doctor and patient during a consultation. This contrasts, for example, with the traditional medical history taking approach that provides a processing sequence, albeit a deterministic one, that informs the information gathering approach during the consultation. Therefore, the artefact is likely to be limited to practitioners who have had some experience with its use and are comfortable with an improvised approach to information gathering rather than a rigid, linear one.

Furthermore, the ability of a user to make inferences about the combinations of cells – above and beyond relevant content of a single cell – is also not described and is highly user-dependent. This ability to identify and understand relevant combinations (and permutations) also extends to higher and lower levels of granularity. For example, is the relational complex at the level of the broad body, activity and environment level, or is it a relationship of finer grain data within a cell, for example, potential drug interactions in the 'products and technology' cell, or indeed an interaction across a range of granularities. To that end, the artefact lacks a high degree of procedural transparency and the current study does not provide extensive insights into detailed procedural aspects of application.

8.16 Cognitive Load

In addition to the lack of procedural structure that is inherent in the design of the cognitive artefact, the artefact is also limited by the additional cognitive load that is required where the unlabeled, blank cells require the user to commit to memory the 'label' of each cell.

8.17 Cognitive Style

Importantly, it is likely that the use of a 2-dimensional spatial array will exploit cognitive skills, strengths and preferences in certain groups of practitioners where, for others, representing information in such a way may make information processing and problem solving less efficient. For example, using the cognitive artefact as an external paper-based tool may be more appealing to using the same array to support mnemonic capabilities in visual imagery where the user may visually scan the array during visual working memory tasks to aid in problem solving. As such, the artefact design is an appeal to cognitive biodiversity where a range of cognitive artefacts designed to achieve the same end may all be equally of value depending on the cognitive style of the user.

Additionally, the current artefact is likely to appeal to clinicians who gravitate to a Gestalt, holistic perspective, whilst recognising the important place that fine grain data has in contributing to an overall scene.

8.18 ICF Application Limitations

In using the existing chapter headings of the ICF as the basis of the artefact there is no explicit reference to the 'personal factors' of the ICF. As discussed in chapter 4 and 6, however, these factors are inferred by the unique data configuration and relationships that emerge when gathering data during the consultation process.

8.19 Real-time Application

As the study has focused largely on the theoretical design and description of the cognitive artefact there has been limited attempts to examine the real-time application of the artefact in a practice setting beyond a fictitious case example. This omission limits the degree to which readers might understand application and is a trade-off with other areas of description and discussion that have been included in the study.

Similarly, application of the artefact outside the singular experience of the study author were not undertaken that again represent a trade-off when aspects of cost and value were considered in the study design.

8.20 Artefact Permanence

At its current stage of development and use the study artefact is an ephemera. In practice the 20-cell artefact is sketched on a blank A4 sheet of paper and when completed forms the basis for a more formal hand-written entry into the medical record, or a dictated letter. The artefact itself is not kept as part of the medical record that, in effect, exists as an important information workspace that informs the permanent medical record entry.

Implications

This study has several implications that pertain to the understanding of cognition and artefact use in medicine that relate, in particularly, to the applied use of the WHO FIC in Rehabilitation Medicine. Furthermore, the study has implications for informing phenomenological approaches to study in medical practice settings.

8.21 Applied Use of the WHO FIC

First and foremost, this study was motivated by a personal desire, in response to a general 'top-down' request by the WHO, for clinicians to 'use ICF and ICD together' in practice. To that end this study adds to the literature a detailed phenomenological account of the integrated use of the WHO FIC in the setting of Rehabilitation Medicine practice where, to date, no such accounts have been available. Such accounts are arguably a vital part, however small, of the iterative process of classification development and use that will continue as long as humans categorise using language.

8.22 Phenomenology of Practice

In providing a first-person account of a cognitive artefact developed during the course of applied professional practice the study contributes to medical research that has a strong ecological basis. To that end the study adds to an eclectic, yet growing body of research that applies phenomenological approaches to practice settings. Specifically, the study is a contribution to the currently modest body of medical phenomenology literature. As a result, the study provides previously unavailable insights into aspects of medical cognition as it pertains to the specialty practice of Rehabilitation Medicine. Furthermore, the study provides an understanding of how cognitive artefacts can be perceived, developed and applied in medicine in response to contemporary problems.

8.23 Cognitive Science

From a cognitive science perspective, the study provides a philosophical contribution to a contemporary body of literature that highlights the extended nature of cognitive systems that includes artefacts. Detailed, first-hand accounts of cognitive artefact development and use are currently limited, and their description provides a window into links between the internal and external components of cognitive systems.

In addition, with its focus on complexity, the study contributes to an appreciation of this phenomenon as an important aspect of Rehabilitation Medicine cognition where the use of a structured artefact aims to assist in negotiating this challenging cognitive task.

Recommendations for Research and Practice

In completing this study, several outstanding questions remain that set potential directions for future research. Firstly, as an up-front phenomenological account, this study raises several important questions about the generalisability to other practitioners. To that end, future research could be directed toward understanding how other clinicians, both novice and expert, may learn and apply the cognitive artefact used in the study in their own practice. Does, for example, the artefact appeal to clinicians with a particular cognitive style? Or, how, if at all, does using the cognitive artefact change practice in line with the overarching goals of the WHO FIC?

8.24 Understanding Rehabilitation Heuristics

Beyond important questions of feasibility for use in broader populations, a future focus for research may be to determine the common heuristics or ‘rules of thumb’ that Rehabilitation Medicine physicians might apply to the artefact when approaching problem solving in practice. For example, in the clinical department in which I work, we often discuss the ‘house, nouse, spouse’ heuristic where having a home to go to (‘house’), the cognitive ability to function at a safe level (’nouse’), and the support of a partner (‘spouse’) are key elements for successfully navigating a rehabilitation process. Having ‘3 out of 3’ of these components is ideal, ‘2 out of 3’ ok, ‘1 out of 3’ less than ideal and ‘0 out of 3’ often the basis for a ‘wicked problem’ that can be very hard to solve. Regarding the cognitive artefact, would it be possible to identify the types of heuristics that are ‘runnable’ on the artefact in the same way that algorithms run on an automaton. Which cells need to be activated? In what sequence?, and what are the threshold levels for turning a cell ‘on’?

8.25 Going Digital

As an n=1 study of a ‘pen and paper’ artefact a potential future direction for research is the development of a digital version of the artefact. Whilst a digital version of the artefact would permit permanent storage of information the benefits of this may be limited given the very transient nature of the artefact that is designed to be understood in real-time by the user. To that end, as the artefact is not intended primarily as a device for interpersonal communication, preserving it may not add value. However, the 20-cell structure of the artefact currently designed for use on an A4 page would, intuitively, transfer well to a touch-screen format such as tablet device. Importantly, consideration would need to be given to the relative advantages and disadvantages of moving from a paper-based to digital format where potential tensions exists between use of an artefact to guide situated action and awareness as opposed to the production of information for digital archiving. If a digital version was explored, the potential for heuristics to support reasoning could be considered.

Final Note

Regardless of any future research directions this work may take it is hoped that the reader will have developed a greater insight into some of the cognitive challenges that confront the contemporary practice of Rehabilitation Medicine where navigating complexity is at the heart of many clinical encounters. Tools that assist in both describing and navigating complexity through the integration of multiple framing perspectives, is one way to support this task. Furthermore, the classifications we devise to help us understand and navigate our worlds are both vital yet incomplete. Improved integration of classifications serves to potentially improve wholistic understanding of the problems human's encounter for which many of the most challenging and complex arise in the practice of healthcare.

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