

**OCCUPATIONAL PERFORMANCE AND INFORMATION  
PROCESSING IN ADULTS WITH AGITATION FOLLOWING  
TRAUMATIC BRAIN INJURY**

By

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# ABSTRACT

Agitation following traumatic brain injury (TBI) is characterised by a heightened state of activity with disorganised information processing that interferes with learning and achieving functional goals. This thesis outlines a series of studies across four research phases, investigating how occupational performance of adults with TBI is affected by agitated behaviour and information processing difficulties.

Clinicians report the presence of agitation interferes with engagement in therapy and achievement of rehabilitation goals. Research Phase One used a retrospective chart review of 80 adults with severe TBI to identify a high incidence of agitated behaviour during inpatient TBI rehabilitation. Agitated behaviour was associated with lengthier rehabilitation admission, prolonged duration of post-traumatic amnesia (PTA), and poor cognitive functioning at discharge. The association between agitation and poor cognition persisted for at least two years after discharge, highlighting the significant impact of agitated behaviour on people's ability to relearn cognitive skills for daily function.

These initial research findings directed subsequent research phases, in which an information processing model was adopted to examine application of cognitive strategies during occupational performance. An emerging occupational therapy assessment, The Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis, was selected as the primary method for evaluating how application of cognitive strategies during occupational performance is affected in agitated patients. Clinical utility of this measure was established in a case study of an adult

demonstrating severely agitated behaviour during inpatient TBI rehabilitation, followed by examination of instrument reliability and validity with ten experienced occupational therapists and five adults with agitated behaviour following brain injury.

The PRPP System of Task Analysis emerged as a valid and reliable method for determining strategy application deficits during occupational performance of adults with agitated behaviour, in acute stages of TBI rehabilitation. Consistent patterns of processing deficits were related to the Perceive and Recall Quadrants of the PRPP System.

The assessment tool forms part of a dynamic, interactive assessment and intervention system. The PRPP System of Intervention was evaluated in the final research phase, using an experimental single case design with replication across eight adults. The effectiveness of PRPP Intervention was examined in comparison to conventional occupational therapy in an ABAB design. Efficacy of the PRPP Intervention was demonstrated, with patients applying significantly more information processing strategies to occupational performance tasks during PRPP Intervention than during conventional occupational therapy sessions. Agitated behaviour concurrently reduced over the period of the study. Relationships between information processing and agitated behaviour are hypothesised.

# DECLARATION

I, **MELISSA THERESE NOTT**, hereby declare that the work contained within this thesis is my own and has not been submitted to any other university or institution as a part or a whole requirement for any higher degree.

I, **MELISSA THERESE NOTT**, hereby declare that I was the principal researcher of all work included in this thesis, including work published with multiple authors.

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Signed \_\_\_\_\_

Date \_\_\_\_\_

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# CHAPTER ONE: INTRODUCTION

## 1.1 RESEARCH BACKGROUND

The overarching purpose of this research was to better understand how difficulties with information processing impact on the occupational performance of adults with agitated behaviour following severe traumatic brain injury (TBI). In particular, it sought to examine current and emerging occupational therapy assessment and intervention practices with adults demonstrating agitated behaviour during acute TBI rehabilitation. This research was prompted by the experiences of the researcher working in the area of TBI rehabilitation, and contributes to the developing evidence base in this area of occupational therapy practice.

In Australia, occupational therapists are actively involved in TBI rehabilitation from the acute stage of recovery, typically engaging the patient in daily monitoring of post-traumatic amnesia (PTA) and in some rehabilitation programmes, commencing functional assessment and retraining. PTA is defined as the period of time after TBI when a patient is “confused, amnesic for ongoing events and likely to evidence behavioural disturbance” (Levin, O'Donnell, & Grossman, 1979, p. 675). The underlying cognitive processes associated with this form of behavioural disturbance and the subsequent impact on occupational performance are only just beginning to be examined.

Occupational therapy literature and cognitive rehabilitation literature provide little guidance to clinicians working with patients in this early stage of TBI recovery

(Wilson, Herbert, & Shiel, 2003). In part this may be due to the long-held belief that new learning does not take place during PTA, therefore emergence from PTA has, in some cases been used as a clinical indicator for commencement of formal assessment and therapy (Tate, Perdices, Pfaff, & Jurjevic, 2001; Tate, Pfaff, & Jurjevic, 2000). This approach is by no means universal with an increasing body of literature questioning these long-held beliefs, and providing evidence of learning during PTA (Ewert, Levin, Watson, & Kalisky, 1989; Gasquoine, 1991; Giles & Clark-Wilson, 1999; Glisky & Delaney, 1996; Weir, Doig, Fleming, Wiemers, & Zemljic, 2006).

## **1.2 RESEARCH NEED**

There is a clear need to develop evidence supporting intervention for patients with agitated behaviour. A recent ‘State of the Science’ review into TBI rehabilitation (Gordon et al., 2006) clearly identified the significant number of people with TBI who experience these challenging behaviours and in contrast, the lack of evidence available to guide effective clinical practice. Specific reviews of agitated and aggressive behaviour following TBI have made similar recommendations for the development of evidence based interventions applicable throughout the recovery process (Kim, 2002). The early stages of rehabilitation following coma emergence provide the first opportunity for patients to actively engage in rehabilitation, and are therefore a priority area for clinical research.

The reported incidence of agitated behaviour in TBI rehabilitation settings varies between 36–71% (Bogner, Corrigan, Fugate, Mysiw, & Clinchot, 2001; Kadyan et al., 2004; Lequerica et al., 2007; Maryniak, Manchanda, & Velani, 2001; Reyes, Bhattacharyya, & Heller, 1981). Even using the lowest reported incidence rate,

agitated behaviour is present to some degree in at least one-third of adults during TBI rehabilitation, highlighting the significance of this problem. Occupational therapists working with agitated patients following TBI report a range of verbally and physically aggressive behaviours from patients (Beaulieu, 2007). These experiences can lead to uncertainty in therapy provision, particularly during activities known to increase the likelihood of agitated or aggressive behaviour such as close physical contact in self-care tasks, and unpredictable situations during unstructured activities. The experiences of occupational therapists resonate with those of nursing staff who have described physical and social environmental factors within rehabilitation units as being irritating to patients with TBI (Pryor, 2004).

The behavioural changes apparent during PTA can be extremely distressing to patients, their families and the multidisciplinary team. Agitated behaviour is often identified as the most difficult for staff and families to cope with (Painter, 1990). Staff report frustration when working with this client group (Montgomery, Kitten, & Niemiec, 1997), and there are times when therapists report feeling ineffectual in treatment (Bermann & Bush, 1988). Agitated patients may be resistive to direct care or disruptive to the rehabilitation unit (Lombard & Zafonte, 2005), as their behaviour can pose a physical risk to themselves and staff members (Riedel & Shaw, 1997). This is a particular area of concern for occupational therapists who are responsible for early intervention in TBI rehabilitation. Expected occupational therapy outcomes target improved daily function, however there is no underlying framework to guide intervention with agitated patients in this early stage of TBI recovery (Radomski, 2008).

This research focused on one cognitive theory, information processing, to conceptualise processing difficulties that may underpin agitated behaviour. Specifically, this research investigated how patients with agitation apply information processing strategies during performance of everyday tasks, and how occupational therapy intervention may facilitate improved strategy application. It is hypothesised that improved information processing, assessed through use of processing strategies in functional tasks, will be associated with reduced agitated behaviour, and improved occupational performance.

The current research project attempts to test this hypothesis using a sequential research design, first observing and identifying information processing difficulties during functional task performance of agitated patients, then assessing how agitated patients apply information processing strategies during occupational performance, and finally, implementing and evaluating an intervention to improve information processing strategy application and occupational performance.

### **1.3 RESEARCH QUESTIONS**

The primary aim of this research is to examine how information processing deficits impact on the occupational performance of adults with agitated behaviour following TBI.

To fulfill this aim, the following research questions were generated:

1. To what extent does agitated behaviour impact on functional outcomes following inpatient rehabilitation of adults with TBI?

2. How can the capacity to apply information processing strategies during occupational performance be effectively measured in adults with agitated behaviour during acute TBI rehabilitation?
3. What types of strategy application deficits are identified by Stage 2 of the PRPP System of Task Analysis when observing the occupational performance of adults with agitated behaviour following TBI?
4. How valid and reliable is Stage 2 of the PRPP System of Task Analysis when measuring application of information processing strategies during occupational performance of adults with agitated behaviour following TBI?
5. How effective is the PRPP System of Intervention for improving application of information processing strategies during occupational performance of adults demonstrating agitated behaviour during acute TBI rehabilitation?

## **1.5 DEFINITION OF TERMS**

These definitions provide the conceptual focus at the outset of the study.

### **Traumatic Brain Injury**

TBI results from an external force to the brain producing a complex mixture of diffuse and focal lesions, with transient or permanent neurological dysfunction. TBI can cause long-term cognitive, behavioural, and physical disability; however it is the complex neurobehavioural sequelae that produce the greatest disruption to quality of life. Cognitive and behavioural changes, difficulties maintaining personal relationships and coping with occupational roles are typically reported to be more disabling than physical deficits (Khan, Baguley, & Cameron, 2003).

## **Post-traumatic amnesia**

PTA is defined as the period of time after TBI when a patient is not yet fully conscious and remains confused and amnesic for ongoing events, and is likely to demonstrate disturbed behaviour (Levin et al., 1979). PTA is characterised by widespread cognitive impairment, the most significant features of which are disturbed orientation, memory, and attention (Ahmed, Bierley, Sheikh, & Date, 2000; Tate et al., 2001; Weir et al., 2006).

## **Agitation**

Agitated behaviour that is present during the acute PTA period is often described as non-directed, global emotional and behavioural excess that is linked to an inability to process internal and environmental stimuli. Whereas agitated behaviour occurring after the resolution of PTA, termed chronic agitation, manifests as focal emotional and behavioural excess directed towards, but out of proportion to, an external stimulus (Azouvi et al., 1999; Fugate et al., 1997a; Hagen, 2001; Hagen, Malkmus, & Durham, 1979; Mysiw, Jackson, & Corrigan, 1988; Wilson & Dailey, 1999).

Agitation can be conceptualised along a continuum with varying levels of behavioural disturbance characterised by impulsivity, physical restlessness, inattention, disinhibition, aggression, or emotional lability (Corrigan & Bogner, 1994; Lequerica et al., 2007; Lombard & Zafonte, 2005; Sandel & Mysiw, 1996). In the acute phase of recovery, agitated behaviour is thought to be essentially non-purposeful and may be expressed as restlessness, thrashing in bed, pulling at tubes or restraints, loud or repetitive verbalisations, and repetitive or perseverative behaviour (Hagen, 2001; Hagen et al., 1979).

## **Cognition**

Cognition can be defined as the operation and interaction of processes and mechanisms used during task performance including attending, concentrating, perceiving, recognising, remembering, comprehending, judging, learning, knowing, reasoning and problem solving (Chapparo & Ranka, 1997a; Pool, 2006). Cognition is one of the occupational therapy profession's 'domains of concern' (AOTA, 2002).

## **Information processing deficits**

Information processing includes aspects of perceiving and attending to information from the surrounding sensory environment, processes of recalling and retrieving information from memory stores, executive processes or metacognition, processes for monitoring and adjusting performance, and use of feedback systems. These processes are typically conceptualised as occurring in sequential stages (Huitt, 2003). Information processing deficits occur when processing breaks down at any of these stages.

## **Information processing strategies**

The processes outlined above are activated or applied to task performance in various ways according to specific *cognitive* and *metacognitive strategies* (Lawson, 1980; Missiuna, Mandich, Polatajko, & Malloy-Miller, 2001). Processing strategies can be thought of as small units of behaviour or tactics that select and guide information processing (Abreu & Toggia, 1987; Toggia, 1991).



## **Occupational performance**

Central to the concept of occupational performance is the relationship between people, their environment and the activation of this relationship through occupation (Baum & Christiansen, 2005; Chapparo & Ranka, 1997a; Hagedorn, 2001; Sumison & Blank, 2006). Occupational performance may be defined as the ability to perceive, desire, recall, plan and carry out roles, routines, tasks and sub-tasks for the purpose of self-maintenance, productivity, leisure and rest in response to demands of the internal and/or external environment (Chapparo & Ranka, 1997a).

## **The Perceive, Recall, Plan, and Perform (PRPP) System**

The PRPP System is an occupational therapy assessment and intervention approach, focussing on how people apply information processing strategies during occupational performance (Chapparo & Ranka, 1997b; 2007). The PRPP System of Task Analysis is the assessment component, which adopts a two-stage approach: Stage 1 involves *behavioural* task analysis to identify errors in performance; Stage 2 involves *cognitive* task analysis to evaluate application of information processing strategies during task performance. The research contributing to this thesis focused on Stage 2 of the PRPP System, therefore all references to the PRPP System of Task Analysis, unless otherwise noted, refer to Stage 2 of the instrument.

## **Patient**

Throughout this thesis, the word 'patient' is used instead of 'client' to refer to a person receiving inpatient rehabilitation following TBI. During inpatient hospital admission the person is typically referred to as a 'patient' therefore this convention is continued in this thesis.

## **1.6 SCOPE OF THE RESEARCH**

This research focused on occupational therapy assessment and intervention for patients with agitated behaviour during the acute stage of TBI rehabilitation. It did not include issues relating directly to post-acute rehabilitation, or late stage/chronic agitation and aggression. The occupational therapy assessment and intervention procedures studied in this research targeted information processing strategy deficits that were identified by Stage 2 of the PRPP System of Task Analysis, a cognitive task analysis. Detailed examination of task mastery or functional independence as measured by Stage 1 of the PRP System of Task Analysis, or other measures of function was beyond the scope of this research. Areas of further research that are identified by findings in this study are highlighted in future recommendations in later chapters of this thesis.

## **1.7 DESIGN AND OVERVIEW OF THE RESEARCH**

This research was conducted in four sequential phases relative to the research questions posed.

### **Research Phase One: Agitation outcome study**

Research Phase One involved an investigation of 80 patients with severe TBI discharged from inpatient rehabilitation. Incidence of agitated behaviour during rehabilitation and the subsequent impact on functional outcomes was measured. Differences between agitated and non-agitated patients on several functional measures were evaluated at discharge and for 2 years following discharge.

### **Research Phase Two: Critical case-study**

The second research phase involved detailed analysis of one patient, deemed a critical case, embodying all the clinical features of concern to the study. Repeated assessment over a one-month period with the PRPP System of Task Analysis identified a consistent pattern of information processing strategies deficits, and confirmed the clinical utility of the PRPP System for measuring information processing strategy application during occupational performance of adults with severe agitation during acute TBI rehabilitation.

### **Research Phase Three: Validity and reliability studies**

The next phase of the research focused on the measurement properties of the PRPP System of Task Analysis. This phase involved two separate component studies: a validity study using Rasch analysis techniques, and a reliability study adopting traditional correlational methods.

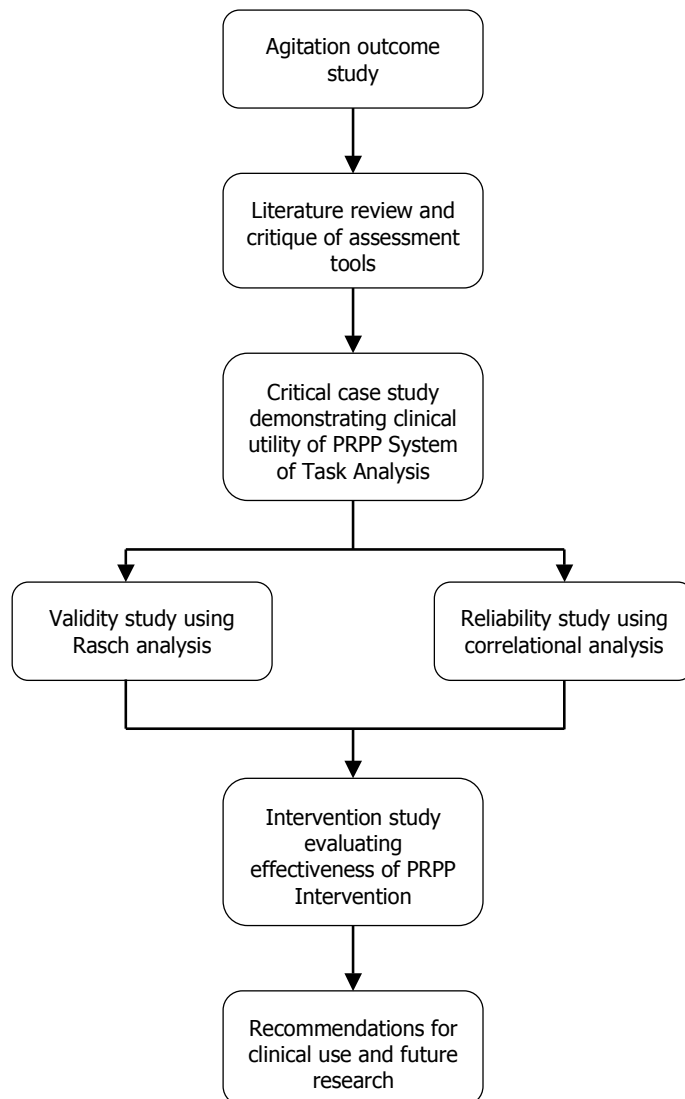
Ten occupational therapists analysed the task performance of five adults with agitated behaviour following brain injury, performing several self-care tasks. Assessment scores were calibrated to create a linear hierarchy of information processing strategies. Rasch analysis was used to evaluate construct validity and unidimensionality of the PRPP System.

Inter-rater and test reliability of the PRPP System of Task Analysis were examined using intra-class correlation coefficients. Intra-rater agreement of therapists over two measurement occasions was examined using Bland and Altman techniques.

### **Research Phase Four: PRPP Intervention study**

Finally, an experimental single case design was implemented across a series of adults to examine the effectiveness of PRPP Intervention in comparison to conventional occupational therapy. An ABAB design evaluated information processing strategy application and concomitant changes in agitated behaviour over a four-week period of acute TBI rehabilitation.

The sequence of research phases is illustrated below in Figure 1.1.



**Figure 1.1** Flowchart of research study

## 1.8 THESIS OUTLINE AND STRUCTURE

This thesis includes traditional chapters and several peer-reviewed papers in published form or submitted manuscript format. These papers form individual chapters within the results section of the thesis. References pertaining to each paper are listed at the end of the relevant results chapter, in published format where publication has occurred. References cited in traditional text chapters (Literature Review, Methods and Discussion) contribute to the main reference list following Chapter 11. The thesis outline, indicating published and unpublished chapters, is presented in Table 1.1.

**Table 1.1: Thesis outline**

<p><b>BACKGROUND (reported in Chapter Two)</b></p> <p>A <b>literature review</b> of research relevant to the areas of TBI rehabilitation, agitated behaviour, information processing and occupational performance is presented in Chapter Two, using the Occupational Performance Model (Australia) as an overarching frame of reference to link relevant areas of literature and hypothesise relationships to be examined within the research.</p>
<p><b>METHODS (reported in Chapter Three)</b></p> <p>A summary of research <b>methods</b> is provided in Chapter Three. Several methodological approaches were adopted throughout the research, each briefly presented as part of the published paper or manuscript in the results section. Chapter Three draws together these methods and elaborates on areas of research design not permitted within the limits of published journal articles.</p>
<p><b>RESULTS (reported in Chapters Four to Ten)</b></p> <p>These seven chapters contain the research <b>findings</b> as they relate to the four research phases. Six chapters are in the format of published papers or manuscripts under review. Chapter Nine provides supplementary analysis to Chapter Eight and is presented in traditional thesis format.</p> <p><b><u>Chapter Four: Research Phase One</u></b></p> <p>A retrospective review of 80 medical records provided initial contextual information about the incidence and nature of agitated behaviour in TBI rehabilitation in Australia. Functional rehabilitation outcomes were examined in relation to the presence of agitation.</p>

**Table 1.1 continued: Thesis outline**

Chapter Four has been published as: Nott, M. T., Chapparo, C., & Baguley, I. J. (2006). Agitation following traumatic brain injury: An Australian sample. *Brain Injury*, 20(11), 1175-82.

### **Chapter Five: Research Phase Two**

An in-depth critical case study of one male adult who was demonstrating severe agitation following TBI was used to evaluate the clinical utility of the PRPP System of Task Analysis for measuring application of information processing strategies during occupational performance.

Chapter Five has been published as: Nott, M. T. & Chapparo, C. (2008). Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 55(3), 188-198.

### **Chapters Six and Seven: Research Phase Three**

Ten occupational therapists participated in an evaluation of the validity and reliability of the PRPP System of Task Analysis.

Chapter six presents findings of the validity study and has been submitted for publication as: Nott, M. T., Chapparo, C., & Linacre, J. M. Exploring the validity of an information processing assessment for measuring occupational performance in adults with brain injury. *Journal of Applied Measurement*, (Under review; submitted December 2007).

Chapter seven presents findings of the reliability study and is in press as: Nott, M. T., Chapparo, C., & Heard, R. Reliability of the Perceive, Recall, Plan and Perform System of Task Analysis: A criterion referenced assessment. *Australian Occupational Therapy Journal*, Published online August 25 2008. DOI: 10.1111/j.1440-1630.2008.00763.x

### **Chapters Eight, Nine & Ten: Research Phase Four**

A series of eight adults with severe brain injuries participated in a single-system intervention study evaluating the effectiveness of PRPP Intervention in comparison to current occupational therapy intervention.

Chapter Eight contains findings related to use of information processing strategies during occupational performance as measured by the PRPP System of Task Analysis.

This chapter has been published as: Nott, M. T., Chapparo, C., & Heard, R. (2008). Effective occupational therapy intervention with adults demonstrating agitation during post-traumatic amnesia. *Brain Injury*, 22(9), 669-683.

**Table 1.1 continued: Thesis outline**

Chapter Nine is a supplementary analysis chapter containing more detailed analysis of the findings presented in Chapter Eight that could not be included in the journal article due to word limits.

Chapter Ten presents findings related to changes in agitated behaviour and information processing strategies as measured by the Agitated Behaviour Scale and the PRPP System of Task Analysis.

This chapter has been submitted for publication as: Nott, M. T., Chapparo, C., & Heard, R. Instructing information processing strategies in clients with agitation following brain injury. *Brain Injury*, (Under review; submitted 30<sup>th</sup> April 2008).

**DISCUSSION AND CONCLUSION (presented as Chapter Eleven)**

Chapter Eleven discusses the findings from the previous seven chapters in the context of the entire research study, drawing together the discussion points raised at the end of each individual journal article. Recommendations and implications for occupational therapy practice and future research are identified.

## **CHAPTER TWO: LITERATURE REVIEW**

The purpose of this chapter is to review literature relevant to the primary variables under study: TBI, agitated behaviour, information processing and occupational performance. This review contributes to fulfilling the purpose of the overall research, which was to investigate how the occupational performance of adults with TBI is affected by agitated behaviour and information processing difficulties.

This chapter is organised into four sections. First, the effect of TBI on cognition and behaviour during acute rehabilitation is discussed. The incidence of agitation and the relationship between agitated behaviour and functional outcomes following TBI are presented. The second section contains a critical review of several assessment tools used to measure the research variables and identifies the assessment tools used throughout the remaining research phases. Next, current rehabilitation intervention for adults with agitated behaviour and cognitive deficits following TBI is reviewed. The general perspective of team management approaches are outlined followed by more detailed analysis of current occupational therapy paradigms. Finally, a theoretical model of human information processing is described and applied to adults with TBI.

### **2.1 OCCUPATIONAL PERFORMANCE: THEORETICAL FRAMEWORK**

The research outlined in this thesis is a clinically based investigation into the impact of severe agitation on occupational performance. Therefore an occupational therapy practice model, the Occupational Performance Model (Australia) (OPM(A)),



Chapparo & Ranka, 1997a), was used to structure the research, including this literature review. The OPM(A) is briefly described, followed by sections that present a synthesis of the literature structured around the elements of the OPM(A).

Central to the concept of occupational performance is the relationship between people, their environment and the activation of this relationship through occupation (Baum & Christiansen, 2005; Chapparo & Ranka, 1997a; Hagedorn, 2001; Sumison & Blank, 2006). People and their occupations are represented in the OPM(A) as the internal context, while the environment is represented as the external context that influences occupational performance. More specifically, the internal context encompasses a person's occupational roles, performance areas and component capacities, underpinned by the core elements of body, mind, and spirit. The external environment includes the sensory, physical, social and cultural contexts in which occupational performance occurs (Chapparo & Ranka, 1997a). Figure 2.1 demonstrates each of these constructs with arrows that indicate hypothesised links between the constructs.

Effective occupational performance requires a person to possess a range of specific capacities that underpin performance and enable them to carry out tasks and activities in response to internal and/or external environmental demands (Chapparo & Ranka, 1997a). In the case of severe TBI, limitations to occupational performance are evident across all levels of the OPM(A). TBI leads directly to changes in the structure and function of body and mind core elements of occupational performance. These body and mind changes impact on the various capacities that enable people to engage in occupational performance. These are termed biomechanical, sensory-

motor, cognitive, intrapersonal and interpersonal components of performance. In the current research, the primary areas of concern are cognitive, intrapersonal and interpersonal capacities as they relate to the two identified research variables: information processing and agitated behaviour. These capacities may enable or inhibit the performance of roles, routines, tasks and activities for the purpose of self-maintenance, productivity, leisure and rest. Occupational performance activity areas and roles are influenced by the surrounding external context, space and time, to collectively form the fourth and pivotal variable of concern to this thesis: occupational performance. Each of these occupational performance levels will now be discussed.

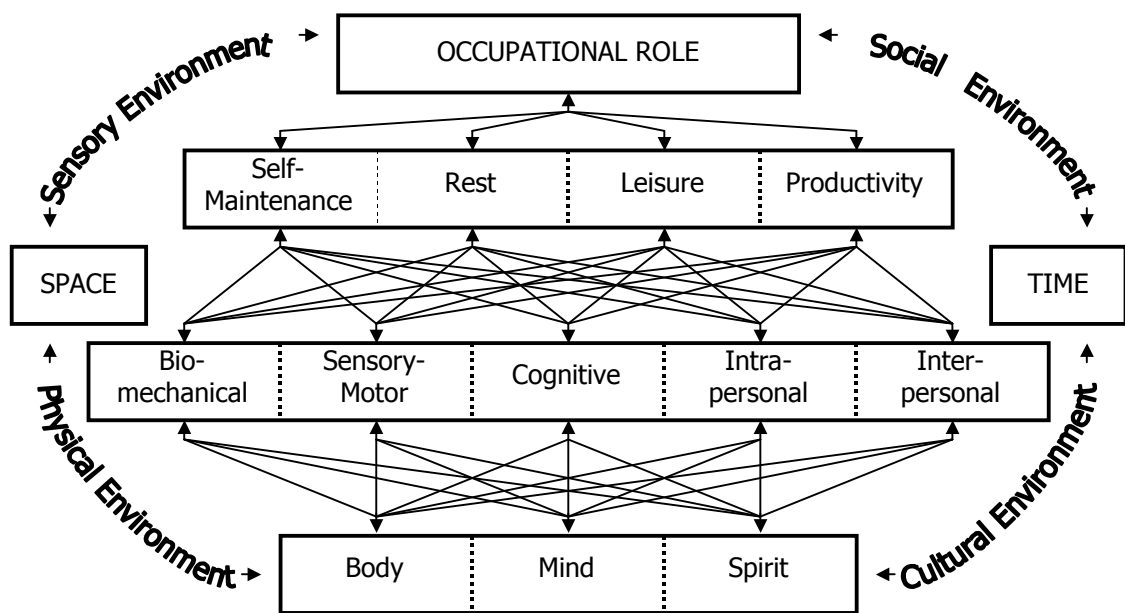


Figure 2.1: The Occupational Performance Model (Australia) (Chapparo & Ranka, 1997a)

## 2.2 TRAUMATIC BRAIN INJURY

Adults with severe TBI experience a wide range of cognitive, behavioural, sensorimotor, and psychological changes that impact on occupational performance (Mysiwi, Fugate, & Clinchot, 2007). Of particular concern to this research and depicted by red highlight in Figure 2.2 are the cognitive and behavioural changes that occur immediately following injury, leading to changes in information processing and agitated behaviour.

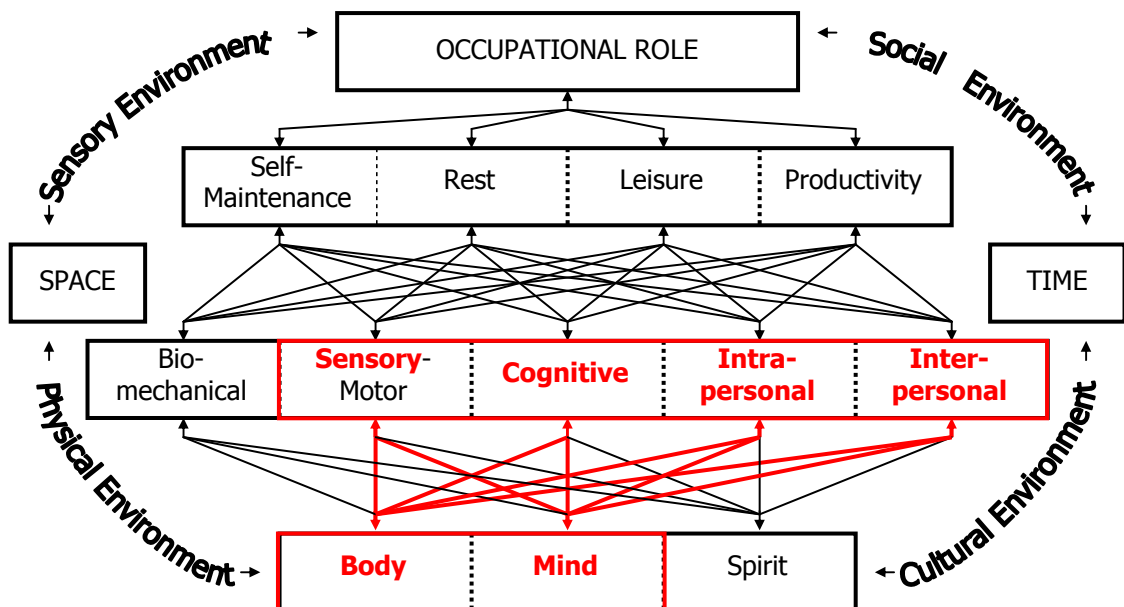


Figure 2.2: Hypothesised relationships between OPM(A) core elements impacted by TBI and related performance components

TBI is typically associated with rapid deceleration injuries that result in damage to the frontal lobe and connecting pathways, caused by the mechanical forces that abrade the brain against bony prominences of the skull during acceleration-deceleration and rotational movements (Eames, 1990; Katz, 1992). In more severe injuries, damage may also occur to the cells and axonal systems of deeper,

subcortical structures (Eames, 1990), leading to diffuse axonal injury (DAI) (Hart & Jacobs, 1993; Stuss & Gow, 1992). The functional impact of injuries to the frontal lobes, temporal lobes and axonal system is evidenced by poor self-regulation of behaviour, limited attention and memory capacity during occupational performance, and poor information processing.

Most significantly, the frontal lobes and prefrontal cortices play a primary role in the executive processes of selecting, planning and sequencing behaviour, monitoring cognitive processes, and inhibiting or changing behaviour in response to the external environment (Fortin, Godbout, & Braun, 2003; Godbout, Grenier, Braun, & Gagnon, 2005; Mattson & Levin, 1990; Stuss & Gow, 1992). These executive processes that underpin cognitive and behavioural control are vulnerable to traumatic injury, and when impaired, may be expressed as agitated and disinhibited behaviour.

### **2.2.1 Neuroanatomical correlates of agitated behaviour, executive function and information processing deficits**

Neuroimaging studies have been instrumental in localising structural anomalies from TBI that are associated with cognitive and behavioural changes (Strangman et al., 2005). In a prospective, consecutive series of 99 adults with mild to severe TBI, frontal lobe and sub-cortical lesions were associated with higher levels of agitation (Fichera, Zielinski, & Mittenberg, 1993). In a later series of 67 adults with mild to moderate TBI, significantly more lesions were observed on computed tomography (CT) and magnetic resonance imaging (MRI) in the frontotemporal region of patients with restlessness, agitation and inappropriate behaviour compared to those who did

not demonstrate these behaviours (van der Naalt, van Zomeren, Sluiter, & Minderhoud, 2000).

Functional neuroimaging studies suggest that reduced cerebral blood flow to the frontal lobes and thalamic region in adults with severe TBI is significantly associated with disinhibited behaviour and cognitive impairment (Oder et al., 1992). Measures of metabolic activity using positron emission tomography (PET) scanning, identified a significant correlation between disinhibited and agitated behaviour with the level of metabolic activity in the prefrontal cortex (bilaterally), the left anterior gyrus, and the middle cingulate gyri bilaterally (Fontaine, Azouvi, Remy, Bussel, & Samson, 1999). These imaging studies suggest an association between disinhibited and agitated behaviour with the neural mechanisms of the frontal lobe, and the cortical and subcortical structures connected to the frontal lobe.

A similar neuroanatomical presentation is associated with deficits in attention, working memory, and executive function following TBI (Azouvi, 2000; Strangman et al., 2005). Decreased metabolic activity and blood flow in the frontal and temporal cortices of adults with TBI has been associated with poor performance on attention tasks (Humayun et al., 1989; Ruff et al., 1994), memory and executive functioning tasks (Fontaine et al., 1999; Goldenberg, Oder, Spatt, & Podreka, 1992), and perseveration errors during task performance (Lombardi et al., 1999).

Brain activation patterns in adults with severe TBI reportedly deviate from healthy controls during working memory and attention tasks, by demonstrating a regionally dispersed activation pattern (Christodoulou et al., 2001; Soeda et al., 2005). This

abnormal dispersal of activity may arise from decreased functional and structural connectivity in the prefrontal and parietal networks, typical of DAI (Soeda et al., 2005; van Zomeren & Brouwer, 1994).

Strangman et al's (2005) review identified an essentially universal pattern of reduced cerebral activity in the frontal lobes and functional/structural disconnection of associated pathways leading to an abnormally dispersed pattern of activation throughout other areas of the brain. Modulation of behaviour and cognitive function is neurally linked with these frontal and pre-frontal cerebral structures, mediated by networks incorporating multiple cortical regions with collaborative and overlapping functions (Elliott, 2003). These studies support the hypothesised relationships highlighted in Figure 2.2, between the neurological changes occurring at the core element level of Body and Mind and performance capacity deficits in cognition, interpersonal and intrapersonal skills. The shared neuroanatomical basis for disinhibited, agitated behaviour and deficits in attention, working memory, executive functioning, and information processing, suggests a structural and functional relationship between these behavioural and cognitive sequelae of TBI.

### **2.3 AGITATED BEHAVIOUR FOLLOWING TBI**

Agitated behaviour observed during the early stages of TBI recovery, is typically associated with the period of post-traumatic amnesia (PTA), characterised by widespread cognitive impairment, the most significant features of which are disturbed orientation, memory, and attention (Ahmed et al., 2000; Levin et al., 1979; Tate et al., 2001; Weir et al., 2006). During this stage of recovery, agitated behaviour can be conceptualised along a continuum with varying levels of behavioural

disturbance characterised by aggression, impulsivity, motor restlessness, inattention, disinhibition or emotional lability (Bogner & Corrigan, 1995; Corrigan & Bogner, 1994; Lequerica et al., 2007; Lombard & Zafonte, 2005; Sandel & Mysiw, 1996). Clinicians agree that agitated behaviour interferes with daily functioning, progress in therapy and limits the achievement of functional goals (Bogner, Corrigan, Bode, & Heinemann, 2000; Burnett, Kennedy, Cifu, & Levenson, 1999; Sandel & Mysiw, 1996). Even low levels of agitated behaviour can substantially disrupt rehabilitation by limiting engagement in therapy (Lequerica et al., 2007).

### **2.3.1 Directed and non-directed agitated behaviour**

Agitated behaviour that is present during the acute PTA period is often described as non-directed, global emotional and behavioural excess that is linked to an inability to process internal and environmental stimuli. Whereas agitated behaviour occurring after the resolution of PTA, termed chronic agitation, manifests as focal emotional and behavioural excess directed towards, but out of proportion to, an external stimulus (Azouvi et al., 1999; Fugate et al., 1997a; Hagen, 2001; Hagen et al., 1979; Mysiw et al., 1988; Wilson & Dailey, 1999).

Non-directed agitated behaviour is usually observed in situations where patients are responding primarily to their own internal state of confusion or discomfort, or when the patient does not understand the demands or context of the surrounding environment, including staff and the intended goal of the rehabilitation task or activity (Corrigan & Mysiw, 1988; Hagen, 2001; Hagen et al., 1979; Riedel & Shaw, 1997; Wilson & Dailey, 1999). In these situations, agitated behaviour is essentially non-purposeful and may be expressed as restlessness, thrashing in bed, pulling at

tubes or restraints, loud or repetitive verbalisations, and repetitive or perseverative behaviour (Hagen, 2001; Hagen et al., 1979). The patient may be perceived by staff to be resisting care or therapy, and if pressed, this resistance can escalate into combative behaviour to avoid engagement in the rehabilitation task or activity. This form of non-directed agitated behaviour is characteristic of Level IV on the Rancho Levels of Cognitive Functioning Scale (Hagen, 2001), used to describe sequential stages in TBI recovery.

In contrast, agitated behaviour characteristic of Level V on the Rancho Scale, is directed towards, or in response to, external stimuli (Hagen, 2001; Hagen et al., 1979; Riedel & Shaw, 1997; Wilson & Dailey, 1999). Patients at Level V are typically distractible, have poor attention, and require redirection to stay on task. They may have limited motivation to perform functional tasks or attend therapy, and have poor insight (Riedel & Shaw, 1997). In comparison to the non-directed behaviour of Level IV, agitated behaviour at Level V is goal directed and purposeful, usually with the intent of 'getting away' from the task, setting, or staff member; for example not engaging in the rehabilitation activity or leaving the rehabilitation setting (Patterson & Sargent, 1990). This form of agitated behaviour has an inherent purpose and can be unintentionally maintained through learned association and reinforcement, if the agitated behaviour does in fact lead to the desired goal of non-participation or avoidance of activities (Treadwell & Page, 1996). As behaviour becomes learned, characteristic agitation may give way to more specific aggressive behaviour (Wilson & Dailey, 1999).



### 2.3.2 Factors contributing to agitated behaviour

Various internal and external factors may drive agitated behaviour. The OPM(A) identifies a range of external factors and internal capacities that have the potential to either inhibit or assist occupational performance. Deficits in occupational performance arise when ‘misfit’ occurs between internal capacities and external demands (Chapparo & Ranka, 1997a). Aspects of the physical, sensory and social environment are known precipitants of agitated behaviour. These aspects of occupational performance are depicted as the outer circle in Figure 2.3.

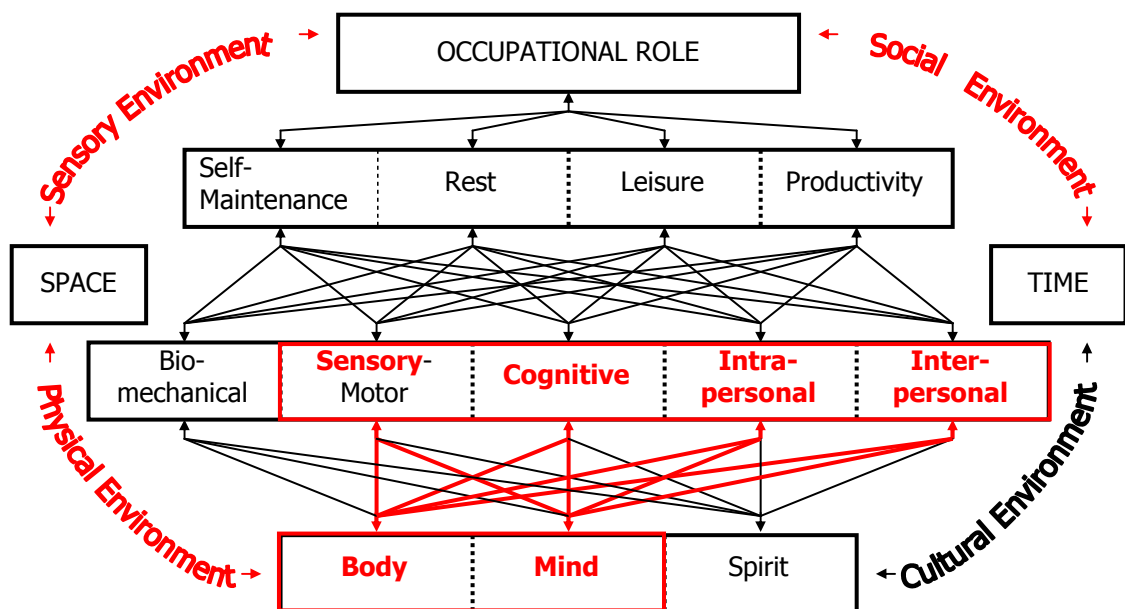


Figure 2.3: Hypothesised precipitants of agitated behaviour: OPM(A) external contextual factors and internal component capacities

Stimuli including ambient noise, interactions with staff and visitors, and physical restrictions have been identified as irritating to brain injured adults and are potential triggers for agitated behaviour (Pryor, 2004). The frequent tactile stimulation involved with nursing care, and the constant demands associated with acute

rehabilitation combine to increase arousal levels, and increase the likelihood of an agitated response (Fluharty & Glassman, 2001; Plylar, 1989).

Limitations to internal component capacities highlighted in level 2 of Figure 2.3 may also contribute to agitated behaviour. Previous research has identified a strong relationship between reduced cognitive ability and agitated behaviour, specifically highlighting the role of impaired attention (Corrigan, Mysiw, Gribble, & Chock, 1992). Inability to selectively attend to, or maintain attention on a task leads to distractible behaviour, fragmented responses, poor information processing and difficulty inhibiting behavioural and emotional responses (Hagen et al., 1979; Katz, 1992; Montgomery et al., 1997; Riedel & Shaw, 1997). This inability to attend and effectively process information is particularly evident when patients are already in the hyper-aroused state common to acute or non-directed agitation (Bermann & Bush, 1988; Prigatano, 1986).

### **2.3.3 Impact of agitated behaviour on functional outcomes**

This literature review has thus far taken a ‘bottom-up’ approach in describing the effect of TBI on the body and mind core elements of occupational performance, the subsequent capacity limitations experienced in the component areas of cognition, interpersonal and intrapersonal performance, and suggested internal and external influences that may contribute to agitated behaviour during acute recovery from TBI. The effect of these changes on occupational performance areas and potential for long-term occupational role loss will now be examined in more detail to highlight the functional consequences and significance of this research. Figure 2.4 highlights the

hypothesised links between each of the four internal construct levels and the surrounding environmental contexts, including time and space.

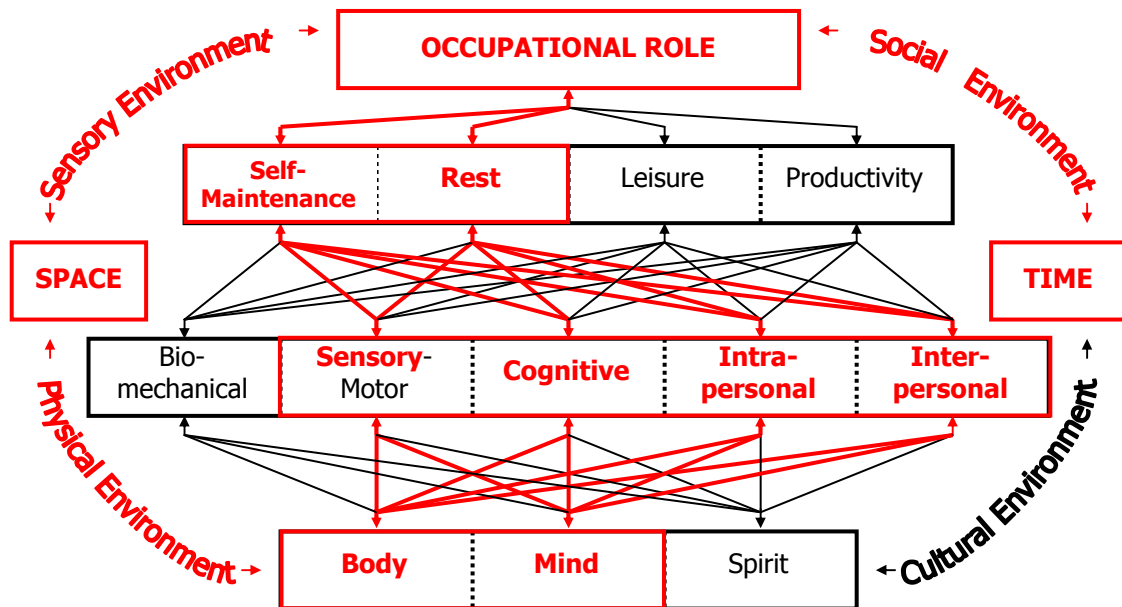


Figure 2.4: Hypothesised relationships between OPM(A) internal and external factors associated with post-TBI agitation and occupational role performance

Agitated behaviour during TBI rehabilitation is associated with limited participation in therapy, difficulty achieving functional goals, and ultimately poor outcome (Bogner et al., 2000; Bogner et al, 2001; Burnett et al., 1999; Lequerica et al., 2007; Sandel & Mysiw, 1996). Lequerica et al.'s (2007) study of 69 adults during acute rehabilitation, demonstrated that progress was significantly reduced by agitated behaviour that disrupted occupational and physical therapy sessions. Lequerica et al.'s (2007) sample was slightly older than typical TBI samples, as one-quarter had sustained non-traumatic injuries (e.g. aneurysm, anoxia, tumour). This study was critical in demonstrating that rehabilitation progress is negatively influenced not only by injury severity, but also by agitated behaviour, leading to poor functional outcomes.

In particular, agitation is associated with poor cognitive outcome at the time of rehabilitation discharge (Bogner et al., 2001), which is a likely contributor to the ongoing need for high levels of supervision. Prospective studies by Reyes et al. (1981) and Bogner et al. (2001) have identified a reduced likelihood for discharge to a private residence, with judgement deemed to be sufficiently impaired to necessitate supervision following discharge, and placement in an alternative medical facility. Reyes et al. (1981) longitudinally followed a group of 87 TBI rehabilitation admissions for a period of five years. Thirty-two were restless and 12 were agitated on admission. All agitated patients required supervision after discharge, with approximately half these patients requiring placement in an alternative medical facility. This finding was re-iterated in Bogner et al.'s (2001) study of 340 consecutive admissions to an acute TBI rehabilitation facility. Lower cognitive functioning at admission was closely related to occurrence of agitation during rehabilitation and decreased the likelihood that an individual would be discharged to a private residence.

Prospective studies by Bogner et al. (2001; consecutive series of 340 adults with TBI) and Kadyan et al. (2004; consecutive series of 158 adults with TBI) have identified the presence of agitated behaviour in patients during acute rehabilitation to be associated with prolonged rehabilitation admissions. Extended admissions may arise when treatment goals cannot be directly pursued until after the goal of reducing agitation has first been addressed (Bogner et al., 2001); supporting clinicians' impressions that agitation interferes with the achievement of functional goals (Sandel & Mysiw, 1996).

The consequences of agitated behaviour and effect on occupational performance persist beyond rehabilitation discharge. Studies evaluating outcome in patients post-discharge have identified a higher incidence of psychiatric problems (Reyes et al., 1981), excessive anxiety and depression, greater thought disturbance and a general increase in psychopathology in patients who demonstrated agitated behaviour during acute admission compared to those who did not (Levin & Grossman, 1978).

Agitation during acute rehabilitation has been associated with greater residual disability and difficulty resuming paid employment (Denny-Brown, 1945; Reyes et al., 1981; van der Naalt et al., 2000).

#### **2.3.4 The incidence of agitated behaviour**

The extent of agitation during acute TBI rehabilitation remains unclear. Reported incidence of agitated behaviour in TBI rehabilitation settings varies between 36–58% (Bogner et al., 2001; Kadyan et al., 2004; Maryniak et al., 2001; Reyes et al., 1981), with variability in these rates resulting from inconsistent definitions and diverse data collection techniques across these studies. Even using the lowest reported incidence rate, agitated behaviour is present to some degree in at least one-third of adults during TBI rehabilitation, highlighting the significance of this problem.

Bogner et al. (2001) and Kadyan et al. (2004) recruited similar samples of adults in acute rehabilitation, with mild to severe TBI, aged 33 years and 36 years (average), and comprising 79% and 76% males (respectively). In both studies, agitated behaviour was measured daily, using the Agitated Behaviour Scale (ABS; Corrigan, 1989); identifying 36% and 41% of study participants as agitated. In these studies, an ABS cut-off score > 21, recorded three times within 48 hours, indicated presence of

agitation. Prospective measures of agitation using standardised tools such as the ABS (Corrigan, 1989) have consistently identified lower levels of agitation in comparison to methods based on review of medical records (Maryniak et al., 2001).

One hundred and twenty adults with traumatic and non-traumatic brain injuries, admitted to a brain injury rehabilitation facility over two years were recruited to Maryniak et al.'s (2001) study. Multidisciplinary progress notes were reviewed to determine presence and degree of agitation. Agitation was reported in 58% of admissions; however it is unclear how agitation was defined in these cases.

The methodological variance in these studies and resultant wide range of reported incidence highlights the importance of accurate measurement. The impact of differing definitions and data collection methods has been clearly highlighted when determining incidence. Lequerica et al. (2007) measured agitated behaviour daily in 69 inpatients of a specialist rehabilitation facility. Both timing and method of measuring agitation appeared to significantly influence the reported incidence rate. Agitation was measured during the first week of rehabilitation admission. Ninety-one percent of patients in the acute period of confusion (APOC) demonstrated one or more agitated behaviours. In patients who had already emerged from APOC, the level of agitated behaviour dropped to 71%. In even greater contrast, when the ABS cut-off score was applied to these patients who demonstrated at least some degree of agitation, only 6% of the same sample were categorised as agitated. Differences in measurement procedures, timing, and frequency, appear to create significant variation in reported incidence rates.

In summary, section one of this review has outlined the links between TBI, agitated behaviour, and occupational performance, within the framework of the OPM(A). The studies presented in the later part of section one highlight the incidence and impact of agitated behaviour on occupational performance. Agitated patients tend to experience greater cognitive impairment, require lengthier rehabilitation, need more supervision at discharge, experience greater anxiety and depression, and have difficulty resuming occupational roles.

## **2.4 REVIEW OF MEASUREMENT INSTRUMENTS**

The second section of this chapter reviews measurement tools designed to assess the primary variables under study in this research: agitated behaviour, information processing and occupational performance in adults with TBI. Assessment tools were selected from the literature according to the purpose stated by assessment developers, and were reviewed against established measurement criteria (Law, 1987; Law, Baum, & Dunn, 2001). Recommendations are made for further use of two instruments in subsequent research phases.

The OPM(A) framework also guided the assessment selection and review process. Measures of inter-personal, intra-personal and cognitive components of occupational performance best represented the constructs of agitated behaviour and information processing ability. Measures of functional performance focusing on the area of self-care were primarily sought and reviewed. First, assessments measuring agitated behaviour and cognitive ability at the component capacity level are presented. Second, assessments designed to measure function at the occupational performance level are presented, followed by assessments that attempt to span both these levels of the OPM(A).

### **2.4.1 Assessment tools for measuring agitated behaviour**

Agitated behaviour in an acute TBI rehabilitation context has traditionally been measured using rating scales and observational methods. Unfortunately, less than one-quarter of brain injury specialists report using an objective measure of agitated behaviour to measure the presence or severity of agitation, or to evaluate treatment efficacy (Fugate et al., 1997b). The most commonly used measures, as reported by



physicians of the Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation, include the ABS (Corrigan, 1989) and the Overt Aggression Scale (OAS; Yudofsky, Silver, Jackson, Endicott, & Williams, 1986).

Three measurement instruments, including the ABS, the OAS and a modified version of the OAS were selected for review based on the following criteria:

- Developed/adapted for measuring behaviour in adults with TBI
- Suitable for administration during acute rehabilitation with patients in PTA
- Observational in nature
- Measures a range of behaviours consistent with the definition of agitation
- Measures not only presence, but also degree of agitation
- Repeated administration possible after a short interval

#### ***2.4.1.1 Agitated Behaviour Scale***

The ABS is an observational measure with 14 items (Corrigan, 1989), reported to measure agitation as represented by three underlying factors: disinhibition, aggression and emotional lability (Corrigan & Bogner, 1994). Items are measured on a 4-point scale indicating levels of interference with functional activities. Clinical studies have suggested use of a cut-off score (ABS total = 21) to classify the presence of agitation (Bogner et al., 2001; Corrigan, 1989; Kadyan et al., 2004); however there is some disagreement as to the clinical utility of using an objective cut-off score, citing a potential to inadvertently mask levels of agitated behaviour that are considered 'sub-threshold' that may still impact on performance and achievement of functional goals (Lequerica et al., 2007). The ABS was specifically

developed for serial assessment of agitated behaviour in the acute TBI context; demonstrating appropriate levels of reliability, internal consistency, concurrent validity, and construct validity (Bogner, Corrigan, Stange, & Rabold, 1999; Corrigan, 1989; Corrigan & Bogner, 1994).

#### ***2.4.1.2 Overt Aggression Scale***

The OAS is a measure of aggressive behaviour divided into 4 categories: (1) verbal aggression, (2) physical aggression against objects, (3) physical aggression against self, and (4) physical aggression against other people (Silver & Yudofsky, 1991; Yudofsky et al., 1986). Rating occurs relative to a specific episode; during which all observed behaviours and resultant interventions are ticked. Behaviours and interventions are weighted, thereby contributing different proportions towards the total score. The OAS was developed for measuring violent and aggressive behaviours in an inpatient psychiatric population; however use in acute TBI rehabilitation has been reported (Brooke, Patterson, Questad, Cardenas, & Farrel-Roberts, 1992; Brooke, Questad, Patterson, & Bashak, 1992). Recordings of aggressive behaviour using the OAS have been found to be more accurate and sensitive than medical charts or ward based communication systems (Silver & Yudofsky, 1991). Administration and totaling of scores is suggested for weekly epochs, requiring a 1-month baseline before intervention. Reports of inter-rater reliability have varied, most notably for verbal aggression items (Yudofsky et al., 1986).

#### ***2.4.1.3 Overt Aggression Scale – Modified for Neurorehabilitation (OAS-MNR)***

The OAS-MNR is an adapted version of the OAS, designed specifically for measuring aggressive behaviour in people with brain injury (Alderman, Knight, & Morgan, 1997). The OAS-MNR expands the OAS by including antecedent descriptions and broadening the range of intervention options, however the basic structure of items representing four categories of aggressive behaviour remains consistent. Inter-rater reliability has been reported as fair to good on different parts of the measure, with improved correlation between severity of aggression and intrusiveness of intervention in comparison to the OAS (Alderman et al., 1997). Examples of the clinical utility have been confined to the post-acute stage of TBI rehabilitation (Alderman, Davies, Jones, & McDonnell, 1999; Alderman, Knight, & Henman, 2002).

#### ***2.4.1.4 Excluded scales***

Several instruments measuring global constructs of behaviour that include a single item assessing agitated behaviour exist in the literature: the Cognitive Behaviour Rating Scale (Galski, Palasz, Bruno, & Walker, 1994), Neurobehavioural Rating Scale (Levin et al., 1987), Neurobehavioural Rating Scale – Revised (McCauley et al., 2001), and the Neuro Psychiatric Inventory (Cantagallo & Dimarco, 2002; Cummings et al., 1994). These tools did not meet all the inclusion criteria set out in Section 2.4.1 and were thus excluded from further critique and review.

**Table 2.1 Summary of selected instruments for measuring agitated behaviour (adapted from Law et al., 2001)**

	ABS	OAS	OAS-MNR
1. Clinical usefulness:			
Target population	✓	✗	✓
Administration	✓	✓	✓
Time	✓	✓	✓
Cost	✓	✓	✓
Flexibility	✓	?	?
Utility	✓	✗	✗
2. Test standardisation	✓	✓	✓
3. Approach:			
Norm-referenced	✗	✗	✗
Criterion-referenced	✓	✓	✓
Bottom-up	✓	✓	✓
Top-down	✗	✗	✗
4. Psychometrics			
Reliability	✓	?	?
Validity	✓	?	?
5. Ecological validity	✓	✓	✓
6. Theoretical base	✓	✓	✓
7. Cultural considerations	✗	✗	✗
8. Occupation-based assessment	✗	✗	✗
9. Client-centred assessment	✗	✗	✗
10. Training required	✗	✗	✗

Notes: ✓ test characteristic reported with clear evidence  
 ? test characteristic reported with equivocal evidence or further testing required  
 ✗ test characteristic not reported

#### **2.4.1.5 Summary**

Of the measures reviewed, the ABS is the only measure designed for the target population of adults in acute TBI rehabilitation, and is consistently recommended in reviews of agitation following TBI (Lombard & Zafonte, 2005; Sandel & Mysiw, 1996). In contrast, the OAS was developed for a psychiatric population; while the OAS-MNR has been developed for TBI post-acute rehabilitation. In addition, the measurement properties of the OAS and OAS-MNR remain under-examined. Therefore, the ABS was selected as the most appropriate measure of agitated behaviour for use in later phases of this research.

## **2.4.2 Assessment tools for measuring cognitive function**

The next stage of this review identified and critiqued assessment tools for measuring cognition following TBI.

Measures of cognition were selected for review according to the following criteria:

- Developed/adapted for measuring cognition in adults with TBI
- Suitable for administration during acute rehabilitation, with patients in PTA and demonstrating agitated behaviour
- Measures a range of cognitive/processing skills applicable to everyday function
- Repeated administration possible after a short interval
- Assessment findings provide clear direction for intervention planning

From the array of cognitive assessments published and suggested as suitable for measuring cognitive functioning post-TBI, the following five measurement tools were selected for more detailed review. These five measures were reported as suitable for use during PTA:

- Westmead PTA Scale
- Rancho Los Amigos Level of Cognitive Functioning Scale
- Moss Attention Rating Scale
- Barry Rehabilitation Inpatient Screening of Cognition
- Neurobehavioral Cognitive Status Exam

#### ***2.4.2.1 Westmead Post-Traumatic Amnesia Scale***

There are several prospective measures of PTA. The Westmead PTA Scale (WPTAS) was selected for review from the available measures as it is the scale used clinically at both facilities involved in this research project, and is reportedly the most widely used PTA scale in clinical practice in Australia (Leach, Kinsella, Jackson, & Matyas, 2006; Ponsford et al., 2004)

The WPTAS is a daily, prospective measure of orientation and recall, designed to monitor emergence from the state of PTA following TBI (Shores, Marosszky, Sandanam, & Batchelor, 1986). The test consists of 12 items administered by questioning the patient and showing picture cards to recall each day (Marosszky, Ryan, Shores, Batchelor, & Marosszky, 1997).

Adequate inter-rater reliability has been determined from a small sample of raters and patients with TBI (Geffen, Bishop, Connell, & Hopkins, 1994). Validation studies initially identified and later confirmed concurrent validity with neuropsychological tests of verbal new learning (Shores, 1995; Shores et al., 1986), and predictive validity (Geffen, Encel, & Forrester, 1991).

The WPTAS is reported to be a standardised, objective, quick assessment of the recovery process until such time as more detailed neuropsychological evaluation is indicated (McFarland, Jackson, & Geffen, 2001; Tate et al., 2000); however daily administration can become problematic in agitated patients, as frustration with repeated failure can exacerbate agitated behaviour.

#### ***2.4.2.2 Rancho Los Amigos Level of Cognitive Functioning Scale (LCFS)***

The LCFS is a behavioural description of eight stages of cognitive reorganisation through which brain injured patients typically progress (Hagen et al., 1979). The scale has recently been revised to ten phases of recovery (Hagen, 2001). Although this scale reflects common trends in recovery, it does not specifically identify the cause of cognitive disorientation that influences behaviour. The authors of the scale clearly state the intended purpose is to provide behavioural descriptions covering a wide range of responses to stimuli (Hagen et al., 1979), not for diagnostic purposes (Hagen, 2001). The psychometric properties of the scale have not been widely tested (Flannery, 1998); however it remains in widespread use due to the simplicity and clinical utility of the scale (Hall, Bushnik, Lakisic-Kazazic, Wright, & Cantagallo, 2001).

#### ***2.4.2.3 Moss Attention Rating Scale (MARS)***

The MARS is a global measure of attention, integrating 22 items, rated on a 5-point scale from definitely true to definitely false, based on observation during structured and unstructured interactions (Whyte, Hart, Bode, & Malec, 2003). This tool has great potential for clinical utility during early stages of TBI rehabilitation, as the observational nature enables use with patients who are otherwise unable to complete traditional psychometric tests (Gillen, 2009).

Extensive pilot work and initial psychometric testing using Rasch analysis supports instrument validity (Whyte et al., 2003). Factor analysis identified a 3-factor model representing: the ability to initiate without cueing; the ability to inhibit perseverative, restless or irrelevant responses; and the ability to sustain attention and persist on

tasks (Hart et al., 2006). Internal consistency is high, while inter-rater reliability is moderate, with evidence of discipline specific differences in scoring (Whyte et al., 2003).

#### ***2.4.2.4 Barry Rehabilitation Inpatient Screening of Cognition (BRISC)***

The BRISC is a standardised screening assessment designed for patients with ABI, recommended for use in patients who have emerged from coma but who remain in PTA (Barry, Clark, Yaguda, Higgins, & Mangel, 1989). The eight BRISC subtests include reading, design copy, verbal concepts, orientation, mental imagery, mental control, initiation, and memory. It is reported to be suitable for repeated administration during early recovery to monitor change (Barry et al., 1989).

Concurrent validity with existing neuropsychological tests and screening batteries ranges from low to high for individual areas and the overall composite score (Barry et al., 1989; Lannin & Scarcia, 2004). Poor correlation with disability measures such as GCS and the Modified Barthel Index have been reported (Shah & Muncer, 2003). While the BRISC has demonstrated internal consistency (Lannin & Scarcia, 2004) and responsiveness to change during rehabilitation, it does not predict length of stay (Shah & Muncer, 2003). Test-retest and inter-rater reliability were demonstrated on relatively small samples during initial development phases only (Barry et al., 1989).

#### ***2.4.2.5 Neurobehavioral Cognitive Status Examination (NCSE)***

The NCSE (alternatively the Cognistat) assesses level of consciousness, orientation, attention, language, constructional praxis, memory, calculations, and reasoning, using a screen and metric approach (Kiernan, Mueller, Langston, & Van Dyke,



1987). Patients initially attempt a demanding screen item (in each domain area) that if passed, results in the maximum score for that subscale; however, if the screening item is failed, a series of test items, increasing in difficulty are administered.

Relatively high false negative rates have been identified on the screen items of several subtests, raising doubts regarding validity (Doninger, Bode, Heinemann, & Ambrose, 2000).

The NCSE was found to be sensitive to the presence of cognitive impairment following TBI, and individual subscales correlate with respective neuropsychological tests, supporting individual subscale concurrent validity and specificity of cognitive domain assessment (Lannin & Scarcia, 2004; Nabors, Millis, & Rosenthal, 1997).

Despite extensive study, the psychometric properties of this instrument remain underdeveloped. Rasch analysis of the NCSE rating scale structure suggests the hierarchical ordering of domain items is consistent with neuropsychological deficits following TBI (Doninger et al., 2000). A shorter version has been developed, however Doninger, Bode, Ehde, Knight, and Bombardier (2006) report inability to differentiate cognitive status in people with TBI using the shortened version.

#### ***2.4.2.6 Summary***

The reviewed cognitive measures represent a variety of assessment types, focusing either on a single cognitive skill or assessing a broad range of processes, using observation, daily questioning, team discussion, or standardised test items. A summary is provided in Table 2.2. The LCFS was determined to be a descriptive indicator rather than a measurement instrument, and was excluded from further review.

The BRISC and NCSE both comprise batteries of multiple test items that may not be clinically applicable to adults in PTA who are demonstrating agitated behaviour (Fry & O'Brien, 2002). Flexibility in administration is essential for adults with very impaired ability to attend to information, instructions and tasks, therefore these two measures were considered inappropriate for testing cognitive abilities in agitated adults with TBI. Further to this, the psychometric properties of the NCSE require further examination.

The WPTAS and MARS were both developed specifically for use with adults following TBI and demonstrate good utility in acute rehabilitation. When examined against the criteria in Section 2.4.2, the areas of cognitive processing analysed by each assessment were too narrow, primarily focusing on aspects of orientation and recall, or attention. The cognitive assessment measures reviewed in this section did not meet all criterion established in Section 2.4.2 therefore were not deemed appropriate as primary outcome measures in later research phases.

**Table 2.2 Summary of selected instruments for measuring cognitive processing (adapted from Law et al., 2001)**

	Westmead PTA	Rancho LCFS	MARS	BRISC	NCSE/ Cognistat
1. Clinical usefulness:					
Target population	✓	✓	✓	✓	?
Administration	?	✓	✓	✗	✗
Time	✓	✓	✓	?	?
Cost	✓	✓	✓	✗	✓
Flexibility	✗	✓	✓	✗	✗
Utility	✗	?	✓	✗	✗
2. Test standardisation	✓	✗	✓	✓	✓
3. Approach:					
Norm-referenced	✗	✗	✗	✗	✗
Criterion-referenced	✓	✗	✓	✓	✓
Bottom-up	✓	✗	✓	✓	✓
Top-down	✗	✗	✗	✗	✗
4. Psychometrics					
Reliability	?	✗	✓	?	?
Validity	✓	✗	✓	?	?
5. Ecological validity	✗	✗	✓	✗	✗
6. Theoretical base	✗	✗	✓	?	✓
7. Cultural considerations	✗	✗	✗	✗	✗
8. Occupation-based assessment	✗	✗	✓	✗	✗
9. Client-centred assessment	✗	✗	✗	✗	✗
10. Training required	✗	✗	✗	✗	?

Notes: ✓ test characteristic reported with clear evidence

    ? test characteristic reported with equivocal evidence or further testing required

    ✗ test characteristic not reported

### **2.4.3 Assessment tools for measuring functional performance**

Agitated behaviour is reported to impact on functional performance during TBI rehabilitation, and is associated with poor outcome (Bogner et al., 2000; Lequerica et al., 2007; Sandel & Mysiw, 1996). Therefore measures of functional performance were included in this review to reflect the impact of agitated behaviour on functional performance. The area of self-care was specifically targeted as early TBI rehabilitation commonly focuses on this aspect of occupational performance.

Numerous assessments are available for measuring functional performance during rehabilitation. A review of current literature and practice focused on assessments that met the following criteria:

- Established utility for measuring functional performance in adults with TBI
- Suitable for administration during acute TBI rehabilitation, with patients in PTA and demonstrating agitated behaviour
- Observational in nature
- Sensitive to the effect of cognitive deficits on functional performance
- Repeated administration possible after a short interval
- Assessment findings provide clear direction for intervention planning

Four functional performance measures were considered to meet these criteria:

- The Barthel and Modified Barthel Indices
- The Functional Independence Measure
- The Rivermead Activities of Daily Living Assessment
- The Assessment of Motor and Process Skills

#### ***2.4.3.1 Barthel and Modified Barthel Index***

The Barthel Index was one of the first measures developed to assess the rehabilitation process, and has served as a benchmark by which more recently developed assessments have been measured (Cohen & Marino, 2000). It was designed to assess functional change in adults with neurological or musculoskeletal disorders during rehabilitation (Mahoney & Barthel, 1965), and has recently demonstrated utility during inpatient TBI rehabilitation (Shah, Muncer, Griffin, & Elliott, 2000; van Baalen et al., 2006). The Barthel Index measures independence in personal activities of daily living (ADL). Items are totaled to give a score range from 0 to 20 (Houlden, Edwards, McNeil, & Greenwood, 2006; van Baalen et al., 2003; van Baalen et al., 2006) or 0 to 100 in the modified version (Cohen & Marino, 2000; Shah et al., 2000).

Criterion validity is well established with other measures of ADL performance (Cohen & Marino, 2000), demonstrating predictive ability from start to end of TBI inpatient rehabilitation (Shah et al., 2000; Shah & Muncer, 2003). Both floor and ceiling effects have been previously noted to limit sensitivity (Shah & Muncer, 2003). Test-retest, inter-rater and intra-rater reliability of the Barthel Index has been consistently high (Cohen & Marino, 2000; van Baalen et al., 2006).

The Barthel Index demonstrates good association with measures of physical dysfunction but shares limited association with measures of cognitive ability (Hajek, Gagnon, & Ruderman, 1997; Shah & Muncer, 2003). This represents a significant limitation to use in the TBI population (McPherson & Pentland, 1997).

#### ***2.4.3.2 Functional Independence Measure (FIM)***

The FIM is the most widely used functional assessment in the rehabilitation community, developed as part of the Uniform Data Set for Medical Rehabilitation (Hamilton, Granger, Sherwin, Zielesny, & Tashman, 1987). The FIM measures level of required assistance across 13 personal ADL, communication and social cognition items, and was designed to be collected by trained clinicians (Cohen & Marino, 2000).

The psychometric properties of the FIM have been extensively reported (Cohen & Marino, 2000). A quantitative review of FIM reliability studies identified very high inter-rater and test-retest reliability. In general, reliability of FIM motor items is greater than FIM cognitive items (Ottenbacher, Hsu, Granger, & Fieldler, 1996).

Measurement validity related to adults with TBI has been addressed in numerous studies (Corrigan, Smith-Knapp, & Granger, 1997; Dodds, Martin, Stolov, & Deyo, 1993; Hall, Hamilton, Gordon, & Zasler, 1993; Houlden et al., 2006; Kidd et al., 1995; van Baalen et al., 2006). The floor and ceiling effects limiting the Barthel Index are less problematic for the FIM (Houlden et al., 2006) as a wider range of disability can be measured. The hierarchical structure of the 18-items is reported to be stable from admission to discharge, thereby providing a valid measure of change with sound predictive ability (Heinemann, Linacre, Wright, Hamilton, & Granger, 1994; Linacre, Heinemann, Wright, Granger, & Hamilton, 1994). As such, the FIM may be a useful assessment for measuring change over time (van Baalen et al., 2006), and in response to rehabilitation intervention (Houlden et al., 2006), however

the utility for guiding specific intervention, given the global nature of assessment, is limited.

#### ***2.4.3.3 Rivermead Activities of Daily Living (ADL) Assessment***

The Rivermead ADL Assessment is a performance-based assessment for adults with stroke and head injury (Whiting & Lincoln, 1980). Items are divided into two domains: self-care and household items. Items are scored on a 3-point scale indicating level of dependence-independence. Items in each scale are purported to be hierarchical; whereby administration involves consecutive item performance until three consecutive failures. The utility of a test-to-failure procedure in adults with agitated behaviour is questionable. Initial validity and reliability measures were reported from a limited set of therapists and clients, and have not been subsequently examined (Chong, 1995; Whiting & Lincoln, 1980).

#### ***2.4.3.4 Assessment of Motor and Process Skills (AMPS)***

The AMPS is a client-centered assessment designed to measure the quality of a person's ADL performance (Donnelly & Carswell, 2002; A. Fisher, 1993). Tasks to be performed are selected from a pre-defined list of personal and instrumental ADL by the therapist and client in collaboration (Linden, Boschian, Eker, Schalen, & Nordstrom, 2005). The prescribed test items emphasise instrumental ADL task performance (Gillen, 2009), however the addition of several personal ADL tasks has improved utility during acute TBI rehabilitation (Bray, A. Fisher, & Duran, 2001).

As the name suggests, the AMPS consists of two domains of occupational performance: ADL motor and ADL process skills. The ADL motor skills reflect the

degree of physical effort a client exerts during ADL task performance; while ADL process skills reflect the client's overall level of efficiency and safety as well as his or her ability to compensate for problems. Each motor and process item is rated on a 4-point scale for efficacy and efficiency. Raw scores are entered into the AMPS computer-scoring program for Rasch analysis (A. Fisher, 1993; W. Fisher & A. Fisher, 1993).

The psychometric properties of the AMPS have been well researched, emphasizing content and construct validity (A. Fisher, 1993; Robinson & A. Fisher, 1996), ecological validity (Darragh, Sample, & A. Fisher, 1998; Park, A. Fisher, & Velozo, 1994), and cultural sensitivity (Buchan, 2002). Rater reliability was found to be lower than desired in comparison to other functional instrumental ADL performance assessments (Josman & Birnboim, 2001), however this finding appears to conflict with test developer reports of moderate to high inter- and intra-rater reliability and stability (Bernspång, 1999; Fisher, 1995; Doble, 1991). Strong test-retest reliability was reported when testing aging adults, and adults with psychiatric illness (Doble, 1991; Doble, Fisk, Lewis, & Rockwood, 1999). It is suggested that rigorous training and scoring procedures requiring computer analysis increases the reliability of administration but limits accessibility to some clinicians (Donnelly & Carswell, 2002).

Research involving the AMPS has primarily focused on assessment of client groups with dementia, stroke, brain injury, or learning disabilities (A. Fisher & Bernspång, 2007). On closer examination of the literature, few studies have involved adults with



TBI either during the acute stage of rehabilitation (Linden et al., 2005; Wæhrens & A. Fisher, 2007), or the post-acute phase of rehabilitation (Darragh et al., 1998).

**Table 2.3 Summary of selected ADL performance assessments (adapted from Law et al., 2001)**

	M/BI	FIM	Rivermead ADL	AMPS
1. Clinical usefulness:				
Target population	✓	✓	?	✓
Administration	✓	✓	✓	?
Time	✓	✓	?	✓
Cost	✗	✓	✓	✗
Flexibility	✗	✓	✗	✓
Utility	✓	?	✗	?
2. Test standardisation	✗	✓	✗	✓
3. Approach:				
Norm-referenced	✗	✗	✗	✗
Criterion-referenced	✓	✓	✓	✓
Bottom-up	✗	✗	✗	✗
Top-down	✓	✓	✓	✓
4. Psychometrics				
Reliability	✓	✓	✗	✓
Validity	✓	✓	✗	✓
5. Ecological validity	✗	✗	✗	✓
6. Theoretical base	✗	✗	✗	✓
7. Cultural considerations	✗	✗	✓	✓
8. Occupation-based assessment	✓	✓	✓	✓
9. Client-centred assessment	✗	✗	✗	✓
10. Training required	✗	✓	✗	✓

Notes: ✓ test characteristic reported with clear evidence  
 ? test characteristic reported with equivocal evidence or further testing required  
 ✗ test characteristic not reported

#### 2.4.3.5 Summary

The ceiling effects of the Barthel Index and poor correlation with cognitive aspects of recovery are particularly problematic for this research, while the limited investigation of the Rivermead ADL Assessment prevents further consideration of this instrument as a valid assessment measure at this time.

The FIM is primarily used to index function at the start and finish of the inpatient rehabilitation process, and as such is primarily evaluative in purpose. For the FIM to be clinically useful in directing treatment planning, more regular assessment would be required.

Finally the AMPS appears more clinically useful than the FIM for frequent assessment, however the links between functional performance and underlying process skills are not explicit in order to clearly direct therapy. The AMPS developer clearly states that it was not designed to evaluate the presence of cognitive impairments, or underlying capacities, thereby limiting the utility for this research.

#### **2.4.4 Assessment of component capacities and occupational performance**

Earlier reviews of assessments targeting *either* cognitive performance components or functional performance did not yield an assessment suitable for use in this research.

As such, the final part of this review included measures purported to assess *both* the underlying component capacities and occupational performance simultaneously.

Assessment tools in this section were reviewed against the criteria of *both* previous sections:

- Developed/adapted for measuring cognition in adults with TBI
- Established utility for measuring functional performance in adults with TBI
- Suitable for administration during acute rehabilitation, with patients in PTA and demonstrating agitated behaviour
- Observational in nature
- Measures a range of cognitive/processing skills applicable to everyday function
- Repeated administration possible after a short interval
- Assessment findings provide clear direction for intervention planning

Three assessment tools were considered to meet these criteria:

- The ADL-focused Occupation-based Neurobehavioural Evaluation
- The Executive Function Performance Test
- The Perceive, Recall, Plan, and Perform System of Task Analysis

#### ***2.4.4.1 The ADL-focused Occupation-based Neurobehavioral Evaluation (A-ONE)***

The A-ONE (Árnadóttir & A. Fisher, 2008), previously called the Árnadóttir OT-ADL Neurobehavioral Evaluation (Árnadóttir, 1990) was the first standardised, occupational therapy specific assessment tool designed to identify the link between neurobehavioural deficits in adults and occupational performance (Gardarsdóttir & Kaplan, 2002). The A-ONE identifies the level of ADL assistance required and the nature of underlying neurobehavioural problems interfering with ADL performance (Árnadóttir, 1999; Árnadóttir & A. Fisher, 2008). The ADL scale of the A-ONE assesses five functional domains, during which therapists identify impairments such as apraxia, unilateral body neglect, somatoagnosia, perseveration, and sequencing/organisation (Árnadóttir, 1990). While the manual suggests the targeted population includes a diverse range of people with central nervous system dysfunction including TBI, the most prominent area of use continues to be cerebral-vascular accident (CVA). The focal nature of the identified deficits appears to align itself more closely with CVA than TBI.

The A-ONE uses a criterion-referenced 5-point rating scale that has recently been recalibrated to a 4-point scale (Árnadóttir & A. Fisher, 2008). Inter-rater and test-retest reliability of the scales have been established at acceptable levels (Árnadóttir, 1990), however these studies recruited small samples, representing a specific diagnosis (20 CVA subjects in each study), thereby limiting generalisation of findings. Construct and discriminant validity of the assessment were established during development phases (Árnadóttir, 1990). Rasch analysis of unidimensionality suggests some items do not fit with a unidimensional model, and a ceiling effect was noted with nine patients achieving maximum scores (Árnadóttir & A. Fisher, 2008).

The developers state the intended purpose of the A-ONE is to assist intervention planning, not to evaluate change in ADL performance over time or evaluate the effectiveness of intervention (Árnadóttir & A. Fisher, 2008), thus limiting the clinical utility of the tool as an outcome measure.

In summary, the published studies examining reliability and validity of the A-ONE appear limited to adults with CVA, thereby raising questions about the validity of the tool when evaluating adults with TBI. The A-ONE employs occupation-based assessment, starting with task performance and proceeding to identification of cognitive deficits that inhibit performance. Although this approach is congruent with occupational therapy philosophy and fits within the clinical framework of the OPM(A), it uses neuropsychological terminology to define underlying cognitive deficits, such as apraxia, somatoagnosia, spatial neglect and topographical disorientation.

#### ***2.4.4.2 The Executive Function Performance Test (EFPT)***

The EFPT is a recently developed ecological measure designed to provide occupational therapists with a performance-based, standardised assessment of cognitive function (Baum, Morrison, Hahn, & Edwards, 2007). It is based upon an earlier functional assessment, the Kitchen Task Assessment (KTA; Baum & Edwards, 1993). The EFPT is described as a ‘top-down’ assessment to examine cognitive integration and functioning in an environmental context. The EFPT specifically examines executive function, defined as “a group of cognitive processes which mediate goal-directed activity” (Baum et al., 2007, p.2).

The EFPT examines the execution of four basic tasks considered essential for self-maintenance and independent living: simple cooking, telephone use, medication management, and bill payment. The patient's task initiation, task execution (requiring organisation, sequencing, judgment and safety), and task completion (Baum et al., 2007) are assessed. The level of cueing necessary to support task performance is indicated by one of five cueing levels, with higher scores reflecting the need for more cueing, suggesting greater executive deficits (Katz, Tadmor, Felzen, & Hartman-Maeir, 2007).

Recent validation studies have included patients with non-TBI diagnoses. Katz et al. (2007) reported high internal consistency, and evidence of concurrent validity with the Behavioral Assessment of the Dysexecutive Syndrome (Wilson, Alderman, Burgess, Emslie, & Evans, 1996) in adults with acute and chronic schizophrenia. Discriminant validity was reported for differentiating adults with multiple sclerosis from healthy controls (Goverover et al., 2005); however concurrent validity with self-report measures of ADL performance was poor. Goverover et al. (2005) suggested there was little to no relation between the objective performance-based scores from the EFPT and the subjective self-report assessment tools used in their study. Further psychometric testing of this instrument is clearly required. Gillen (2009) reports on work by the tool developers that is currently in press, highlighting correlations with standardised measures of working memory, verbal fluency and attention, along with high inter-rater reliability estimates.

In summary, the clinical utility, validity and reliability of this assessment tool for evaluating adults in acute stages of TBI recovery is yet to be determined. The EFPT

manual firmly states that “all test items must be administered regardless of the participant’s preferences or experiences towards/with task items” (Baum et al., 2007, p.3), raising concerns about the client centeredness, and flexibility of the instrument.

#### ***2.4.4.3 The Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis***

The PRPP System of Task Analysis (Chapparo & Ranka, 1997b) measures the hypothesised link between the cognitive component of performance of the OPM(A) and the occupational tasks, activities and roles than people perform. The PRPP is not a test of cognition *per se* but an assessment of cognitive strategy application during occupational performance, relative to the criterion demands of the particular task and the person performing the task in situ.

A two-stage analysis approach is adopted: Stage 1 involving *behavioural* task analysis to identify errors in performance, followed by Stage 2 in which a *cognitive* task analysis is conducted to evaluate the effectiveness of 34 different information processing strategies required during task performance. These strategies represent four primary areas of processing: Perceive, Recall, Plan and Perform. Strategies are rated on a 3-point scale indicting the level to which performance of that particular strategy assisted or inhibited task performance.

Tasks performed are individually selected, not prescribed nor limited to a pre-defined list, as per the assessments reviewed in this and earlier sections (for example, the A-ONE, AMPS and EFPT). The task unit can be large, as in an entire occupational role, or small, representing a task or sub-task within a task. This flexibility enhances clinical utility during acute TBI rehabilitation, as appropriate task units can be

selected for patients with limited ability to attend and participate (Fry & O'Brien, 2002).

Preliminary reliability and validity studies conducted during the development of the PRPP System of Task Analysis have been supplemented by subsequent studies evaluating clinical utility across a number of diagnostic groups. Face and content validity were first established in adults with TBI during inpatient rehabilitation (Chapparo & Ranka, 1997b), with subsequent studies demonstrating concurrent validity with neuropsychological measures and community functioning in schizophrenia (Aubin, Chapparo, G elinas, Stip, & Rainville, 2008; Aubin, G elinas, Stip, Chapparo, & Rainville, in press; Still, Beltran, Catts, Chapparo, & Langdon, 2002). Internal consistency within each quadrant is reported to be high (Fordham, 2001). Acceptable to high levels of inter-rater, intra-rater, and test-retest agreement have been established in a number of published and un-published studies (Aubin et al., 2008; Chapparo & Ranka, 1997b; Lohri, 2005; Munkhetvit, 2005; Pulis, 2002). Test and rater reliability have not been specifically examined in the acute TBI population. Further psychometric testing in this area is clearly required.

#### ***2.4.4.4 Summary***

The three measures evaluated in this section attempt to span assessment across two levels of the OPM(A). The EFPT and PRPP appear to measure a broad range of processing skills/cognitive strategies that impact on performance in acute TBI rehabilitation; however the rigid administration procedures of the EFPT limit implementation with the specific population under investigation. In this area the PRPP demonstrates greatest flexibility and utility. The A-ONE presents as the most



psychometrically sound of these three measures at this time, however an increasing body of research supports the reliability and validity of the PRPP. Following review of these three measures, the PRPP System of Task Analysis was selected for further examination as part of this research study.

**Table 2.4 Summary of combined ADL performance and cognitive measures (adapted from Law et al., 2001)**

	A-ONE	EFPT	PRPP
1. Clinical usefulness:			
Target population	?	✓	✓
Administration	✓	✓	✓
Time	✓	✓	✓
Cost	✓	✓	✓
Flexibility	✓	✗	✓
Utility	?	?	✓
2. Test standardisation	✓	✓	✓
3. Approach:			
Norm-referenced	✗	✗	✗
Criterion-referenced	✓	✓	✓
Bottom-up	✗	✗	✗
Top-down	✓	✓	✓
4. Psychometrics			
Reliability	✓	✗	?
Validity	✓	?	✓
5. Ecological validity	?	?	✓
6. Theoretical base	✓	✓	✓
7. Cultural considerations	✗	✗	✓
8. Occupation-based assessment	✓	✓	✓
9. Client-centred assessment	✓	?	✓
10. Training required	✓	✗	✓

Notes: ✓ test characteristic reported with clear evidence  
 ? test characteristic reported with equivocal evidence or further testing required  
 ✗ test characteristic not reported

### 2.4.5 The PRPP System of Task Analysis: in-depth review

This section elaborates on the summary provided in Section 2.4.4.3 to evaluate the appropriateness of using the PRPP System of Task Analysis in subsequent phases of this research.

The PRPP System is an emerging measurement system that enables assessment of performance over time and in context, affording therapists a mechanism to measure the relationship between underlying cognitive capacities and occupational performance as outline in the OPM(A). The PRPP Assessment it is not a test of cognition *per se* but a measure of how a person applies cognitive strategies during occupational performance, in the specific context defined by the criterion requirements of the task, in the ‘here and now’. As can be seen in Figure 2.5, the PRPP Assessment not only considers the relationship between internal factors, but also external environmental factors and the concepts of time and space.

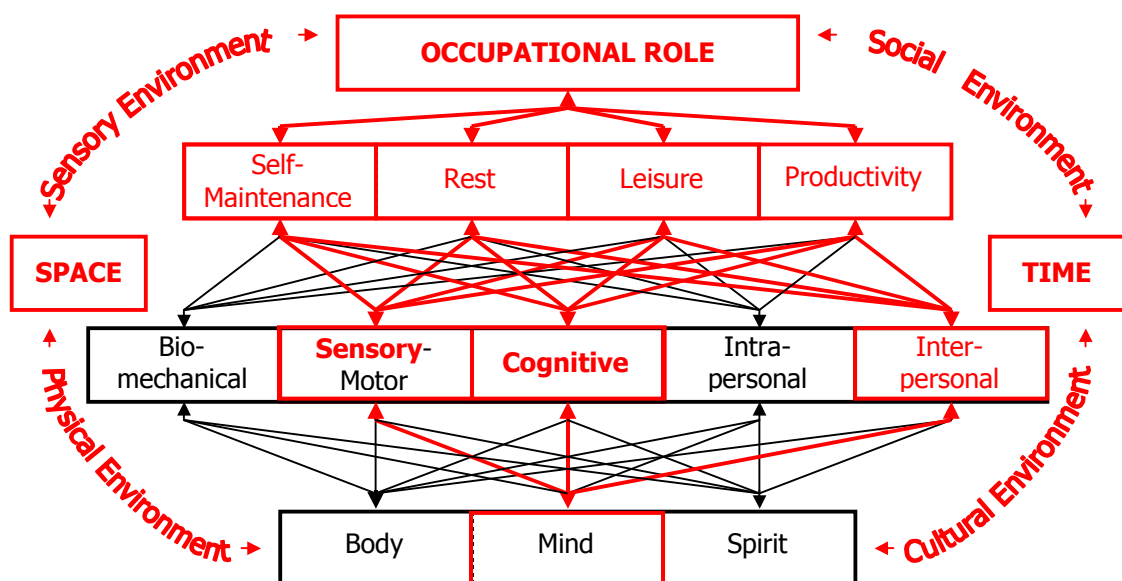


Figure 2.5: PRPP Assessment of the relationship between component capacities, occupational performance areas, and occupational roles



Stage 2 of the PRPP System focuses on application of information processing strategies during performance by adopting a *cognitive* task analysis. Cognitive task analysis is a family of assessment methods that describe cognitive processes underlying task performance and the cognitive strategies used to respond adeptly to complex situations (Militello & Hutton, 1998; Schraagen, Chipman, & Shalin, 2000). In total, 34 strategies, termed *descriptors* are rated on a three-point scale indicating the patient's application of each processing strategy as (3) effective for task performance, (2) questionable, or (1) not effective (refer to Stage 2 score sheet on the right hand side of Figure 2.6). These strategies are derived from four areas of information processing: sensory perception (Perceive), memory (Recall), response planning and evaluation (Plan), and performance monitoring (Perform). These are depicted as the central quadrants of the PRPP System in Figure 2.7.

The conceptual model underlying the PRPP System of Task Analysis is adapted from an information processing model in the field of instructional design which was used to explain the process of learning tasks in the work place (Romiszowski, 1984). As depicted in Figure 2.7, the PRPP System of Task Analysis is centred on four processing quadrants that form the inner layer with multi-directional arrows illustrating the multi-staged flow of information in theoretical models of information processing.

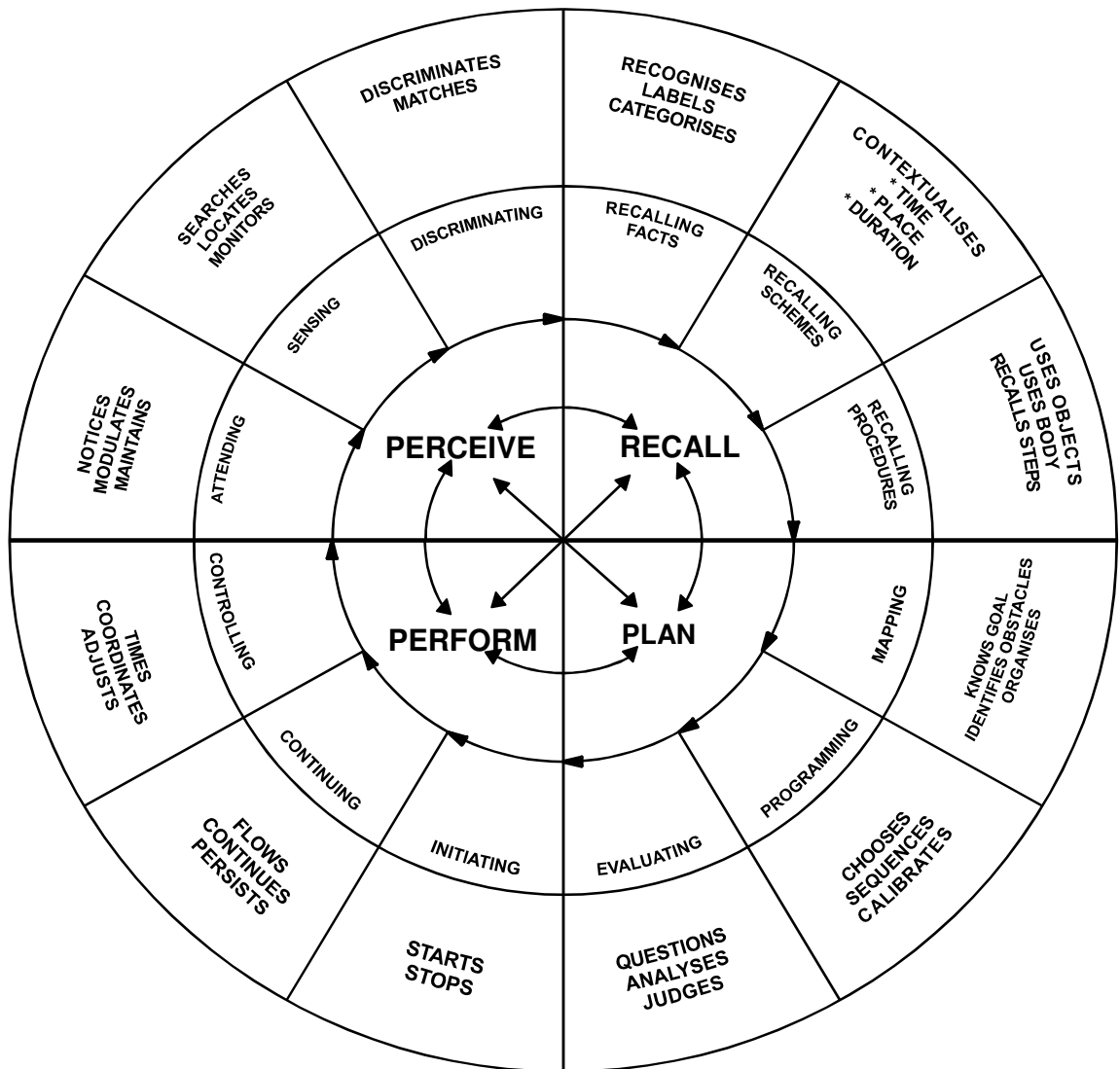


Figure 2.7: The PRPP System of Task Analysis (Chapparo & Ranka, 2005)

The Perceive Quadrant assesses strategies for gathering sensory information from the environment in order to form sensory images of one's body and the task environment. Processing of information in this quadrant determines what is attended to, what form an object or body part takes and what is or is not central to task completion. The second quadrant, Recall, involves a number of strategies that allow constant comparison between sensory input and previously stored information, in order to make sense of what is being perceived, or to determine its importance.

Recognition, retrieval and storage are the primary information processing procedures enacted at this stage. Sensory and stored information is used to map out and program salient responses in the Plan Quadrant. Planning involves executive skills such as critical thinking, ideating, reasoning, and decision making to construct and evaluate goal-oriented strategies for novel or complex situations. The final quadrant, Perform, involves strategies that prompt the initiation and inhibition of plans and monitoring of responses during performance (Chapparo & Ranka, 2005).

Each quadrant is broken down into three sub-quadrants (middle layer Figure 2.7) and several underlying information processing strategies termed ‘descriptors’ (forming the outer layer Figure 2.7). The assessment requires therapists to observe occupational performance, for example a patient brushing his or her teeth or hair in the bathroom, and to systematically rate the extent to which the patient applies each information processing strategy to that task.

#### ***2.4.5.1 Criterion referenced measurement***

The PRPP is described as a criterion referenced measure. Criterion referenced measures assess what patients “can do and what they know, not how they compare to others” (Anastasi, 1988, p. 102). In Stage 1 of the PRPP assessment, the required level of mastery is specified as the criterion, while in Stage 2, the effectiveness of processing strategies (descriptors) that form the outer ring of the model are specified as the criteria. The criterion performance level is typically determined by the task itself, for example the descriptor, *Knows Goal* requires the patient to demonstrate, through actions or words, their understanding of the task intent, and to maintain this foremost in their mind, eliminating other distractions until the completion of the task.

Criterion performance levels have been established for all 34 strategies to enable therapists to determine if the strategy applied by the patient meets the required task demands. In this way, the PRPP uses uniform procedures for administration as outlined in the training manual and adopts a standardised scoring rubric that is representative of patient performance (Chapparo & Ranka, 1997b; 2005).

The PRPP System of Task Analysis is an emerging assessment tool, with a developing evidence base. Comprehensive reliability and validity data is not currently available; however several reliability and validity studies conducted during the development of the PRPP System of Task Analysis provide an initial knowledge base, to which subsequent research findings are now being added.

#### ***2.4.5.2 Instrument validity***

Face and content validity studies utilised an expert panel approach to micro-analyse performance errors in several studies. First, over 4000 performance errors, observed during occupational performance of 45 adults with brain impairment were categorised into the four quadrant areas of Perceive, Recall, Plan and Perform (Figure 2.7 inner layer). Next, occupational performance of 25 adults with brain impairment was videotaped and coded for errors. All errors could be classified using the sub-quadrants outlined in the PRPP System of Task Analysis (Figure 2.7 middle layer). Finally, 60 occupational therapists from a range of practice areas confirmed the degree to which descriptors (Figure 2.7 outer layer) were able to identify performance errors across a range of everyday self-care and productivity tasks, performed by adults and children (Chapparo & Ranka, 1997b).

Subsequent concurrent validity studies have demonstrated agreement between PRPP quadrant and sub-quadrant scores with neuropsychological measures of planning, memory and insight in adolescents with schizophrenia (Still et al., 2002), between PRPP Total scores and community functioning (Aubin et al., 2008, Aubin et al., in press), and between PRPP quadrant and sub-quadrant scores and measures of cognitive play in typical and learning-disabled children (Boland, 2004). Validation studies published since initial instrument development have not included adults with brain injury or the specific group of adults with agitated behaviour following TBI. Further research is necessary to evaluate instrument validity for measuring information processing in adults with TBI during the initial stages of recovery when occupational performance is affected by PTA and agitated behaviour.

#### ***2.4.5.3 Clinical utility***

The breadth of information processing areas assessed by the PRPP System increases the flexibility and clinical utility (Aubin et al., 2008). This contrasts with assessments measuring cognitive and/or perceptual skills in isolation from daily occupation, such as the Rivermead Perceptual Assessment Battery (Whiting, Lincoln, Bhavnani, & Cockburn, 1985) and the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 2003), or occupational based assessments that focus on one particular area of cognition, for example the MAS (Whyte et al., 2003) or the EFPT (Baum et al., 2007). It contrasts with other ecological assessments such as the AMPS (A. Fisher, 1995), which is designed to measure activity participation and restriction without specifically evaluating underlying impairments or capacities within the cognitive domain (Boman, Lindstedt, Hemmingsson, & Bartfai, 2004).



#### ***2.4.5.4 Instrument reliability***

Evaluation of inter-rater reliability during development of the PRPP System of Task Analysis reported rater agreement above 90% for identification of Stage 1 errors during task performance of 20 adults with brain injury, and 85% agreement for categorisation of errors into sub-quadrants using Stage 2 analysis on 10 adults with brain injury (Chapparo & Ranka, 1997b). Subsequent studies have focused on the inter-rater reliability of therapists using Stage 2 of the PRPP System, with various clinical populations including children with learning disorders, adults with acquired brain injury, and adults with schizophrenia. Reliability estimates from published studies report acceptable levels of inter-rater reliability (Aubin et al., 2008), with several unpublished studies reporting acceptable to high levels of inter-rater, intra-rater, and test-retest agreement (Lohri, 2005; Munkhetvit, 2005; Pulis, 2002).

The limited published information available on measurement properties of the PRPP System reflects the emerging nature of the measurement system. Test and rater reliability have not been specifically examined in the acute TBI population. In particular, the reliability of raters using Stage 2 descriptor scores to evaluate performance of adults with agitated behaviour following TBI has not been investigated. Further psychometric testing in this area is clearly required.

In summary, the PRPP System of Task Analysis presents a unique assessment approach, concordant with the stated research aims. The instrument utilises observation of everyday task performance rather than a standard battery of items, suggesting greater clinical utility in acute TBI rehabilitation, particularly with agitated patients. The direct relationship between cognitive strategy application and

occupational performance facilitates the exploration of these two research variables, and the direct link between assessment outcomes and intervention planning enables further evaluation of the role that occupational therapy intervention may play in managing adults with agitated behaviour following severe TBI. However, measurement properties of the PRPP System have not been evaluated with adults demonstrating agitated behaviour following TBI, highlighting the critical need for further research in this area, prior to widespread use in acute TBI rehabilitation.

## **2.5 INTERVENTION APPROACHES**

In the third section of this chapter, multi-disciplinary approaches to managing adults with agitated behaviour following TBI will be reviewed, followed by a more detailed analysis of cognitive rehabilitation approaches adopted by occupational therapists. Finally, an alternative occupational therapy intervention approach will be presented that targets occupational performance within the conceptual framework of the OPM(A).

### **2.5.1 Management of agitated behaviour during TBI rehabilitation**

Recent reviews of agitation management in adults with TBI, and general reviews of TBI rehabilitation containing sections on agitated behaviour, have consistently reported the lack of high quality evidence upon which to plan and implement effective intervention with this client group (Das-Gupta & Turner-Stokes, 2002, Fleminger, Greenwood, & Oliver, 2003; Gordon et al., 2006, Kim, 2002; Levy et al., 2005; Lombard & Zafonte, 2005).

Clinical surveys classify non-pharmacological agitation management techniques into three broad categories: structured daily activities/routines, environmental interventions, and behaviour modification (Gaber, 2006; Herbel, Schermerhorn, & Howard, 1990). These three management techniques are based within a behavioural paradigm that conceptualises behaviour as a response to external stimuli; where behaviour can be modified by adapting the initial stimuli (antecedent management) or through reinforcement (contingency management).

Once again, the OPM(A) was used as a frame of reference to conceptualise different approaches to management of agitation. Implementation of structured daily routines and environmental interventions can be considered to impact on occupational performance via external factors of the OPM(A), represented by the social, sensory, and physical environment, time, and space (Figure 2.8). In contrast, behaviour modification techniques are directed at the internal components of the OPM(A), focussing on modifying sensory, cognitive, inter- and intra-personal capacities.

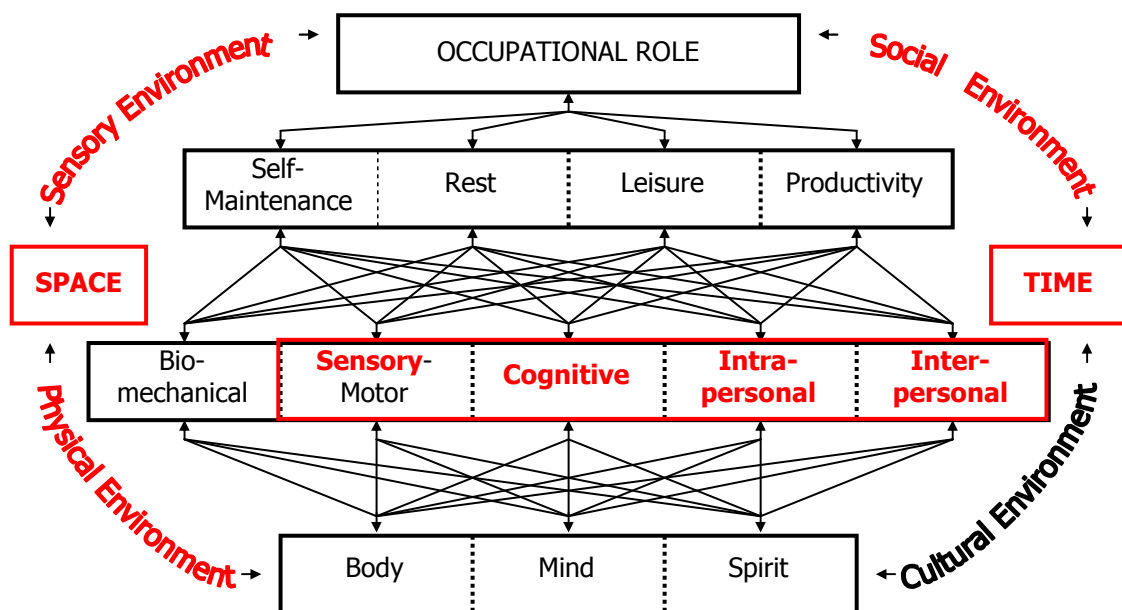


Figure 2.8: Management of agitated behaviour as represented by the OPM(A)

### ***2.5.1.1 Management of time, space and the external environment***

Several authors recommend structuring or modifying the surrounding physical environment to minimise sensory stimulation and remove potential precipitants (Ducharme, 1999; Lombard & Zafonte, 2005; Radomski, 2008). Controlling the sensory environment by reducing over-stimulating noise, light, visitors, and staff, is reported to reduce triggers that may lead to agitated behaviour (Bermann & Bush, 1988; Giles & Clark-Wilson, 1999; Pryor, 2004; Wilson & Dailey, 1999). Reducing the level of environmental stimulation is reported to minimise distractions during occupational performance (Hartnedy & Mozzoni, 2000; Radomski, 2008). While this approach receives a high level of anecdotal support within the literature, limited experimental studies support the effectiveness of this intervention for the management of agitated behaviour (Hartnedy & Mozzoni, 2000).

In combination with structuring the environment, many specialist rehabilitation services advocate the development of structured daily routines to manage agitated behaviour (Gurka, 2005; Herbel et al., 1990; Mysiw et al, 1988). The restoration of day and night activity patterns, with highly structured activity and rest periods, are reported to facilitate orientation and maintain a predictable routine (Giles & Clark-Wilson, 1999; Lombard & Zafonte, 2005, Radomski, 2008; Riedel & Shaw, 1997). Within this structured approach, functional retraining of automatic and over-learned tasks may occur (Bermann, 1988; Gurka, 2005), where the activity itself and the instructions given are concomitant with a predictable and consistent daily routine (Yuen & Benzing, 1996). Although descriptive reports anecdotally support the implementation of structured routines for management of agitated behaviour, there is no evidence from intervention studies upon which to base this support.

### ***2.5.1.2 Behavioural management of agitated behaviour***

In contrast to the *external* intervention approaches described previously, a third approach is commonly implemented to manage agitation (and other challenging behaviours) by modifying the *internal* behavioural response to specific stimuli using contingency based adaptation. Intervention approaches within this broad area of behavioural modification have recently been characterised into two different approaches labelled ‘traditional contingency management’ and ‘positive behaviour interventions and supports’ (Ylvisaker et al., 2007).

Ylvisaker et al.’s (2007) systematic review appraised the current available evidence from clinical studies, including individual case studies. Both traditional contingency management procedures and positive behaviour support procedures were found to be effective, and could be regarded to as evidence-based treatment options, however a variety of methodological concerns prevent stronger application to acute TBI agitation. Only 9 of the 65 studies included individuals less than 16 weeks post-TBI, therefore evidence relevant to acute TBI rehabilitation is still lacking. Of the 22 subjects included in these 9 studies, only 3 subjects were adults (18+ years) (Alderman et al., 1999; Andrews, 1989; Hegel, 1988).

A structured routine and environment was combined with contingency-based reinforcement in Alderman et al.’s (1999) case study, to reduce the frequency and severity of aggressive behaviour in a 34 year old male who remained in PTA. Similarly, a contingency-based reinforcement programme was implemented by Hegel (1988) with an 18 year old male to reduce disruptive behaviour and improved learning outcomes in therapy. In Andrews’ (1989) case study, extinction and

differential reinforcement conditions resulted in reduced disruptive behaviour in a 32 year old female with a hypoxic injury described as amnesic with generalised intellectual impairment, having limited speech and communication abilities and near continuous screaming. The target behaviour (screaming) was eliminated following the reinforcement programme however family members reported difficulty following the programme. Ylvisaker et al. (2007) rated these three studies as Level IV, III and IV evidence respectively, highlighting the limited evidence available upon which to make clinical decisions regarding behavioural interventions during early stages of brain injury rehabilitation.

These behaviour modification techniques could be considered representative of intervention at the component level of occupational performance within the OPM(A) framework. Typically behaviour modification approaches focus on interpersonal and intrapersonal components of performance, with some approaches utilising cognitive capacities to promote learning in contingency-response situations. The goals of behaviour modification are usually defined by the target behaviour, for example, measuring compliance in therapy by the frequency of disruptive vocalisations (Hegel, 1988). Even though agitated behaviour is frequently reported to interfere with activities of daily living and to limit the achievement of functional goals, very few behaviour modification programmes are directed at improving performance of everyday tasks.

## **2.5.2 Occupational therapy intervention**

In contrast to behavioural modification approaches that intervene at the component level of performance, occupational therapy intervention is primarily concerned with task, activity and role level occupational performance. Occupational therapy in acute TBI rehabilitation targets activity and task retraining, adaptation of the environment and modification of task demands, techniques described as “especially useful for agitated and non-compliant clients” (Yuen & Benzing, 1996, p.231).

Historically, at least two different approaches have been used to guide occupational therapy intervention with adults following brain injury: interventions with a task/behavioural focus, or a cognitive/skill retraining focus. These intervention approaches have alternatively been termed *functional* and *remedial* intervention (Haslam & Beaulieu, 2007), the *macro* and *micro* levels of intervention (Wood, 1995), and *top-down* or *bottom-up* approaches (Trombly, 1993). In contrast, contemporary intervention approaches focused on cognitive strategy training represent an emerging field of occupational therapy practice in TBI rehabilitation (Greber, Ziviani, & Rodger, 2007a, 2007b; Kennedy et al., 2008; Kennedy & Coelho, 2005; Sohlberg, Ehlhardt, & Kennedy, 2005).

### **2.5.2.1 Functional task/ behavioural approaches**

Within the context of adult brain injury rehabilitation, the top-down, task/behavioural approaches are characterised by task oriented, adaptive and compensatory techniques, with the primary focus on functional task performance (Kielhofner, 2004; Lee, Powell, & Esdaile, 2001). Intervention focuses training on activities of daily living themselves, rather than the perceptual and cognitive skills that underpin

functional behaviour. Treatment techniques such as task and environmental modification are used to minimise cognitive load on the patient during task performance. Compensatory techniques may also involve systematic training to develop routines and procedural strategies for occupational performance (Sohlberg & Mateer, 1989). Systematic instructional techniques involving task analysis, cueing, prompting and chaining, support and guide task performance (Giles & Clark-Wilson, 1999; Snell & Zirpoli, 1987). Several single-subject or small-group studies have demonstrated the effectiveness of functional skills training in adults with brain injury (Donnelly & Carswell, 2002; Giles, 1998; Giles, Ridley, & Frye, 1997). This systematic instructional approach has also been described as direct, therapist initiated intervention, congruent with an acquisitional frame of reference based on learning theory (Greber et al., 2007a).

#### ***2.5.2.2 Remedial skill training approaches***

The second approach, described as a bottom-up, remedial or micro approach, specifically focuses on retraining areas of cognitive deficits resulting from the brain injury, such as attention and memory, drawing from neuropsychological and cognitive theory bases (Auerbach & Katz, 1998; Sohlberg & Mateer, 2001). Specific cognitive skills are usually removed from the task in which they are required and targeted in therapy, using practice exercises, drills and repetition (Abreu & Toglia, 1987; Haslam & Beaulieu, 2007; Sohlberg & Mateer, 2001). This deficit-specific approach targets individual cognitive skills in isolation, and does not attempt to direct therapy towards the interrelationship *between* specific cognitive skills, nor does it consider how these skills should be applied to salient task performance (Toglia, 1998). The primary limitation of this approach is considered to be lack of



skill generalisation. While specific skill training is likely to rapidly improve acquisition of the targeted skill, it is not possible to individually teach each of the many cognitive skills required for the complexity of occupational performance. Therefore techniques that emphasise generalisation are considered more effective strategies for improving overall function (Dirette & Hinojosa, 1999).

### ***2.5.2.3 Strategy training and application***

Contemporary approaches to cognitive rehabilitation integrate aspects of both the remedial and functional traditions, with an information processing approach based around application of cognitive strategies in the context of occupational performance (Abreu & Peloquin, 2005; Kennedy et al., 2008; Kielhofner, 2004; Polatajko, Mandich, Missiuna et al., 2001; Togli, 2005).

Occupational therapy practice models that have developed over the past decade emphasise an information processing approach to explain behaviours observed after brain injury and to identify the processing stages at which cognitive dysfunction disrupts occupational performance. These models include the Quadrasonic Approach (Abreu, 1998; Abreu & Peloquin, 2005), the Dynamic Interactional Model (Togli, 1998, 2005), and the Cognitive-Perceptual Model (Kielhofner, 2004) that suggests occupational performance is based on an individual's "ability to perceive and evaluate sensory information, and the ability to conceive of, plan, and execute purposeful action" (Kielhofner, 2004, p.129). In contrast to traditional methods of systematic or direct instruction, these contemporary approaches target acquisition and implementation of *strategies* to efficiently process information (Abreu & Togli, 1987).

During occupational performance, people use cognitive strategies to enhance their ability to perceive the nature of a task in the context of the environment, to recognise similarities between the present task and previous experiences, to identify relevant task cues, enhance goal formation, and make decisions about performance (Singer & Cauraugh, 1985). TBI may affect how effectively people apply these strategies to occupational performance (Gagné, Wagner, Golas, & Keller, 2005), requiring specific intervention to relearn how to apply strategies during occupational performance.

Strategy based information processing approaches have demonstrated positive treatment effects with adults following brain injury (Freeman, Mittenberg, Dicowden, & Bat-Ami, 1992; Kennedy et al., 2008; Landa-Gonzalez, 2001; Levine et al., 2000; Neistadt, 1994; Rath, Simon, Langenbahn, Sherr, & Diller, 2003; von Cramon & Matthes-von Cramon, 1992). Kennedy et al.'s most recent systematic review and meta-analysis (2008) calculated a very large treatment effect associated with strategy instruction that was significantly larger than the effect size associated with conventional approaches. The findings of this systematic review led to a Level A recommendation that metacognitive strategy instruction is the intervention of choice with young to middle-aged adults following TBI, when improvement in everyday function is the goal of intervention. In comparison to the limited evidence presented in support of behavioural modification intervention in Ylvisaker et al.'s systematic review (2007), this rehabilitation approach appears to be supported by stronger, higher quality evidence.

#### ***2.5.2.4 The Perceive, Recall, Plan and Perform (PRPP) System of Intervention***

Most recently, Chapparo and Ranka (2007) proposed an intervention approach that integrates aspects of systematic instruction, learning theory, information processing theory and the strategy training and application techniques described above. The PRPP System of Intervention complements the PRPP System of Task Analysis described earlier in Section 2.4.5 (Chapparo & Ranka, 1997b). These two components form a dynamic assessment and intervention approach to occupational therapy that simultaneously focuses on task training, strategy training and strategy application within the context of everyday occupational performance. The PRPP System of Intervention purports to broaden the traditional focus of programmed learning and behavioural task analysis by incorporating information processing strategies that are not solely concerned with the manipulation of learning conditions and their behavioural consequences, but also with the cognitive processes being employed while learning (Chapparo & Ranka, 2007). The core PRPP Intervention strategies are described in Table 2.5 (Chapparo & Ranka, 2007), with evidence to support use of each intervention strategy as part of an integrated system of occupational therapy intervention.

As part of the PRPP System of Intervention, patients learn to apply a sequence of processing strategies to '*Stop, Sense, Think, Do*'. '*Stop*' strategies target the patient's level of arousal and attention, modulating this to the required level for task performance and focusing attention directly on the task. Next one or two strategies from each processing quadrant for '*Sense*' (Perceive Quadrant), '*Think*' (Recall and Plan Quadrants), and '*Do*' (Perform Quadrant) are selected to prompt a sequence of information processing.

**Table 2.5: PRPP Core Intervention Strategies (Chapparo & Ranka, 2007)**

Strategy	Definition	Evidence
Intervention goal is task mastery	<ul style="list-style-type: none"> <li>▪ Expected outcome is improved functional performance in everyday tasks required by the person's occupational roles and context.</li> <li>▪ Intervention success is measured by increased functional performance.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Abreu (1998)</li> <li>▪ Chapparo &amp; Ranka (1997a)</li> </ul>
Application of evidence based principles of systematic instruction	<ul style="list-style-type: none"> <li>▪ Goal of intervention is clear to client.</li> <li>▪ Least to most prompt hierarchy is used.</li> <li>▪ Multiple opportunities for practice of the task of the task and target cognitive strategy are offered and performance errors are prevented.</li> <li>▪ Learning occurs across natural contexts to promote generalisation.</li> <li>▪ Feedback is specific to task mastery and the cognitive strategy that is the target of intervention</li> </ul>	<ul style="list-style-type: none"> <li>▪ Abreu (1998)</li> <li>▪ Snell &amp; Zirpoli (1987)</li> <li>▪ Eakman &amp; Nelson (2001)</li> <li>▪ Giles (1998)</li> <li>▪ Mateer &amp; Sohlberg (2003)</li> </ul>
Cognitive strategies are behaviourally defined and measurable	<ul style="list-style-type: none"> <li>▪ Strategies required for task performance are identified using the PRPP System of Task Analysis (outer ring Figure 2.7) and their effectiveness measured before and throughout intervention.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Chapparo &amp; Ranka (1997b)</li> </ul>
'Chunking' of strategies across all PRPP quadrants is planned	<ul style="list-style-type: none"> <li>▪ Starting with '<i>Stops</i>', one or two strategies are targeted from each processing quadrant for '<i>Sense</i>' (Perceive Quadrant), '<i>Think</i>' (Recall and Plan Quadrants), and '<i>Do</i>' (Perform Quadrant).</li> <li>▪ Single descriptors are not used.</li> <li>▪ A line of processing required for the task mirrors the direction of arrows in the centre of the PRPP System of Task Analysis.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Beck &amp; Horne (1992)</li> <li>▪ Murphy &amp; Cooke (1999)</li> <li>▪ Polatajko et al. (2001)</li> <li>▪ Taylor, Fayed &amp; Mandich (2007)</li> <li>▪ Feeney &amp; Ylvisaker (2003; 2006)</li> </ul>
Focus of intervention is on application of cognitive strategies (descriptors) to real world performance	<ul style="list-style-type: none"> <li>▪ The descriptor behaviours form the verbal, physical or visual prompts given during performance</li> <li>▪ The therapist acts as a cognitive mediator</li> <li>▪ The patient is taught to self-instruct in the strategies.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Giles &amp; Clark-Wilson (1988, 1999)</li> <li>▪ Yuen &amp; Benzing (1996)</li> <li>▪ Missiuna et al. (1998)</li> <li>▪ Selznick &amp; Savage (2000)</li> <li>▪ Kennedy et al. (2008)</li> </ul>

The sequential facilitation of multiple cognitive processes, rather than targeting specific, individual cognitive deficits, is thought to be one of the integral components to the success of this, and similar approaches (Singer & Cauraugh, 1985; Swanson & Sachse-Lee, 2000).

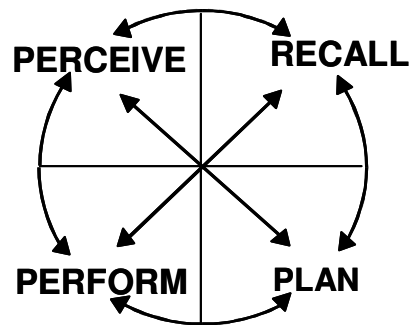
The prompts of *Stop, Sense, Think, Do* (given via verbal, visual, gestural and/or physical modes) are used initially as content free ‘meta-prompts’ to alert patients to process information required for task performance (Chapparo & Ranka, 2007; Fish et al., 2007). These global prompts are followed up with more specific content based behavioural prompts selected by the therapist, based on findings from the PRPP System of Task Analysis. For example:

**Table 2.6 “*Stop, Sense, Think, Do*” verbal prompting example**

<b>Strategy</b>	<b>Prompt (verbal)</b>	<b>Quadrant</b>	<b>Descriptor</b>
<i>Stop</i>	“Stop David”	PERFORM	<i>Stops</i>
<i>Sense</i>	“Look at your shirt” “Feel where the sleeve ends”	PERCEIVE	<i>Modulates Searches</i>
<i>Think</i>	“Figure out how to move your arm to there” “Ask yourself: Does that look right?” “Remember from earlier....that’s it!”	PLAN RECALL	<i>Uses body Recalls steps Analyses</i>
<i>Do</i>	“Now start putting it on”	PERFORM	<i>Starts</i>

The cognitive strategies applied within the PRPP System of Intervention stem directly from the cognitive theoretical approach termed information processing. The theory of information processing underpins the selection of strategies that apply to occupational performance, and the sequential ‘chunking’ of strategies in the specific order: *Stop, Sense, Think, Do*. The directional arrows in the centre of the PRPP

System of Task Analysis illustrate this processing sequence (Figure 2.9). Prompts to *Stop, Sense, Think, Do* trace the flow of information processing around the four quadrants *Perceive, Recall, Plan Perform*.



**Figure 2.9 Central PRPP quadrants with multi-directional arrows**

Patients learn to apply these information processing strategies to their task performance by initially observing and modelling the therapist. The therapist's role is to act as a cognitive mediator between the patient and the task (Missiuna et al., 1998). The therapist's participation fades as the patient internalises the strategies and applies them across a range of tasks and settings, representing a shift from therapist directed to patient directed instruction (Greber et al., 2007a). This mediatory approach draws from research in education and occupational therapy with children experiencing learning difficulties.

The PRPP System of Intervention is an extension of the 'Stop Think Do' program developed for use with children and adolescents with intellectual disability (Beck & Horne, 1992), self harm tendencies, impulsivity and anger management issues (Murphy & Cooke, 1999). While this approach is relatively new to adult brain injury rehabilitation in Australia, it builds upon a body of evidence supporting the use of

multi-processing strategy approaches in children, for example Michenbaum and Goodman's (1971) 'Goal-Plan-Do-Check' approach with hyperactive children, later implemented with children with learning disorders (Polatajko, Mandich, Miller et al, 2001), and most recently adapted by Feeney and Ylvisaker (2003, 2006) into the 'Goal-Plan-Do-Review' approach with children following brain injury.

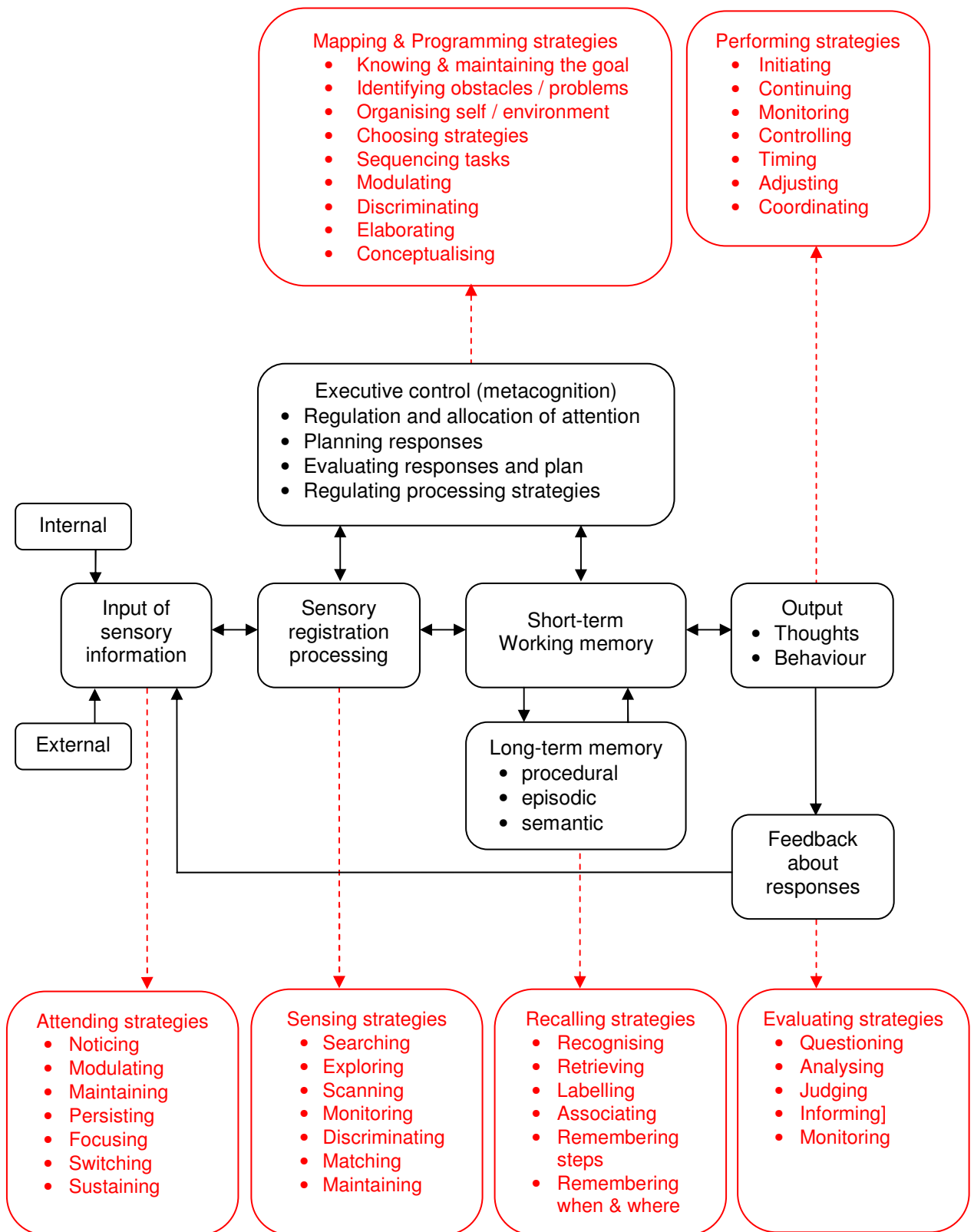
At present, the PRPP System of Intervention is a theoretical approach with limited evidence supporting clinical application and efficacy. While evidence exists for many of the separate components of the system as outlined in Table 2.5, there are no clinical studies evaluating the effectiveness of the PRPP System of Intervention as a whole. Anecdotal reports attest to the PRPP System's efficacy in clinical settings, however extensive research is necessary to evaluate the utility in practice, and the effectiveness for improving application of information processing strategies during occupational performance.

## 2.6 INFORMATION PROCESSING FOR OCCUPATIONAL PERFORMANCE

Information processing models describe a sequence of steps or stages through which information is manipulated to facilitate decision making and action (Massaro & Cowan, 1993). Formative models of information processing represented three modal stages: initial reception of information, a processing function (storage/elaboration), followed by an action (Atkinson & Shiffrin, 1968; DePoy & Burke, 1992; Eysenck & Keane, 2000; Lerner, 2002). A multi-store memory system was initially conceptualised as central to the information processing models (Lerner, 2002). As the field progressed, more complex components were included to allow for parallel processing of automatic and controlled actions (Shiffrin & Schneider, 1977), executive control processes (Baddeley, 1990; Baddeley & Della Sergio, 1996; Norman & Shallice, 1986; Shallice & Burgess, 1996), and various feedback/feedforward loops enabling multi-directional information flow (Schmidt & Wrisberg, 2004; Shumway-Cook & Woollacott, 2007; Singer, 1980).

Information arising from the interaction between people and their environment can be manipulated or transformed by many different *processes*. These processes are activated or applied in various ways according to specific *cognitive* and *metacognitive strategies* (Lawson, 1980; Missiuna et al, 2001). Processing strategies can be thought of as small units of behaviour or tactics that select and guide information processing (Abreu & Toglia, 1987; Toglia, 1991). The strategies, required to process information at each stage of the input-throughout-output model of information processing, are depicted in Figure 2.10 (adapted from Lerner, 2002).





**Figure 2.10 Information processing model with associated processing strategies**

The view of information processing adopted in this research (represented in Figure 2.10) includes aspects of perceiving and attending to information from the surrounding sensory environment, processes of recalling and retrieving information from memory stores, executive processes or metacognition, processes for monitoring and adjusting performance, and use of feedback systems. This approach is broader than perspectives that solely focus on processes of attention, memory, speed of processing or executive function in isolation from the remaining processes that are necessary for occupational performance. These segmented approaches do not consider how these skills relate to each other for integrated cognitive processing and task performance (Toglia, 1998), and may therefore be limited in addressing the overall research purpose: to investigate how the occupational performance of adults with TBI is affected by agitated behaviour and information processing difficulties.

These processes and strategies applied to occupational performance congruent with each processing stage are depicted in Figure 2.10. The impact of agitated behaviour in application of these strategies during occupational performance is discussed in the following sections.

### **2.6.1 Strategies for processing sensory input – impact of agitation**

Information processing begins with sensory input through visual, somatic, auditory, olfactory, kinaesthetic and proprioceptive receptors (Schmidt & Wrisberg, 2004).

Strategies that direct attention at this stage of the process include noticing, focusing, and modulating attention resources (Refer to Figure 2.10). Most stimuli that bombard the sensory receptors is not relevant to the occupational task at hand (Lerner, 2002), and requires discrimination and modulation to determine which information will

flow through to the sensory register. Attending strategies that are applied throughout task performance include arousal, alertness, orienting, noticing, switching, and maintaining attention (Chapparo & Ranka, 2007).

Adults experiencing agitation during acute recovery from TBI are described as being in a heightened state of activity, unable to selectively attend to people or objects within the environment, and with reduced ability to process information from the environment (Hagen et al., 1979). It is hypothesised that these agitated behaviours are associated with impaired strategy application at this stage of information processing. Incorrect processing of sensory information, or an inability to shift to other incoming information, may be associated with repetitive/perseverative behaviours observed in agitated adults who frequently attempt to remove restraints or other foreign objects such as splints, plaster casts, or dislodging intravenous tubes, tracheostomy tubes and catheters (Hagen et al., 1979; Levin, Benton, & Grossman, 1982).

### **2.6.2 Strategies for sensory registration/discrimination – impact of agitation**

Sensory input acquires meaning through the perceptual processes of registration and discrimination (Lerner, 2002). Strategies for searching, exploring, discriminating, matching and distinguishing the sensory features of an object (Chapparo & Ranka, 2007; Togliola, 2005) are critical to the deeper registration of sensory information (Refer to Figure 2.10). These perceptual processes depend upon people's ability to organise and attach meaning to sensory stimuli (Lerner, 2002). Effort is required to maintain attention on items in the sensory register. In cases where insufficient attention is allocated to this process, sensory images will be lost.

Adults with TBI who experience difficulties understanding their environment and the expectations of staff and others around them (Prigatano, 1992) may experience difficulty applying strategies at this stage of processing (Chapparo & Ranka, 1997b). In particular, inability to process details of sensory images may contribute to reduced recognition of objects, people and events in the surrounding environment, exacerbating agitated behaviour (Brigman, Dickey, & Zegeer, 1983). In these cases, behaviour is thought to be primarily driven by an internal state of confusion (Plylar, 1989).

### **2.6.3 Strategies for memory and recall – impact of agitation**

The next stage of information processing involves memory. Memory is functionally divided into at least two separate components: a short-term working memory and a long-term memory store. As illustrated in Figure 2.10, working memory and short-term memory are co-located as there is general agreement that the function of short-term memory is to serve as a working memory (Baddeley, 2004). Short-term working memory holds and manipulates information relevant to the immediate task at hand (Lerner, 2002). In order to ‘know what to do’ in everyday situations, the brain continually samples sensory information from the environment and information from its own memory stores to formulate and act upon current goals (Baddeley & Logie, 1999). In contrast, long-term memory serves as a more permanent storage facility, forming a platform of knowledge based on years of associations. Information coded and stored in long-term memory may be declarative (knowledge of facts), schematic/episodic (knowledge of time and space schemas), or procedural (knowledge of motor schemes) (Eysenck & Keane, 2000; Lou & Lane, 2005).

The level or depth of processing afforded to incoming information may contribute to how well encoded the information will be, and in turn, how readily retrievable it will be in the future ( Craik, 2002; Lockhart & Craik, 1990; Nyberg, 2002). Strategies applied to this stage of processing may include attending to information longer, elaborating on the use of the information, or developing associations with existing memory stores (Toglia, 2005). Effective recognising, categorising and labeling of sensory images for encoding ensures information is stored correctly, and facilitates later retrieval (Refer to Figure 2.10). When patients are unable to apply recall strategies for encoding information, repetitive re-learning of the same information over and over is required, limiting progress in rehabilitation, and increasing patient frustration.

To recall previously stored knowledge, strategies for recalling facts, procedures and schemes of action are required to know where, how, and when a task should be performed (Chapparo & Ranka, 2007). Strategies for recalling task steps, recalling use of objects, and recalling how to use parts of the body for task performance (Chapparo & Ranka, 2007) draw upon implicit, procedural knowledge of previously learned occupational performance. Procedural memory enables performance of skilled actions automatically, based on past experience, without the involvement of conscious recollection (Eysenck & Keane, 2000). This implicit form of knowing contrasts with the explicit requirements of declarative memory, and is thought to remain intact during the state of PTA enabling learning and performance of occupational tasks and activities (Glisky & Delaney, 1996).

Patients with TBI typically experience a period of PTA early in recovery, during which time memory is significantly affected. During this time, patients who are unable to develop stable schematic memory cannot recall 'when' or 'where' to perform tasks and actions (Leach et al., 2006), leading to behaviour that is 'inappropriate' to the context (Harmsen, Geurts, Fasotti, & Bevaart, 2004). The need for assistance and prompting during functional tasks may be attributed to poor short-term memory in agitated patients who remain in PTA (Weir et al., 2006).

#### **2.6.4 Strategies for planning, organising, and regulating behaviour – impact of agitation**

Several cognitive processes integrate to determine goal-directed behaviour. These processes include formulating goals, initiating behaviour, anticipating consequences of actions, monitoring and adapting behaviour to fit specific task contexts, and are collectively referred to as *executive functions* (Cicerone et al., 2000). These processes are considered super-ordinate over lower-order cognitive skills, representing a hierarchical structure and function of executive control (Busch, McBride, Curtiss, & Vanderploeg, 2005; Sohlberg, Mateer, & Mateer, 1993; Stuss, 1991).

Executive strategies applied during occupational performance include knowing and maintaining the task goal, identifying obstacles, organising, choosing, sequencing, modulating, regulating and evaluating behaviour (Abreu, 1998; Chapparo & Ranka, 2007). These processes are multi-directional, as information is processed forward and backward between all stages of the model (Refer to Figure 2.10), enabling constant updating and development of an action plan that best fits the demands of the occupational context.

Strategies for information updating and cognitive flexibility are essential for changing or shifting mental-set during occupational performance (Busch et al., 2005; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). The thinking style of people who are unable to apply these strategies to modify behaviour in accordance with incoming information is typically referred to as ‘concrete’ or inflexible (Burgess & Wood, 1990).

Executive strategies are also required to inhibit inappropriate responses (Busch et al., 2005; Miyake et al., 2000). Discrimination between potential responses is first required, then activation of strategies to choose the best tactics for the specific task. People who are unable to do this may appear disorganised during task performance, making incorrect choices about how to do tasks, and may constantly seek advice about how to progress with the task. Adults who demonstrate agitated behaviour are typically unable to engage in this sequence of strategic processes, finding it difficult to inhibit the first response that comes to mind (Greve et al., 2002).

### **2.6.5 Strategies for response generation and processing feedback – impact of agitation**

The final stages of information processing involve executing a response according to the plan generated in previous processing stages, and monitoring this output through feedback systems (Refer to Figure 2.10) (Lerner, 2002; Schmidt & Wrisberg, 2004). Strategies are applied to start and stop performance when the task and context demands, to continue and persist when presented with obstacles or distractions, to control performance, time, coordinate and adjust motor responses (Chapparo & Ranka, 2007).

Strategies for monitoring, evaluating, analysing and judging the quality and efficacy of performance are applied through feedback loops (Schmidt & Wrisberg, 2004; Shumway-Cook & Woollacott, 2007). This sensory, external feedback becomes an additional source of sensory input (Refer to Figure 2.10) and is used strategically in the system to refine immediate and future responses (Chapparo & Ranka, 2005; Rodger, Pham & Mitchell, 2008). In this way, the information processing system is thought to continually inform itself about what will happen in the next moment (feedforward), what is happening in the current moment (production feedback), and about what has happened in the last moment (feedback about consequences of actions) (Schmidt & Wrisberg, 2004).

In summary, the information processing strategies illustrated in Figure 2.10 and outlined above, provide a conceptual framework upon which the PRPP System is based. At present, evidence to support this framework is largely theoretical, with little empirical support. The PRPP System attempts to link this information processing framework to the concept of occupational performance, providing a theoretical framework to assess and provide intervention for people with information processing strategy deficits that impact on functional performance. It is hypothesised that modifying strategy application can improve occupational performance in people with processing difficulties, such as adults with agitated behaviour following TBI.



## 2.7 CHAPTER SUMMARY

This chapter reviewed literature relevant to the primary variables under study and contributed to the overall purpose of the research, which was to investigate how the occupational performance of adults with TBI is affected by agitated behaviour and information processing difficulties.

Literature was presented within an occupational performance frame of reference, leading to these summarised findings:

- Agitated behaviour following TBI is associated with structural changes in the central nervous system, represented by OPM(A) body and mind core element changes, and characterised by damage to the frontal lobe and associated pathways in the brain
- These core element changes limit performance capacities in the component areas of cognition, inter-personal and intra-personal behaviour that impact upon occupational performance and occupational roles
- Disordered processing of environmental events are associated with agitated behaviour following TBI, and can be explained within an information processing model of cognition and human performance
- The information processing model of cognition describes processes of input, throughput, output and feedback, and may guide assessment and intervention of adults with agitated behaviour following TBI.
- The PRPP System of Task Analysis measures these information processing aspects of performance by evaluating the application of processing strategies during occupational performance, and may be an appropriate assessment

system for evaluating adults with agitated behaviour during acute TBI rehabilitation.

- Cognitive strategy training approaches to cognitive rehabilitation is an emerging field in the area of TBI rehabilitation, supported by strong, high quality evidence. This approach may be effective for adults with agitated behaviour during acute TBI, yet to date this population group has received limited study.
- The PRPP System of Intervention is one of these cognitive strategy training approaches, unique to occupational therapy and potentially applicable to adults with agitated behaviour following TBI.
- There is limited clinical evidence supporting the effectiveness of PRPP Intervention with adults demonstrating agitated behaviour following TBI. Additionally, measurement properties of the PRPP Assessment, as applied to this population, require further investigation.

# CHAPTER THREE: METHODS

## 3.1 INTRODUCTION AND PURPOSE

The purpose of this chapter is to summarise the research design and methods adopted in each phase of this research. Research methods relevant to each published study are contained within the journal articles and manuscripts forming results in Chapters Four to Ten. A summary only is provided to reduce repetition of information in subsequent published chapters. However, where more than one published study is based on data from the same study phase, research design and methods are unavoidably repeated in the coming results chapters. In cases where limitations to methodological descriptions were imposed by publishing the articles, greater detail is provided in this chapter.

This research was conducted in four sequential phases, using multiple research methods to investigate the primary research question ‘How do information processing deficits impact upon the occupational performance of adults with agitated behaviour following TBI?’

A concept driven, mixed-method approach was adopted where study design and method were congruent with the research questions and design of each sequential phase (Greene & Caracelli, 2003). Qualitative and quantitative techniques were integrated to draw upon the complementary strengths of each methodological approach (Ivankova, Creswell, & Stick, 2006; Morgan, 1998) in order to answer the following specific research questions:

1. To what extent does agitated behaviour impact on functional outcomes following inpatient rehabilitation of adults with TBI?
2. How can the capacity to apply information processing strategies during occupational performance be effectively measured in adults with agitated behaviour during acute TBI rehabilitation?
3. What types of processing strategy deficits are identified by Stage 2 of the PRPP System of Task Analysis when observing the occupational performance of adults with agitated behaviour following TBI?
4. How valid and reliable is Stage 2 of the PRPP System of Task Analysis when measuring application of information processing strategies during occupational performance of adults with agitated behaviour following TBI?
5. How effective is the PRPP System of Intervention for improving application of information processing strategies during occupational performance of adults demonstrating agitated behaviour during acute TBI rehabilitation?

### **3.2 ETHICS APPROVAL PROCEDURES**

The Human Research and Ethics Committee (HREC) of The University of Sydney and the HRECs of each participating medical facility separately reviewed each phase of this research. Approval documentation is provided in Appendix I.

### **3.3 RESEARCH PHASE ONE - AGITATION OUTCOME STUDY**

Phase one explored the nature and incidence of agitated behaviour during TBI rehabilitation in order to answer the first research question:

*To what extent does agitated behaviour impact on functional outcomes following inpatient rehabilitation of adults with TBI?*

#### **3.3.1 Research design**

A retrospective medical record review was conducted on a sample of adults with TBI who had participated in specialist inpatient rehabilitation. Daily agitated behaviour was recorded and the relationship with functional outcome was then investigated at three time points; rehabilitation discharge, 6- and 24-months post-discharge.

#### **3.3.2 Participants**

This sample included 80 participants admitted to a specialist brain injury rehabilitation facility in Sydney, who had sustained a TBI and had consented to participate in a longitudinal outcome study (Felmingham, Baguley, & Crooks, 2001).

#### **3.3.3 Data collection**

##### ***3.3.3.1 Agitation data from medical records***

A pilot review of five medical records and contemporaneous literature review produced a list of commonly used terms to describe and define agitated behaviour. This list was reduced to 24 terms forming the basis of a data collection model used to review medical records of the 80 participants in this study.

### **3.3.3.2 Outcome data**

Outcome measures collected at rehabilitation discharge included length of rehabilitation admission, duration of PTA as measured by the Westmead PTA Scale (Shores et al., 1986), and level of functional independence in cognitive and motor activity assessed using the Functional Assessment Measure (FAM; Hall et al., 1993). Medium term outcome was examined through follow-up at 6- and 24-months post-discharge, using the FAM, the Community Integration Questionnaire (Sander et al., 1999), the Overt Aggression Scale (Yudofsky et al., 1986) and the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985).

### **3.3.4 Data analysis**

Independent t-tests or non-parametric Mann-Whitney tests examined differences between agitated and non-agitated groups. Spearman's rank order correlations measured the association between duration of agitation with functional outcomes. Spearman's correlations were used because some variables were on an ordinal scale or were not normally distributed.

A more detailed description of the research methods and results pertaining to Research Phase One are presented in Chapter Four: Nott, M. T., Chapparo, C., & Baguley, I. J. (2006). Agitation following traumatic brain injury: An Australian sample. *Brain Injury*, 20(11), 1175-1182.

Findings from Research Phase One indicated a persistent relationship between agitated behaviour and cognitive difficulties in adults with TBI. This highlighted the need to further explore current and potential methods of assessment and intervention

aimed at improving cognition during acute TBI rehabilitation. An extensive literature review identified several assessments purported to measure cognition, functional performance or both of these constructs within the population of adults recovering from TBI. The PRPP System of Task Analysis was selected from these measures as meeting the criteria outlined in Section 2.4.4, and because it demonstrated the greatest potential for clinical utility with adults demonstrating agitated behaviour following TBI. Detailed examination of the tool's clinical utility and measurement properties formed the basis of Research Phases Two and Three.

### **3.4 RESEARCH PHASE TWO - CRITICAL CASE STUDY**

In Research Phase Two, a case study was used to explore the clinical utility of the PRPP System for measuring information processing strategy application during occupational performance of an adult with severe agitation following TBI.

Research Phase Two addressed the following two research questions:

*How can the capacity to apply information processing strategies during occupational performance be effectively measured in adults with agitated behaviour during acute TBI rehabilitation?*

*What types of strategy application deficits are identified by Stage 2 of the PRPP System of Task Analysis when observing the occupational performance of adults with agitated behaviour following TBI?*

### **3.4.1 Critical case study**

An embedded critical case study (Miles & Huberman, 1994; Yin, 2003) was designed to identify difficulties applying processing strategies during occupational performance. The purpose of this case study was to generate further hypotheses about the nature of information processing strategy deficits during agitation, and to determine whether the PRPP assessment tool could be used in research involving larger numbers of patients and therapists. Case study research has been recognised as an appropriate framework for the study of variables that are linked to patient performance and outcomes in the occupational therapy process (I. Fisher & Ziviani, 2004; Salminen, Harra, & Lautamo, 2006).

### **3.4.2 Case description – AT**

This case study represents a 4-week period of rehabilitation in a patient with severe agitation approximately three months post-TBI. He was transferred to a specialist brain injury rehabilitation unit 2 months post injury. At this time he demonstrated features of PTA and was functioning at Rancho Level IV – Agitated and Confused (Hagen, 2001). Agitated behaviour was characterised by motor restlessness, pacing and attempts to abscond, verbal aggression towards others, and physical aggression towards objects.

### **3.4.3 Data collection and interpretation procedures**

The impact of AT's agitated behaviour on information processing strategy application was repeatedly measured using The PRPP System of Task Analysis during three tasks that were targeted for occupational therapy intervention: upper-



body dressing, making a sandwich and making a cup of coffee. Tasks were selected to evaluate:

1. routine, procedural task performance: upper-body dressing
2. novel task performance with limited choice: sandwich making with pre-prepared filling
3. novel task performance with greater choice: making coffee

Strategy application during occupational performance was measured using Stage 2 of the PRPP System of Task Analysis. Scores as a percentage of the possible 100% score for each sub-quadrant were calculated and represented using radial graphs (Figures 2–9 in Chapter 5). These radial graphs were structured to conform to the PRPP conceptual model illustrated in Figure 2.7 (Chapter 2). The shaded area represents AT's percentage scores for each sub-quadrant. Progressive increases in the shaded area of each graph indicated progressive improvement in performance. Use of radial graphs in this case study was a novel method for displaying change over time in strategy application during occupational performance. This graphical approach effectively communicated changes over time, highlighting the PRPP System's responsiveness to change; and enabled clear identification of specific processing strengths and weaknesses.

A more detailed description of the research methods and results pertaining to Research Phase Two are presented in Chapter Five: Nott, M. T., & Chapparo, C. (2008). Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 55(3), 188-198.

### **3.5 RESEARCH PHASE THREE - VALIDITY AND RELIABILITY STUDY**

The third phase of this research involved two studies, quantifying the validity and reliability of the PRPP System of Task Analysis with the specific population under study: adults demonstrating agitated behaviour following brain injury. These studies focused on Stage 2 of the PRPP System of Task Analysis, as the results from this component of the assessment directly relate to information processing strategies as defined by the research question. Earlier research by the test developers established the validity and reliability of Stage 1 of the PRPP System of Task Analysis in adults with brain injury (Chapparo & Ranka, 1997b), therefore this research focused in the area of greatest need in advancing the understanding of the PRPP System's measurement properties.

Research Phase Three addressed the following research question:

*How valid and reliable is Stage 2 of the PRPP System of Task Analysis when measuring application of information processing strategies during occupational performance of adults with agitated behaviour following TBI?*

#### **3.5.1 Measuring construct validity and internal consistency**

Research Phase Three utilised traditional and modern test methods, specifically Rasch measurement for determining construct validity. While Rasch measurement models have been used extensively in educational research, application to health sciences is a relatively new area of statistical practice. As such, an overview will first be provided, followed by the specific methods of this research phase.

### ***3.5.1.1 Overview of Rasch Measurement***

Observations of human performance are typically evaluated or measured using ordinal level rating scales; for example: performs independently, requires assistance, or is dependent. The rating categories represent a decreasing level of independence but the difference between categories is not quantified. Rasch measurement models quantify the difference between ordinal categories such as these, by converting raw ordinal data to interval measures using logistic transformation (Rasch, 1960). Once converted from a raw ordinal rating to an equal-interval unit of data, the measurement unit is referred to as a *logit* (log odds unit; Bond & Fox, 2007). Equal interval scales enable more accurate measurement of an individual's ability over time, measurement between individuals, or across groups (Bode, Heinemann, & Semik, 2000). In addition, a logit scale has a mathematical advantage in the measurement of people with severe disabilities such a brain injury, as log odds scales do not bias towards scores in the middle of the scale, or against people who score at the extremes; the area in which severely brain injured people typically score (Bond & Fox, 2007).

In addition to producing interval-level measures, Rasch measurement models provide techniques for evaluating the quality of the measures produced, this being the primary purpose for which Rasch measurement was used in this research. Rasch analysis can answer questions such as: How well does each item or task fit with the underlying construct? How well do the set of tasks define a single construct such as information processing ability? Does the set of tasks cover a wide enough range of abilities to effectively measure information processing? How well do raters use the rating scale? The answers to these questions provide evidence for the construct

validity of the measure. Establishing construct validity, that is to the extent to which a test measures the particular construct or trait that it intends to (Aiken, 2003), is an ongoing process that requires several theoretical and empirical approaches for gathering evidence. In Rasch measurement, construct validity is supported when the recorded performances of individuals and test items are true reflections of a single underlying construct. Fit analysis provides an indicator of how well each item and person fits with the underlying construct. Items that do not fit the unidimensional construct are those that diverge unacceptably from the expected ability/difficulty pattern (Bond & Fox, 2007).

The Rasch model is particularly useful for investigating aspects of human performance with developmental aspects (Bond & Fox, 2007) such as information processing capacity. Rasch models incorporate the key property of sensitivity to ordered skill acquisition, enabling the estimation of developmental distances between skills or between individuals. In addition, it can be determined whether the general developmental pattern shown among items and persons accounts for the general pattern of development shown by every item and every person (Bond & Fox, 2007). Rasch measurement models are further discussed in the Method section of the manuscript (currently under review) that forms the basis of Chapter Six: Nott, M. T., Chapparo, C., & Linacre, J. M. Exploring the validity of an information processing assessment for measuring occupational performance in adults with brain injury. *Journal of Applied Measurement, (Under review; submitted December 2007).*

### ***3.5.1.2 Participants – Patient group***

Five adults were recruited to the study during inpatient rehabilitation following brain injury. All patients demonstrated agitation and confusion interfering with functional performance. Refer to Section 6.2, Chapter Six for more detailed information on participants. Each participant was videotaped performing four to five self-care tasks during occupational therapy sessions.

### ***3.5.1.3 Participants – Therapist group***

Ten occupational therapists, considered to be expert clinicians in the area of neurological rehabilitation, with post-graduate training in use of the PRPP System of Task Analysis, participated in this phase of the study.

### ***3.5.1.4 Data collection procedures***

Therapists viewed video-footage of occupational therapy sessions with the patients during acute TBI rehabilitation. The use of videotaped patient performance has been shown to be effective in allowing multiple raters to observe and score the exact same performance (Pierce, 2005; Portney & Watkins, 2000). This was particularly important in this study as the presence of additional raters during therapy sessions would have been inappropriate with agitated and confused patients.

Therapists were sent a research package containing a DVD and all necessary score-sheets. The breakdown of task steps in the Stage 1 analysis had been completed for all patients and tasks. Therapists were asked to record Stage 1 errors, and complete the Stage 2 assessment using the provided score sheets as illustrated in Figure 3.1.

**THE PRPP SYSTEM SCORING SHEET**

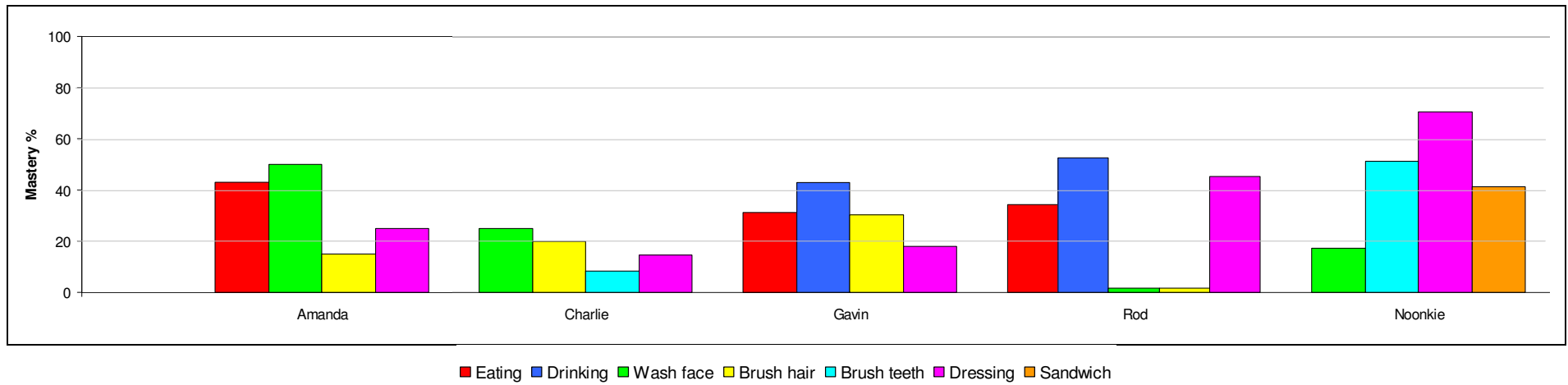
Client Name: GAVIN		Date:		Task: DRINKING FROM A CUP	
3(-) = Performance of this descriptor meets criterion expectations; reasonable time, without assistance; without prompts					
2(?) = Performance of this descriptor meets criterion expectations but indicates concern due to timing or prompts needed					
1(X) = Performance of this descriptor does not meet criterion expectations; inhibits performance					
<b>STAGE ONE ANALYSIS: CRITERION %</b> _____			<b>STAGE TWO ANALYSIS RATING</b>		
<b>STEPS</b>	<b>ERRORS</b>				
	Acc	Rep	Om	Ti	
1. Roll to side					
2. Sit on edge of bed					
3. Locate cup					
4. Reach to cup					
5. Lift to mouth					
6. Drink from cup					
7. Give cup to OT					
<b>PERCENTAGE SCORE:</b> _____					

Figure 3.1 Sample PRPP scoresheet with Stage 1 task breakdown

Therapists' Stage 1 error recordings were totalled to calculate a mean mastery score for each patient on each performed task. This provided an indication of the level of task mastery demonstrated by these patients, and the degree to which agitated behaviour was limiting their task performance. Figure 3.2 displays mastery % scores for each patient, on each performed task.

Noonkie was the only patient to score above 50% on any of the tasks. In general, the criterion for these self-care tasks was 85% or above error free. No patients achieved this criterion level of performance mastery, reflecting the early stage of brain injury recovery at which each patient was functioning.

Therapists then completed Stage 2 of the PRPP System of Task Analysis. Therapists' ratings of the 34 information processing descriptors that comprise Stage 2 (right hand side of score sheet in Figure 3.1) were then entered into a Rasch measurement model (Rasch, 1960) for analysis.



**Figure 3.2 Level of task mastery (PRPP Stage 1 % score) achieved by each patient on each performed task**



### 3.5.1.5 Data analysis

Four factors were present in the situation being measured by this research: patients; occupational tasks; the PRPP assessment items; and the raters; thus a four-faceted Rasch model was generated.

The standard Rasch model for dichotomous data with persons and items is:

#### Equation 3.1: Dichotomous form of the Rasch model

$$\log\left(\frac{P_{ni}}{1 - P_{ni}}\right) = B_n - D_i$$

where  $P_{ni}$  is the probability that person  $n$  will succeed on item  $i$   
given that:  
person  $n$  has ability  $B_n$  and  
item  $i$  has difficulty  $D_i$

The Many-Faceted Rasch Model is one of several extensions to the dichotomous Rasch Model. Based on a four-facet paradigm, with an ordinal rating scale, the Rasch equation was represented as below:

#### Equation 3.2: Multi-faceted form of the Rasch model with a rating scale

$$\log\left(\frac{P_{nmijk}}{1 - P_{nmijk}}\right) = B_n - A_m - D_i - C_j - F_k$$

where  $P_{nmijk}$  is the probability that person  $n$  will succeed on item  $i$   
given that:  
person  $n$  has ability  $B_n$   
task  $m$  has challenge  $A_m$   
item  $i$  has difficulty  $D_i$   
judge  $j$  has severity  $C_j$  and  
 $F_k$  is the barrier to being observed in category  $k$  relative to category  $k-1$

PRPP Stage 2 ratings were analysed according to this Rasch model using the FACETS computer programme (Linacre, 2007) to first construct linear measures for the four facets under investigation, then to evaluate 'fit' with the Rasch model.

FACETS reports infit and outfit as unstandardised mean square values and standardised  $z$ -scores. Larger differences between the modelled and observed item values suggest poorer fit with the Rasch model (Bond & Fox, 2007). For clinical observations, a mean-square range of 0.5-1.7 is considered acceptable; however, a fit range of 0.6-1.4 is suggested for survey style data (Wright & Linacre, 1994). The more stringent parameters were applied in this study as per recent studies of occupational performance (Bode et al., 2000; Lautamo, Kottorp, & Salminen, 2005).

Standardised fit values are a statistic with a distribution like  $t$ . The acceptable fit range for  $z$ -scores is  $< |2|$  (Bond & Fox, 2007; Lautamo et al., 2005). The suggested criterion for determining sufficient level of 'fit' allows 5% of items to misfit by chance when  $z > |2|$  (Smith, 1991).

In addition to examination of fit statistics, contributory evidence for construct validity was also gained from inspecting the Rasch calibrated hierarchy of PRPP items. The generated hierarchy of items, ordered from easiest to hardest processing strategy, was compared to the expected ordering based on clinical experience (Bode et al., 2000; Whyte et al, 2003), the conceptual information processing model that guided instrument development (Huitt, 2003; Lerner, 2002), theories of organised human cognition (Constantinidou, Thomas, & Best, 2004) and learning theory (Snell & Zirpoli, 1987).

*Internal consistency* within the four main PRPP quadrants and 12 sub-quadrants was examined using traditional test methods, evaluating extent to which different test items correlate with each other (Polgar & Thomas, 2000). Items that are highly correlated with each other are said to be internally consistent. Although correlation is traditionally associated with reliability, this application pertains to validity.

Cronbach's alpha ( $\alpha$ ) was used to measure internal consistency (Cronbach, 1951), with  $\alpha$  values of 0.7 - 0.8 considered satisfactory, and  $\alpha \geq 0.9$  considered desirable (Bland & Altman, 1997).

The research methods and results pertaining to this component of Research Phase Three are detailed in Chapter Six: Nott, M. T, Chapparo, C., & Linacre, J. M. Exploring the validity of an information processing assessment for measuring occupational performance in adults with brain injury. *Journal of Applied Measurement*, (Under review; submitted December 2007).

### **3.5.2 Measuring test and rater reliability**

A common issue in clinical assessment is the extent to which clinicians agree with each other in their assessment of patients (Polgar & Thomas, 2000). The second study contained within Research Phase Three examined the test and rater reliability of the PRPP System of Task Analysis. As this component of Research Phase Three focused on the reliability of actual therapist ratings, rather than the validity of the assessment tool, raw ratings were used rather than Rasch calibrated values.

### ***3.5.2.1 Participants***

Nine of the ten occupational therapists involved in the above validity study participated in the reliability study. The same patients and video footage were used for the reliability and validity components of the study.

### ***3.5.2.2 Data collection procedures***

In addition to the data collection procedures outlined above in Section 3.5.1.3, a repeat assessment occasion was included in the reliability component of the study. A second DVD containing one client, performing one task, was sent two weeks after return of the first research package for the purposes of measuring intra-rater agreement.

### ***3.5.2.3 Data analysis***

#### *Inter-rater and test reliability*

In this study, three factors were present in the measurement situation: the patients, the occupational tasks being performed, and the raters. As such, three-way intraclass correlation coefficients (ICC; Wong & McGraw, 1999) were used to estimate inter-rater and test reliability. Two ICCs were calculated for each of the four PRPP quadrant scores, and the PRPP Total score.

The first ICC was focused on the raters, and was structured to assess the reliability of an average rater in the population from which the raters came. The second ICC was focused on the PRPP test procedures, and was structured to assess the reliability of the PRPP assessment system as applied to the population from which the sample of patients came. These are referred to as inter-rater and test reliability respectively.

Three-way ICCs and confidence intervals were calculated using a spreadsheet provided by Ken McGraw based on the mathematical equations presented in Wong and McGraw (1999). ICC's were calculated based on mean square values from Type IV Analysis of Variance (ANOVA) computed using SPSS 15.0 (SPSS Inc, 2006). Output from the three-way ICC analyses is provided in Appendix III.

### *Intra-rater reliability*

Each therapist re-assessed one patient twice, with a minimum two-week interval between measurement occasions. Intra-rater agreement refers to the stability of PRPP scores recorded by each rater across these two measurement occasions, and was estimated using the Bland and Altman method for repeated scoring (Bland & Altman, 1986). If ratings were completely reliable, the difference between each therapist's ratings at Time 1 and Time 2 would be zero (0). If therapists generally rated higher or lower at Time 2, the average difference would be significantly different to 0, a situation referred to as 'bias'. The presence of bias was tested by calculating the standard deviation and 95% CI of the difference between ratings at scoring Time 1 and Time 2. We expected 95% of the difference to be less than 2 standard deviations from the mean (Bland & Altman, 1986).

A more detailed description of the research methods and results pertaining to this component of Research Phase Three are presented in Chapter Seven: Nott, M. T., Chapparo, C., & Heard, R. Reliability of the Perceive, Recall, Plan and Perform System of Task Analysis: A criterion referenced assessment. *Australian Occupational Therapy Journal*. Published online August 25 2008. DOI: 10.1111/j.1440-1630.2008.00763.x

The overall purpose of Research Phase Three was to determine the measurement properties of the PRPP System of Task Analysis with the intention of using it as an outcome measure in Research Phase Four.

### **3.6 RESEARCH PHASE FOUR - PRPP INTERVENTION STUDY**

The fourth and final phase of this research involved a clinical intervention study that applied a single-system experimental design across eight subjects. Research Phase Four specifically addressed the final research question:

*How effective is the PRPP System of Intervention for improving application of information processing strategies during occupational performance of adults demonstrating agitated behaviour during acute TBI rehabilitation?*

#### **3.6.1 Research design**

An ABAB experimental design compared the PRPP Intervention (experimental condition; B phases) with current occupational therapy intervention (baseline condition; A phases), using a sequential introduction and withdrawal design (Gianutsos & Gianutsos, 1987; Thompson, 2006).

##### ***3.6.1.1 Target behaviours/dependent variables***

Two dependent variables were measured. The primary target behaviour or dependent variable, information processing capacity during occupational performance, was measured using the PRPP System of Task Analysis (Chapparo & Ranka, 1997b). The second dependent variable, agitated behaviour, was measured using the ABS (Corrigan, 1989).

### *3.6.1.2 Intervention/independent variable*

The independent variable in this study was occupational therapy intervention. Subjects received usual occupational therapy intervention during baseline phases, alternating with the PRPP Intervention during the intervention phases.

### **3.6.2 Participants**

Eight adults with brain injuries participated in this component of the study. Detailed demographic and injury related information is available in Table 8.2 (Chapter 8).

### **3.6.3 Intervention Procedures**

The study protocol involved four sequential phases, alternating between baseline and experimental intervention. The study period (4-weeks) was established from findings in Chapter 4, identifying the average duration of agitation in patients at this rehabilitation facility to be approximately 4 weeks. Weekly alternation between phases enabled collection of at least six data points (Backman, Harris, Chisholm, & Monette, 1997) on six consecutive days within each phase and served pragmatic purposes in treatment planning within the clinical context.

#### ***3.6.3.1 Baseline intervention—current occupational therapy approach***

During baseline phases, subjects received daily occupational therapy from the clinical OT. The current approach was described as functional/compensatory with aspects of behavioural management. Methods of intervention included systematic instruction; task adaptation; environmental modification; physical guidance; and facilitation. Intervention was conducted as part of a multi-disciplinary programme

including medical and nursing care, physiotherapy, occupational therapy, speech pathology, clinical psychology and social work.

### ***3.6.3.2 Experimental intervention—PRPP System of Intervention***

Occupational therapy was provided during the intervention phases by the researcher using the PRPP intervention approach. The PRPP system, as outlined in Section 2.4.4.3, is a dynamic assessment and intervention approach. Intervention sessions specifically targeted application of information processing strategies using graded prompts, progressing from content free metaprompts to more specific content based behavioural prompts. Patients learnt to apply *stopping, sensing, thinking, and doing* strategies to their performance across various occupational tasks. Multi-disciplinary rehabilitation continued as per the baseline phase, with the frequency of intervention remaining consistent across all phases.

### **3.6.4 Data collection procedures**

Individual responses to both the PRPP Intervention and current occupational therapy were measured daily using several assessment tools, each collected by independent raters as outlined in Table 3.1 to reduce potential measurement bias.

**Table 3.1 Measures collected by independent raters**

<b>Measure</b>	<b>Frequency</b>	<b>Rater</b>
PRPP	Daily	Researcher
ABS	Daily	Nursing staff
PTA	Daily	Clinical OT



### **3.6.5 Data analysis**

#### ***3.6.5.1 Visual analysis***

Visual analyses of PRPP and ABS data were performed. Change in performance level between adjacent phases, latency of change, and trend/slope of plotted data were determined by visual analysis (Kazdin, 2003). Linear regression lines or mean lines were overlaid where appropriate to assist the interpretation of visual data.

Visual data is presented in Chapters 8, 9 and 10.

#### ***3.6.5.2 Analysis of Variance***

Prior to statistical analysis serial dependency of the data was checked using autocorrelation coefficients (refer to Ottenbacher, 1986, p.173 for specific procedures). Stage 2 Total PRPP% scores demonstrated a level of autocorrelation that did not reach significance, permitting statistical analysis. Analysis of Variance (ANOVA) examined the differences between phase means, with Scheffé post-hoc tests to localise significant differences between individual study phases (critical p value  $\leq .05$ ). Treatment effect size was measured using partial eta squared ( $\eta_p^2$ ), with effect sizes above .26 considered large (Bakeman, 2005; Tabachnick & Fidell, 2007). These results are presented in Chapter 8.

#### ***3.6.5.3 Rasch analysis***

Rasch modelling was also performed on the raw data from PRPP Stage 2 analysis. The hierarchy generated was compared to the hierarchy initially calibrated in Research Phase Three. Correlation between item measures from each hierarchy was performed to determine the degree of association between the two generated hierarchies.

### **3.6.6 Rater reliability**

Observer bias is a commonly cited limitation to single-system designs (Thompson, 2006). Therefore, therapy sessions were videotaped to analyse intra-rater and inter-rater reliability (Elder, 1999). This video-footage was observed and scored using the PRPP System of Task Analysis by an independent observer. Agreement between the independent observer and the researcher was measured using a Type (3,1) ICC, with random subject factor and fixed rater factor, testing for absolute agreement (Rankin & Stokes, 1998; Shrout & Fleiss, 1979). A coefficient  $\geq 0.85$  was considered acceptable for intra-rater and inter-rater agreement (Backman et al., 1997).

The level of inter-rater agreement achieved, ICC = 0.86 (95% CI: 0.73–0.93), exceeded the criterion and compares favourably with ABAB studies based on observation of behaviour in adults with brain injuries (Barreca et al., 2003).

To measure the consistency of the researcher over time, all video footage was re-analysed by the researcher at the end of the 12-month study and ratings were compared to initial scores. Intra-rater reliability was measured using the same procedures as for inter-rater reliability and found to be very high, ICC = 0.97 (95% CI: 0.94–0.99).

### **3.6.7 Treatment fidelity**

Treatment fidelity refers to the methodological strategies used to monitor and enhance the validity of intervention provided in the B phases of the study (Bellg et al., 2004). The overall goal of enhancing treatment fidelity was to increase scientific confidence that change in performance was attributable to the PRPP intervention

(Borrelli et al., 2005). Treatment fidelity is particularly important in studies that evaluate a clinical outcome (Nelson & Mathiowetz, 2004), as fidelity can impact on the effect size and statistical power of the evaluated intervention (Bellg et al., 2004; Moncher & Prinz, 1991; Resnick et al., 2005).

Evaluation of treatment fidelity in this study considered study design, training of the researcher, delivery of treatment, receipt of treatment by the patients, and enactment of treatment skills in real-life contexts (Bellg et al., 2004; Resnick et al., 2005).

These five areas have been identified by the National Institutes of Health Behavior Change Consortium (Bellg et al., 2004) as most salient when implementing intervention targeting change in an individual's behaviour.

#### ***3.6.7.1 Study design***

Fidelity related to study design focused on assuring the study could adequately test the central hypothesis in relation to underlying theory, and the elimination of extraneous variables (Resnick et al., 2005). In this study, the experimental PRPP intervention had a sound theoretical basis in information processing and learning theory as outlined in Section 2.5.2.4. The assessment instrument had direct association with the intervention being evaluated.

To eliminate extraneous variables, clear protocols for intervention sessions including duration and frequency of treatment sessions were outlined and kept consistent across the experimental treatment phases and the control treatment phases.

Intervention was provided during both phases by therapists with specialist skills in brain injury rehabilitation (Borrelli et al., 2005). Treatment contamination was

controlled by ensuring the clinical OT did not observe therapy sessions conducted by the researcher, either in person or viewing video footage, and did not receive knowledge or training in PRPP Intervention methods (Kolanowski, Buettner, & Moeller, 2006).

### ***3.6.7.2 Researcher training***

Treatment fidelity related to training focused on the ability of the researcher to provide the PRPP intervention, and ensuring a satisfactory level of skill in delivering the PRPP Intervention to participants (Bellg et al., 2004; Resnick et al., 2005).

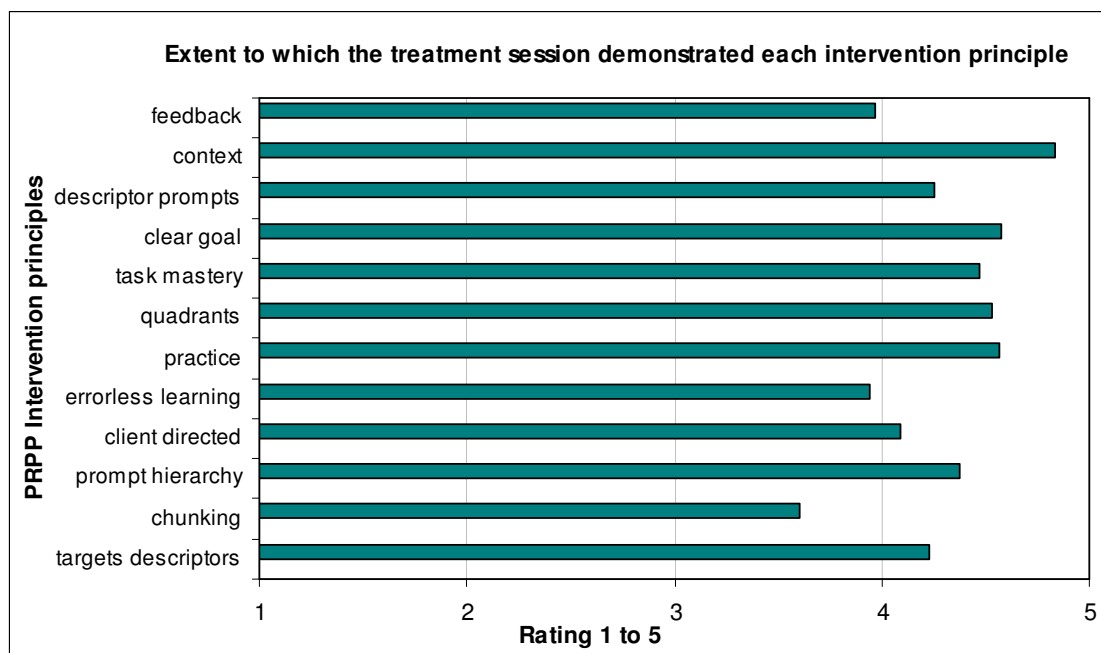
Training was initially conducted with one of the developers of the PRPP System of Intervention (Chapparo & Ranka, 2007). The intervention developer and the researcher regularly reviewed video-footage of intervention sessions to ensure consistency throughout the study period. As recommended by the Behaviour Change Consortium (Bellg et al., 2004), feedback on intervention techniques and additional training continued to be provided by the developer to the researcher as the study progressed, to ensure specific competencies were maintained for successful delivery of the intervention (Borrelli et al., 2005). A training manual (Chapparo & Ranka, 2007) guided selection of the information processing strategies that formed the basis of the intervention method.

### ***3.6.7.3 Delivery of treatment***

Treatment fidelity related to delivery of the intervention, also termed treatment integrity, referred to the degree to which the PRPP Intervention was implemented as planned, designed, and intended (McIntyre, Gresham, Di Gennaro, & Reed, 2007).

The established gold standard for ensuring treatment integrity is to evaluate

intervention sessions according to a priori criteria (Bellg et al., 2004; Nelson & Mathiowetz, 2004). O’Kelly (2004) recommends that other skilled therapists review audio or videotapes of intervention sessions against the established a priori criteria. To this end, a group of 14 independent occupational therapists viewed video footage of the researcher conducting PRPP Intervention sessions with two participants. Therapists used a 5-point rating scale to indicate the extent to which the treatment session demonstrated each of the twelve core PRPP Intervention principles (1 = not demonstrated at all to 5 = consistently demonstrated). The mean rating for each intervention principle is displayed graphically in Figure 3.3. The mean rating across all intervention principles was 4.3 (SD 1.1; range 3.6-4.8) suggesting a high level of treatment integrity.



**Figure 3.3: Mean ratings of treatment integrity**

### ***3.6.7.3 Receipt of treatment***

Fidelity related to treatment recipients involves processes that monitor and improve the ability of patients to understand and perform treatment-related skills and cognitive strategies during treatment delivery (Bellg et al., 2004). In this study, receipt of treatment focused on ensuring the information processing strategies were effectively modelled by the researcher and learnt by the participants (Resnick et al., 2005). Feedback was provided directly to participants during intervention sessions to reinforce information processing strategy application and functional skills. The nature of PRPP Intervention requires participants to ‘talk out-loud’ and demonstrate specific functional skills, first with the therapist then independently. These aspects of the PRPP Intervention enabled the researcher to evaluate receipt of treatment by monitoring the ability of patients to understand and perform treatment-related functional skills and information processing strategies (Bellg et al., 2004).

### ***3.6.7.4 Ecological validity***

Ecological validity is an integral component of the PRPP System of Assessment and Intervention (Chapparo & Ranka, 2005, 2007). Tasks are performed, for the purposes of both assessment and intervention, in real-life contexts. This is a core intervention principle. This particular component was scored the highest by external reviewers as outlined above, receiving a mean score of 4.8 (range: 4-5) suggesting this intervention principle was consistently demonstrated in the video footage viewed by independent occupational therapists.

The research methods and results pertaining to Research Phase Four are detailed in Chapters Eight to Ten.

- Findings from the statistical analysis of Stage 2 PRPP Total% scores are presented as Chapter Eight: Nott, M. T., Chapparo, C., & Heard, R. (2008). Effective occupational therapy intervention with adults demonstrating agitation during post-traumatic amnesia. *Brain Injury*, 22(9), 669-683.
- Supplementary analysis of PRPP Stage 2 quadrant scores and Rasch hierarchy are presented in Chapter Nine.
- Findings from the visual analysis of daily ABS scores are presented as Chapter Ten: Nott, M. T., Chapparo, C., & Heard, R. Instructing information processing strategies in clients with agitation following brain injury. *Brain Injury*, (Under review; submitted 30<sup>th</sup> April 2008)





# CHAPTER FOUR

## AGITATION FOLLOWING TBI IN AUSTRALIA

### RESEARCH PHASE ONE

Chapter Four reports on the findings from Research Phase One. This paper outlines an investigation into the incidence and nature of agitated behaviour during TBI rehabilitation at a specialist rehabilitation facility in Sydney, and the functional outcomes of adults with agitation compared to those with severe TBI and no agitation. This study provides the only data from an Australian sample against which to compare the existing literature from the US.

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This journal article has been included in published format as per the guidelines of *Brain Injury*. All sources cited in the article are referenced at the end of the article, in consecutive numbered format.

Authorship statements attesting to the contribution of the researcher are included in Appendix II.

## Agitation following traumatic brain injury: An Australian sample

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### Abstract

*Purpose:* Agitation following traumatic brain injury (TBI) is perceived to limit the achievement of rehabilitation goals. The aims of this study were: (1) To examine the nature and incidence of agitation during TBI rehabilitation in an Australian sample; and (2) To explore the relationship between agitation and functional outcomes after TBI.

*Method:* Retrospective medical record review of 80 participants admitted for rehabilitation following TBI. Outcome data collected at discharge, 6 and 24 months post-discharge, included length of stay, duration of post-traumatic amnesia (PTA), community integration, functional independence and life satisfaction.

*Results:* Seventy per cent of patients demonstrated agitation during rehabilitation for an average of 32 days. Agitated patients experienced longer PTA duration, increased length of stay and reduced functional independence, specifically cognitive function, at discharge. These differences between agitated and non-agitated participants did not appear to persist and were not evident at follow-up 6 and 24 months post-discharge. Longer duration of agitation was associated with delayed PTA emergence, longer rehabilitation stay and reduced functional independence at discharge and follow-up.

*Conclusions:* A large proportion of patients with TBI experience agitation. Presence of agitation seems to limit rehabilitation gains at discharge. Longer duration of agitation is associated with persisting limitations to functional independence.

**Keywords:** Traumatic brain injury, agitation, cognition, post-traumatic amnesia, outcomes

### Introduction

Agitation is a well known sequelae of traumatic brain injury (TBI), thought to be driven by internal discomfort often exacerbated by a person's inability to appropriately perceive and understand contextual events [1]. This state of heightened activity with non-purposeful behaviour is consistent with individuals classified as 'Confused-Agitated' on the Levels of Cognitive Functioning Scale [2] and is frequently associated with disorientation to time and place, confusion and severe attention disturbance [3, 4]. More recent definitions of agitation include aspects of disinhibition, aggression, akathisia and lability

present during the period of post-traumatic amnesia (PTA) [5–7]. The pathophysiology of agitation remains poorly understood [7].

The presence of agitation is associated with low levels of cognition [8] and usually resolves prior to emergence from PTA [9]. In one study, physicians were divided in their responses regarding the temporal nature of agitation. Approximately half (52%) conceptualized agitation on a continuum present throughout the process of recovery, both during and after the resolution of PTA, while 45% of respondents reported that agitation was limited to the PTA period [10].

The ‘Confused-Agitated’ state is thought of as a stage in the recovery process following TBI [5]. Agitation is most prevalent during the acute stage of recovery, particularly at coma emergence, with reported incidence rates of between 11–96% [11, 12]. Studies conducted during the rehabilitation stage of recovery following TBI report incidence of agitation between 36–57% [13–16], with the variability of these values appearing to result from inconsistent definitions and data collection techniques.

Attempts to determine pre-morbid or injury related correlates of agitation following TBI have produced inconclusive evidence. Gender does not appear to influence the incidence or intensity of agitation [16]. Pre-morbid factors such as presence of depression, poor social functioning and a history of alcohol and/or substance abuse are significantly associated with aggressive behaviour, however a relationship with agitation is not evident [17]. Fleming [18] states that substance misuse and or withdrawal from addictive substances can exacerbate agitation and aggressive behaviour following TBI.

Denny-Brown [19] suggested that the presence of agitation during TBI recovery may be an important predictor of outcome, reporting that ‘excited and restless’ behaviours were associated with delayed return to work. A higher incidence of psychiatric problems [13], excessive anxiety and depression, greater thought disturbance and a general increase in psychopathology were evident in an agitated group as compared to those without agitated behaviour during acute admission [20]. The presence of agitation has been associated with greater length of stay in rehabilitation and poorer cognitive function at discharge [15]. Agitated patients require a greater level of supervision at discharge, necessitating admission to alternative medical facilities in order to provide the required level of supervision [13, 15].

In summary, agitation occurs in a large proportion of TBI survivors and has a significant and adverse impact on rehabilitation outcomes. Reports of the incidence of agitation following TBI vary widely between 11–96% [11–16], with poor inter-study standardization in terms of data definitions and data collection. Studies have been conducted primarily in the USA, with limited data available from other countries to enable comparison or to set a broader context. On this background, the current research aimed to (1) examine the nature and incidence of agitation during rehabilitation following TBI in an Australian sample and (2) determine the relationship between the presence and duration of agitation with medium- and long-term functional outcomes following discharge from inpatient rehabilitation.

## Method

### Sample characteristics

This sample included 80 participants who were (1) admitted to a specialist TBI rehabilitation facility in Sydney, Australia, (2) had sustained a TBI and (3) had previously consented to participate in an established longitudinal outcome study [21].

Pre-morbid and injury related characteristics were obtained from medical records and a database established at the rehabilitation facility (see Table I). Indicators of injury severity were lowest Glasgow Coma Scale (GCS) score within the first 24 hours, time to commence rehabilitation (in days), duration of PTA (in days measured using the Westmead PTA Scale [22]) and length of hospital admission (in days). Data on psychiatric and substance use history were collected from participants and their significant others.

### Development of the data collection model

Agitation related data were collected retrospectively from medical records. Several processes were undertaken to define the data set and enhance reproducibility of results. First, a data collection model was developed following an extensive review of agitation related literature. This generated a list of terms to classify and categorize agitation from sources such as behavioural descriptions of agitation, definitions proposed by experts in this field of study, behaviour rating scales used to measure cognition and agitation following TBI and definitions derived from diagnostic manuals [1–6, 10, 12, 19, 20].

Table I. Pre-morbid and injury related characteristics of sample.

Characteristic	Value
Age in years, mean (SD)	35.1 (13.8)
Education in years, mean (SD)	11.6 (3.3)
Gender	
Male	71.2%
Female	28.8%
Previous head injury	
Yes	3.8%
No	96.2%
History of substance use	
Yes	12.8%
No	87.2%
Psychiatric history	
Yes	3.8%
No	96.2%
Injury severity, GCS mean (SD)	7.1 (3.9)
Severe	43.1%
Moderate	33.3%
Mild	23.6%
Time to rehabilitation in days, mean (SD)	29.7 (32.9)
PTA duration in days, mean (SD)	59.9 (88.8)
Length of stay in days, mean (SD)	121.2 (153.6)

Secondly, five medical records were reviewed to determine the number of ways that agitated behaviour was described during therapy activities, nursing care tasks, medical interventions, visits from family and friends and when not engaged in activity. Further details were available from formal team meetings to document patient progress, goal-setting and family feedback meetings. This process resulted in an extensive list of 31 terms used to describe cognitive processes and behaviours consistent with agitation.

Finally, the terminology used in the literature was matched with that used in the medical record review to determine if the documented behaviour was classified as representative of agitation or not. This process produced the list of 24 terms used in the final data collection model (as indicated in Table II).

*Operational definitions*

For this study, agitation was considered present when at least two agitated behaviours were recorded in the participant’s medical record during any one day. Recording of only one of these behaviours was not considered to be sufficient evidence of agitation. Data were then collected from the medical records for every day of the hospital admission. This way it was possible to ensure that all agitated events were recorded, as well as ensuring the accuracy of time dependent data (onset and duration of agitation).

Time to onset of agitation was measured in days from the date of injury to the first day of meeting the criteria for agitation. Duration of agitation was measured by the number of days from first to last recording of agitated behaviour in the participant’s medical record. Time dependent data were calculated for a smaller sample for whom full medical records were available. Part of the sample received acute care at alternative hospitals prior to transfer for rehabilitation. Medical records of acute admissions were not available for these participants. Severity was measured by calculating the total

number of co-exhibited agitated behaviours demonstrated by each participant.

*Functional outcome measures*

Outcome data on various measures of functional independence, behavioural adjustment and community integration were collected via survey at discharge, 6 and 24 months post-discharge. Outcome measures collected at the time of discharge included the length of rehabilitation admission and duration of PTA as measured by the Westmead PTA Scale. Functional independence in cognitive and motor activity was assessed using the Functional Assessment Measure (FAM [23]) at discharge from rehabilitation and at 6- and 24-month follow-ups. The Community Integration Questionnaire (CIQ [24]) examined the extent of integration into home, social and productivity domains. Behavioural adjustment was indexed by the Overt Aggression Scale (OAS [25]) and each participant’s global satisfaction with life was measured by the Satisfaction with Life Scale (SWLS [26]).

*Statistical analysis*

Descriptive analysis was used to measure the incidence of agitation, describe frequency of behaviours and measure agitation duration. Independent *t*-tests examined differences between agitated and non-agitated groups on normally distributed functional outcomes at discharge, 6- and 24-months post-discharge. Mann-Whitney tests were performed when distributions were not normal. Statistically significant difference was set at  $p < 0.05$  for all analyses. As multiple tests were performed, the rate of a Type I error occurring is higher. The Type I error rate was not adjusted for each comparison as to do so would have inflated Type II error rate, given the small sample. Readers should take note of this when considering results. Spearman’s rank order correlations were used to measure the association between duration of agitation with functional

Table II. Terms used in data collection model.

Agitated behaviours	
- Restlessness/excessive movement	- Verbally aggressive/screams
- Pulls at tubes or restraints	- Aggressive towards others/property
- Thrashing in bed	- Explosive and/or unpredictable anger
- Rocking/rubbing/moaning	- Self abusive, verbal and/or physical
- Wanders	- Sudden changes in mood
- General agitation	- Emotional lability
- Disinhibition	- Rapid, loud or excessive talking
- Impulsive/impatient	- Makes unusual noises
- Low tolerance to pain/frustration	- Inappropriate verbalizations
- Irritable	- Inappropriate gestures
- Combative	- Bizarre behaviour/delusions
- Uncooperative/resistive to care	- Perseveration—motor or verbal

outcomes at discharge from rehabilitation, at 6- and 24-months post-discharge.

## Results

### *Nature and incidence of agitation*

Agitation was present in 70.0% ( $n = 56$ ) of this sample during rehabilitation following TBI. Acute admission data is also available for a sub-set of 51 participants who received acute medical management at the same facility where this study was conducted. Agitation incidence during the acute admission for the acute group was more prevalent (86.3%;  $n = 44$ ). A statistically significant difference between acute and rehabilitation incidence was evident (binomial probability  $p = 0.004$ ). Agitation incidence decreased between acute and rehabilitation admissions. The most frequently reported behaviours are outlined in Table III. Broad descriptive terms such as general agitation, restlessness, uncooperative, perseverative and impulsive were most commonly reported in medical records.

The onset of agitated behaviour varied over a wide range, with reports of some participants demonstrating agitated behaviour on the day of injury, through to the 322nd day following injury in one participant. This participant had an extended period of coma and minimal responsiveness, thus increasing the time to onset of this participant. Following exclusion of this outlier, the time to onset of agitated behaviour ranged from the day of injury to 41 days after injury. The mean time to onset of agitated behaviour was 6.7 days ( $SD = 9.9$ ) after injury.

The duration of agitation varied from 1–217 days from first to last recording in the medical record. Agitation persisted for longer than 3 months in three participants. These three outliers were excluded from further statistical analysis, reducing the maximum duration to 81 days. Agitation persisted for a mean duration of 23.9 days ( $SD = 20.9$ ).

As an indicator of agitation severity, the number of behaviours co-exhibited by each participant was calculated from the possible list of 24 agitation related behaviours. The mean number of co-exhibited behaviours was 7.9 behaviours ( $SD = 3.5$ ), with

a range of 2–17 behaviours demonstrated simultaneously. Participants demonstrating 0 or 1 agitated behaviour only did not meet the criterion established for presence of agitation.

### *Agitation and post-traumatic amnesia*

Whilst current definitions of agitation confine agitated behaviour to the period of PTA, the experience of clinicians suggests that agitation exists on a continuum, present both during and after the resolution of PTA [10]. Comparison between PTA emergence date and the last date when agitated behaviour was recorded in the participant's medical record showed that recordings of agitated behaviour continued past the date of PTA emergence in 15 cases (26.8%). In these cases, agitated behaviour could be classified as chronic agitation, which is evident towards later stages of PTA emergence. This is contrasted with acute or indirect agitation, usually observed during the period of PTA [10]. In general, agitation improved within a short time following the resolution of PTA. The mean was 11.5 days following PTA resolution ( $SD = 15.1$ ) with a range of 1–54 days.

### *Relationship between presence of agitation and outcome measures*

The second aim of this research was to determine the relationship between presence and duration of agitation with various functional outcomes, measured at discharge, 6- and 24-months post-discharge.

Mean differences between agitated and non-agitated groups on discharge measures are shown in Table IV. Statistical analysis suggests the agitated group had a longer mean PTA duration and rehabilitation length of stay than the non-agitated group. The agitated group had lower mean scores on the FAM Total score and the cognitive sub-scale, but did not differ from the non-agitated group on the FAM Motor sub-scale at time of discharge.

Examining follow-up data shows that FAM Motor, FAM Cognitive and FAM Total scores improved for both groups after discharge ( $F_{1,63} = 21.9$ ,  $p < 0.001$ ;  $F_{1,63} = 89.9$ ,  $p < 0.001$ ;  $F_{1,63} = 86.4$ ,  $p < 0.001$ , respectively). For FAM Cognitive and FAM Total, the improvement over time resulted in the two groups becoming more similar at 6 and 24 months than at discharge ( $F_{1,63} = 10.1$ ,  $p = 0.002$ ;  $F_{1,63} = 9.5$ ,  $p = 0.003$ ).

Mean differences between groups at 6-months and again at 24-months were not statistically significant on measures of community integration (CIQ), overt aggressive behaviour (OAS) and life satisfaction (SWLS). Mean scores remained stable throughout the 2-year follow-up period on these measures.

Table III. Most frequently recorded agitated behaviours.

Behaviour recorded	<i>n</i>	%
General agitation	42	52.5
Restlessness	36	45.0
Uncooperative/resistive to care	35	43.8
Impulsive/impatient	31	38.8
Perseveration—motor or verbal	26	32.5
Pulls at tubes or restraints	25	31.3



*Relationship between duration of agitation and outcome measures*

Correlational analyses involving duration of agitation excluded the three outliers mentioned previously. The removal of these outliers did not alter these results. A moderate correlation is evident between increased duration of agitation with increased rehabilitation length of stay and longer PTA duration (Table V). A mild–moderate negative

correlation with FAM scores was identified, suggesting that increased duration of agitation is related to lower scores on the FAM at discharge from rehabilitation. All correlations between duration of agitation and discharge outcome variables were statistically significant.

Negative correlations between duration of agitation and FAM scores were also observed at the 6- and 24-month follow-ups. The association was mild–moderate and statistically significant

Table IV. Differences between agitated and non-agitated groups.

	<i>n</i>	Agitated	Non-agitated	Statistic	<i>p</i>
Outcomes at discharge					
Length of rehabilitation (days)	80	44.6	31.0	U = 443.0	0.02*
Duration of PTA (days)	70	39.9	26.0	U = 319.0	0.01*
FAM–Total	78	173.8	188.7	<i>t</i> = 2.0	0.05*
FAM–Cognitive sub-scale	78	72.2	83.8	<i>t</i> = 3.1	<0.01*
FAM–Motor sub-scale	78	101.7	104.9	<i>t</i> = 0.8	0.46
Outcomes at 6-months post-discharge					
FAM–Total	67	191.4	197.32	<i>t</i> = 0.7	0.50
FAM–Cognitive sub-scale	67	86.0	91.21	<i>t</i> = 1.3	0.19
FAM–Motor sub-scale	67	105.4	106.11	<i>t</i> = 0.1	0.89
OAS	67	1.8	2.45	<i>t</i> = 1.0	0.31
SWLS	61	16.6	18.11	<i>t</i> = 0.6	0.54
CIQ	66	12.8	13.50	<i>t</i> = 0.5	0.60
Outcomes at 24-months post-discharge					
FAM–Total	80	198.6	203.3	<i>t</i> = 0.7	0.48
FAM–Cognitive sub-scale	80	91.5	94.1	<i>t</i> = 0.9	0.36
FAM–Motor sub-scale	80	107.1	109.1	<i>t</i> = 0.5	0.60
OAS	80	1.8	2.3	<i>t</i> = 0.9	0.35
SWLS	77	16.5	16.1	<i>t</i> = –0.2	0.86
CIQ	80	13.0	13.5	<i>t</i> = 0.4	0.70

\*Difference between groups is significant at the  $p \leq 0.05$  level.  
U = Mann-Whitney test; *t* = *t*-test.

Table V. Spearman’s correlations between agitation duration and outcome measures.

	<i>n</i>	<i>r<sub>s</sub></i>	<i>P</i>
Outcomes at discharge			
Length of stay	48	0.62	$\leq 0.001^{**}$
Duration of PTA	41	0.58	$\leq 0.001^{**}$
FAM–Total	46	–0.56	$\leq 0.001^{**}$
FAM–Cognitive sub-scale	46	–0.58	$\leq 0.001^{**}$
FAM–Motor sub-scale	46	–0.33	0.03*
Outcomes at 6-months post-discharge			
FAM–Total	42	–0.47	0.003*
FAM–Cognitive sub-scale	42	–0.48	0.002*
FAM–Motor sub-scale	42	–0.30	0.07
OAS	43	–0.06	0.70
SWLS	39	–0.14	0.38
CIQ	42	–0.28	0.07
Outcomes at 24-months post-discharge			
FAM–Total	51	–0.34	0.02*
FAM–Cognitive sub-scale	51	–0.34	0.02*
FAM–Motor sub-scale	51	–0.35	0.01*
OAS	51	–0.03	0.81
SWLS	49	0.00	0.99
CIQ	51	–0.24	0.08

\*Correlation is significant at the  $p \leq 0.05$  level; \*\*Correlation is significant at the  $p \leq 0.001$  level.

(Table V), indicating that increased duration of agitation is related to lower FAM scores at both follow-up points. Duration of agitation and the remaining outcome variables (satisfaction with life, overt aggression and community integration) did not show statistically significant associations.

## Discussion

This study sought to explore agitation following TBI in an Australian sample and to examine the impact of agitation on post-rehabilitation functional outcomes. Agitated behaviour was recorded with high prevalence during both acute recovery and rehabilitation following TBI. The incidence of agitated behaviour reduced from the acute phase (86.3%) to the rehabilitation stage (70.0%) as would be expected based on previous studies of agitation incidence. Acute levels of agitation are similar to Rao et al.'s [11] sample of coma emerging patients, of whom 96% demonstrated agitated behaviour. In contrast, only 11% of Brooke et al.'s [12] sample demonstrated agitated behaviour, with 35% demonstrating restlessness during acute recovery. The level of agitation during rehabilitation in this Australian sample is higher than previously reported incidence rates [11, 13–15]. Data collection methods and the context of the study may possibly have contributed to this result. Data collection in this study involved chart review, with the presence of agitation being identified through reporting of at least two of the 24 behaviours listed in Table II. The broad definition used to identify agitated behaviour from medical records may have contributed to a higher representation of agitation in this sample. Prospective measures of agitation using the Agitated Behaviour Scale have revealed lower levels of agitation in a rehabilitation population; 36% [15] and 50% [16]. In addition, this study was conducted at a specialized brain injury rehabilitation facility that provides both short- and long-term rehabilitation programmes. The incidence and duration of agitation shown by these participants may be an indicator of injury severity, typically demonstrated by individuals who are targeted for referral to the long-term rehabilitation programme offered by the facility.

The temporal relationship between agitation and PTA was examined in this study. In 25% of cases, agitated behaviour was reported in the medical record after emergence from PTA. The order of PTA emergence and agitation improvement is not concrete. In some cases, agitated behaviour persists for long periods of time beyond the resolution of PTA. Corrigan and Mysiw's [8] study of agitation and cognition also demonstrated that cognition improves before agitation in participants with low

levels of cognitive ability and high levels of agitation and is contrasted by those for whom improvements in agitation precede improvements in cognition.

Agitation has been considered by the rehabilitation team to be a major limiting factor to participation in rehabilitation and achievement of functional outcomes [6], a finding in part supported by this study. Outcomes collected at the time of discharge highlight differences between agitated and non-agitated groups with respect to length of stay, duration of PTA and functional achievements, particularly cognitive abilities. These findings are consistent with previous results demonstrating a relationship between presence of agitation and increased PTA duration [14], lengthier rehabilitation stay [11, 15] and reduced cognitive score on functional independence measures at discharge [15].

Following discharge, the differences between agitated and non-agitated groups were not significant. Long-term functional gains were equivalent for each group in areas of functional independence, life satisfaction and level of integration into the community. This supports Bogner et al.'s [15] findings that life satisfaction and productivity, measured 1 year following discharge, were not different between agitated and non-agitated groups.

Within the agitated group, longer duration of agitation was associated with greater length of stay, increased duration of PTA and lower functional independence scores for cognitive and motor abilities. The relationship between duration of agitation and functional independence was observed throughout the study timeframe. A negative correlation persisted at both 6- and 24-month follow-up points. This finding suggests that between-group differences may not be apparent longer-term, but within the agitated group, those who experienced more persistent agitation continue to experience an impact for up to 2 years following discharge from rehabilitation. The duration of agitation has previously been identified as a significant predictor of length of stay and discharge destination from rehabilitation [15]. Agitation lasting longer than 26 days has been associated with decreased likelihood for discharge home [15].

Some limitations to this study should be noted. The data collection model employed was intentionally expansive to ensure that all behaviours representative of agitation could be included. Some of these behaviours are not exclusive to the state of agitation. To reduce the risk of over representing the incidence of agitation, the operation definition of agitation required that at least two behaviours were recorded to determine presence of agitation. A further limitation involves the retrospective collection of data, precluding the use of a standardized measure of agitation such as the Agitated

Behaviour Scale [5] to minimize subjectivity in data collection. Additional limitations were evident when collecting data from medical records. Various intervention methods were implemented to minimize agitation, however these could not be controlled for when reporting incidence rates or duration of these behaviours. The final limitation rests with the representativeness of this sample. The sample of 80 participants was drawn from one institution which could limit generalization. In addition, these 80 participants were participants in another longitudinal study being conducted over a 2-year period following discharge from rehabilitation. This sample may not represent other people who did not consent to participate in the previously established study.

### Conclusion

There is a high incidence of agitation in acute rehabilitation following TBI, first noted a mean of 6 days post-injury and persisting for an average of 24 days. In 25% of cases, agitation was evident after the resolution of PTA. The presence of agitation during rehabilitation seems to limit an individual's ability to engage in rehabilitation and has a direct impact on length of stay, duration of PTA and functional independence at discharge. It is encouraging that differences between agitated and non-agitated patients are not directly related to achieving further functional gains following discharge. Both agitated and non-agitated groups were able to continue to make functional gains and experienced similar levels of life satisfaction and community integration.

Differences within the agitated group were evident. Participants with more persistent agitation during rehabilitation demonstrated reduced functional independence in the areas of motor and cognitive recovery up to 2 years following discharge. The duration of agitation appears to be the strongest correlate of poor functional performance. Future research could evaluate whether limiting the duration of agitated behaviour with effective management could improve longer-term functional outcome. Use of standard, formal measures of agitation and cognition during this stage of recovery are essential to a better understanding of these behaviours and for the planning and monitoring of interventions.

### References

1. Plylar PA. Management of the agitated and aggressive head injury patient in an acute hospital setting. *Journal of Neuroscience Nursing* 1989;21:353–356.
2. Hagan C, Malkmus D, Durham P. Levels of cognitive functioning. Rehabilitation of the head injured adult: Comprehensive cognitive management. Downey, CA: Professional Staff Association of Rancho Los Amigos Hospital, Inc; 1979.
3. Galski T, Palasz J, Bruno RL, Walker JE. Predicting physical and verbal aggression on a brain trauma unit. *Archives of Physical Medicine & Rehabilitation* 1994;75:380–383.
4. Katz DI. Neuropathology and neurobehavioral recovery from closed head injury. *Journal of Head Trauma Rehabilitation* 1992;7:1–15.
5. Corrigan JD, Bogner JA. Factor structure of the Agitated Behavior Scale. *Journal of Clinical & Experimental Neuropsychology* 1994;16:386–392.
6. Sandel ME, Mysiw WJ. The agitated brain injured patient. Part 1: Definitions, differential diagnosis, and assessment. *Archives of Physical Medicine & Rehabilitation* 1996;77:617–623.
7. Lombard LA, Zafonte RD. Agitation after traumatic brain injury: Considerations and treatment options. *American Journal of Physical Medicine and Rehabilitation* 2005;84:97–812.
8. Corrigan JD, Mysiw WJ. Agitation following traumatic head injury: Equivocal evidence for a discrete stage of cognitive recovery. *Archives of Physical Medicine & Rehabilitation* 1988;69:487–492.
9. Van der Naalt J, Van Zomeren AH, Sluiter WJ, Minderhoud JM. Acute behavioural disturbances related to imaging studies and outcome in mild-to-moderate head injury. *Brain Injury* 2000;14:781–788.
10. Fugate LP, Spacek LA, Kresty LA, Levy CE, Johnson JC, Mysiw WJ. Definition of agitation following traumatic brain injury: I. A survey of the Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation. *Archives of Physical Medicine & Rehabilitation* 1997;78:917–923.
11. Rao N, Jellinek HM, Woolston DC. Agitation in closed head injury: Haloperidol effects on rehabilitation outcome. *Archives of Physical Medicine & Rehabilitation* 1985;66:30–34.
12. Brooke MM, Questad KA, Patterson DR, Bashak KJ. Agitation and restlessness after closed head injury: A prospective study of 100 consecutive admissions. *Archives of Physical Medicine & Rehabilitation* 1992;73:320–323.
13. Reyes RL, Bhattacharyya AK, Heller D. Traumatic head injury: Restlessness and agitation as prognosticators of physical and psychologic improvement in patients. *Archives of Physical Medicine & Rehabilitation* 1981;62:20–23.
14. Maryniak O, Manchanda R, Velani A. Methotrimeprazine in the treatment of agitation in acquired brain injury patients. *Brain Injury* 2001;15:167–174.
15. Bogner JA, Corrigan JD, Fugate L, Mysiw WJ, Clinchot D. Role of agitation in prediction of outcomes after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation* 2001;80:636–644.
16. Kadyan V, Mysiw WJ, Bogner JA, Corrigan JD, Fugate LP, Clinchot DM. Gender differences in agitation after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation* 2004;83:747–752.
17. Tateno A, Jorge RE, Robinson RG. Clinical correlates of aggressive behavior after traumatic brain injury. *Journal of Neuropsychiatry & Clinical Neurosciences* 2003;15:155–160.
18. Fleminger S. Managing agitation and aggression after head injury: Minimum use of drugs and early care in rehabilitation units are recommended. *BMJ* 2003;327:4–5.



19. Denny-Brown D. Disability arising from closed head injury. *JAMA* 1945;127:429-436.
20. Levin HS, Grossman RG. Behavioral sequelae of closed head injury. A quantitative study. *Archives of Neurology* 1978;35:720-727.
21. Felmingham KL, Baguley IJ, Crooks J. A comparison of acute and postdischarge predictors of employment 2 years after traumatic brain injury. *Archives of Physical Medicine & Rehabilitation* 2001;82:435-439.
22. Shores EA, Marosszeky JE, Sandanam J, Batchelor J. Preliminary validation of a clinical scale for measuring the duration of post traumatic amnesia. *Medical Journal of Australia* 1986;144:569-572.
23. Hall KM, Hamilton BB, Gordon WA, Zasler ND. Characteristics and comparisons of functional assessment indices: Disability Rating Scale, Functional Independence Measure and Functional Assessment Measure. *Journal of Head Trauma Rehabilitation* 1993;8:60-74.
24. Sander AM, Fuchs KL, High Jr WM, Hall KM, Kreutzer JS, Rosenthal M. The Community Integration Questionnaire revisited: An assessment of factor structure and validity. *Archives of Physical Medicine & Rehabilitation* 1999;80:1303-1308.
25. Yudofsky SC, Silver JM, Jackson W, Endicott J, Williams D. The Overt Aggression Scale for the objective rating of verbal and physical aggression. *American Journal of Psychiatry* 1986;143:35-39.
26. Diener E, Emmons RA, Larsen RJ, Griffin S. The Satisfaction with Life Scale. *Journal of Personality Assessment* 1985;49:71-75.

## CHAPTER FIVE

### MEASURING INFORMATION PROCESSING IN A CLIENT WITH AGITATION FOLLOWING TBI

#### RESEARCH PHASE TWO

Chapter Five reports on the findings from Research Phase Two. This paper outlines an in-depth case study of one adult during rehabilitation following severe TBI. This study evaluated the clinical utility of the PRPP System of Task Analysis for assessing how a person with severely agitated behaviour applied information processing strategies during occupational performance, and how strategy application changed over time. This study adds to the developing body of knowledge describing use of the PRPP System in rehabilitation. A novel graphical approach to presentation of findings was integrated into the case study.

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Authorship statements attesting to the contribution of the researcher are included in Appendix II.

## Research Article

# Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis

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**Background/Aims:** Agitation following traumatic brain injury is characterised by a heightened state of activity with disorganised information processing that interferes with learning and achieving functional goals. This study aimed to identify information processing problems during task performance of a severely agitated adult using the Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis. Second, this study aimed to examine the sensitivity of the PRPP System to changes in task performance over a short period of rehabilitation, and third, to evaluate the guidance provided by the PRPP in directing intervention.

**Methods:** A case study research design was employed. The PRPP System of Task Analysis was used to assess changes in task embedded information processing capacity during occupational therapy intervention with a severely agitated adult in a rehabilitation context. Performance is assessed on three selected tasks over a one-month period.

**Results:** Information processing difficulties during task performance can be clearly identified when observing a severely agitated adult following a traumatic brain injury. Processing skills involving attention, sensory processing and planning were most affected at this stage of rehabilitation. These processing difficulties are linked to established descriptions of agitated behaviour. Fluctuations in performance across three tasks of differing processing complexity

were evident, leading to hypothesised relationships between task complexity, environment and novelty with information processing errors. Changes in specific information processing capacity over time were evident based on repeated measures using the PRPP System of Task Analysis. This lends preliminary support for its utility as an outcome measure, and raises hypotheses about the type of therapy required to enhance information processing in people with severe agitation.

**Conclusions:** The PRPP System is sensitive to information processing changes in severely agitated adults when used to reassess performance over short intervals and can provide direct guidance to occupational therapy intervention to improve task embedded information processing by categorising errors under four stages of an information processing model: Perceive, Recall, Plan and Perform.

**KEY WORDS** Assessment, brain injuries, case reports, cognition, information processing.

## Introduction

Recovery from traumatic brain injury (TBI) can be conceptualised along a continuum. At different stages of rehabilitation, people demonstrate unique cognitive and behavioural sequelae described by the Rancho Levels of Cognitive Functioning Scale (Hagen, 2001; Hagen, Malkmus & Durham, 1979), a 10-level behavioural rating scale that illustrates the theoretical reorganisation of cognitive abilities from vegetative to functional states (see Table 1).

Level IV is characterised by confused and agitated behaviour. Information processing is disorganised and learning outcomes are poor. The broadly defined cognitive and behavioural characteristics of 'Level IV — Confused and Agitated' are outlined below (Hagen, 2001; Hagen *et al.*, 1979):

1. A heightened state of activity with severely limited ability to process information from the surrounding environment.
2. Inability to follow commands without the presence of external structure.

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**TABLE 1:** *Rancho Levels of Cognitive Functioning Scale*

Rancho Los Amigos Levels of Cognitive Functioning	
Level	Cognitive and behavioural description
I	Unresponsive to stimuli: no response
II	Generalised response: non-specific, inconsistent, and non-purposeful reaction to stimuli
III	Localised response: response directly related to type of stimulus but still inconsistent or delayed
IV	Confused-agitated: response heightened, severely confused, may be aggressive
V	Confused-inappropriate: some response to simple commands, but confusion with more complex commands; high level of distractibility
VI	Confused-appropriate: response more goal directed but needs cues
VII	Automatic-appropriate: response robot-like, judgement and problem-solving lacking
VIII	Purposeful-appropriate (with standby assistance): response adequate to familiar tasks, but subtle impairments require standby assistance with acknowledging other people's needs and perspectives, modifying plans
IX	Purposeful-appropriate (with standby assistance on request): responds effectively to familiar situations but generally needs cues to anticipate problems and adjust performance; low frustration tolerance possible
X	Purposeful-appropriate (modified independent): responds adequately to multiple tasks but may need more time or periodic breaks; independently employs cognitive compensatory strategies and adjusts tasks as needed

3. Behaviour that is considered out of proportion to the stimulus.
4. Inability to focus attention to a specific task without frequent redirection.
5. Inappropriate verbalisation with confabulation.
6. Severely impaired memory with the confusion of present and past events.
7. Minimal initiation of daily living tasks.
8. Inability to discriminate between persons or objects in the surrounding environment.
9. Severely limited ability to learn new information although performance of previously learned tasks may occur in a structured environment.
10. Restlessness or a desire to wander with the intention of 'going home'.

Agitation is thought to be driven by internal discomfort, often exacerbated by a person's inability to appropriately perceive and understand contextual

events (Plylar, 1989). This state of heightened activity is characterised by non-purposeful behaviour, disorientation to time and place, confusion, and severe attention disturbance (Galski, Palasz, Bruno & Walker, 1994; Katz, 1992). Definitions of agitation highlight disinhibition, aggression, akathisia/restlessness and lability, and link them to the post-traumatic amnesic state (Corrigan & Bogner, 1994; Sandel & Mysiw, 1996). Therapists working in brain injury rehabilitation report that agitation interferes with the achievement of functional goals (Sandel & Mysiw). They describe feelings of frustration with the difficulties presented by challenging behaviour associated with extended periods of agitation (Montgomery, Kitten & Niemiec, 1997). Evidence suggests that early agitation in TBI results in long-term disturbances in mood and antisocial behaviour (Greve *et al.*, 2001). The extent of these behavioural disorders seems to be independent of factors such as time since injury, age at injury, gender and severity of injury (Lazaro, Butler & Fleminger, 2000). Despite documentation of the significant impact of agitation on function, there is inadequate information available on the effects of therapeutic, psychological, or pharmacological interventions (Bogner, Corrigan, Fugate, Mysiw & Clinchot, 2001; Perino, Rago, Ciolini, Torta & Monaco, 2001). Therefore, there is limited guidance for occupational therapists about effective assessment and intervention strategies for this clinical population. Reviews of rehabilitation for people with agitation following TBI conclude that insufficient evidence is available to guide effective practice, and have called for the development of more targeted interventions that consider the variety of organic, environmental and social influences on behaviour (Gordon *et al.*, 2006).

Case studies describing people with diagnoses other than TBI, who exhibit behavioural disturbances similar to agitation, have demonstrated successful occupational therapy outcomes from intervention based on the behavioural principles of systematic instruction (Giles & Shore, 1989; Katzmann & Mix, 1993; Webb, 1991). Methods of therapy instruction used in these case studies have included task analysis, prompting (Alberto & Troutman, 2002), reinforcement (Alberto & Troutman; Westling & Fox, 2004), and error-free learning (Giles & Shore, 1989; Wilson & Evans, 1996). One case study in brain injury literature (Nicholls & Chapparo, 1993) demonstrated effective use of methods of systematic instruction to assist a woman with severe agitation to re-learn the self-care task of eating. While these reports provide some evidence that the application of behavioural and systematic instruction enhances procedural learning of everyday tasks in people who have disordered cognition, little is known about any concomitant changes in information processing, or thinking strategies that underlie this learning.

Processing strategies are defined as organised thinking tactics that guide the processing of information (Toglia, 1998). A major aspect of information processing for occupational performance depends on the ability to select the most appropriate processing strategies that result in efficient use of information. Information processing during everyday tasks that is reported to be most vulnerable in people with severe agitation includes allocation of attention, planning and sequencing complex tasks, and self-monitoring performance (Radomski, 2002; Toglia). While adults with TBI agitation often demonstrate an ability to perform previously well-learned tasks, they have difficulty performing the same tasks under changed conditions (Schacter, Wagner & Buckner, 2000). This has led to a commonly held view that learning, and therefore active rehabilitation, is not effective during this stage of recovery (Radomski).

This paper investigates the changes in information processing that occur during intervention for a client with TBI-related agitation using the Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis (Chapparo & Ranka, 1998). The PRPP System is an emerging assessment system that measures both task performance and information processing performance over time and in context, affording therapists a mechanism to measure performance and processing intervention outcomes. This assessment system is particularly relevant for assessing agitated adults following TBI during the period of post-traumatic amnesia (PTA), as the assessment is observation based, and utilises activity and task performance as the context of the assessment, rather than the use of written, language-based assessments that can be limited in their application to adults with TBI during the period of PTA (Fry & O'Brien, 2002).

### **The Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis**

The PRPP System is a standardised, two-stage, criterion-referenced assessment. It examines the effectiveness of information processing through task analysis methodology, and enables simultaneous measurement of occupational mastery, information processing capacity, and contextual influences (Chapparo & Ranka, 1998). Stage 1 of the PRPP System employs a standard behavioural task analysis, whereby everyday task performance is broken down into steps, and errors in performance are identified (Kirwan & Ainsworth, 1992), generating an overall measure of ability to do specific and relevant occupations. Stage 2 of the PRPP System uses a cognitive task analysis and is the focus of this paper. Cognitive task analysis is directed at the processes underlying performance, specifically the ability to process cues to performance in context. The information

processing strategies measured on the PRPP include attention and sensory perception (Perceive), memory (Recall), response planning and evaluation (Plan), and performance monitoring (Perform). These are illustrated in the central quadrants of the PRPP System's theoretical model (Chapparo & Ranka, 2005; Fig. 1).

The Perceive quadrant outlines functions for gathering sensory information from the environment in order to form sensory images of one's body and the task environment. Processing of information in this quadrant determines what is attended to, what form an object or body part takes and what is or is not central to task completion. The second quadrant, Recall, involves a constant comparison between the sensory information with the previously stored information, in order to make sense of what is being perceived, or to determine its importance. Recognition and retrieval are the two primary information processing procedures enacted at this stage. Sensory and stored information is used to map out and program responses in the Plan quadrant. Planning involves executive skills such as critical thinking, ideating, reasoning, and decision-making to construct and evaluate goal-orientated strategies for novel or complex situations. The final quadrant, Perform, involves processes that prompt the carrying out and monitoring of responses required for performance and during performance (Chapparo & Ranka, 1998). The PRPP System has demonstrated reliability and validity when used with other diagnostic groups and has shown potential to overcome the limitations of other standardised and formal assessments when assessing adults with TBI (Fry & O'Brien, 2002), particularly during the agitated period of recovery. The purpose of this paper is to report on initial investigations of its ability to measure information processing changes that occur during occupational therapy intervention for clients with agitation.

### **Methods**

A case study research design was employed to investigate information processing abilities and changes to these abilities over time, in a severely agitated adult (Bailey, 1998; Yin, 2002). A number of research questions were investigated.

1. Can the PRPP System of Task Analysis identify information processing problems during task performance of a severely agitated adult following TBI?
2. Is the PRPP System of Task Analysis sensitive to changes in task performance over a 4-week period during brain injury rehabilitation?
3. What guidance does the PRPP System of Task Analysis provide to direct occupational therapy intervention for an adult with severe agitation following TBI?

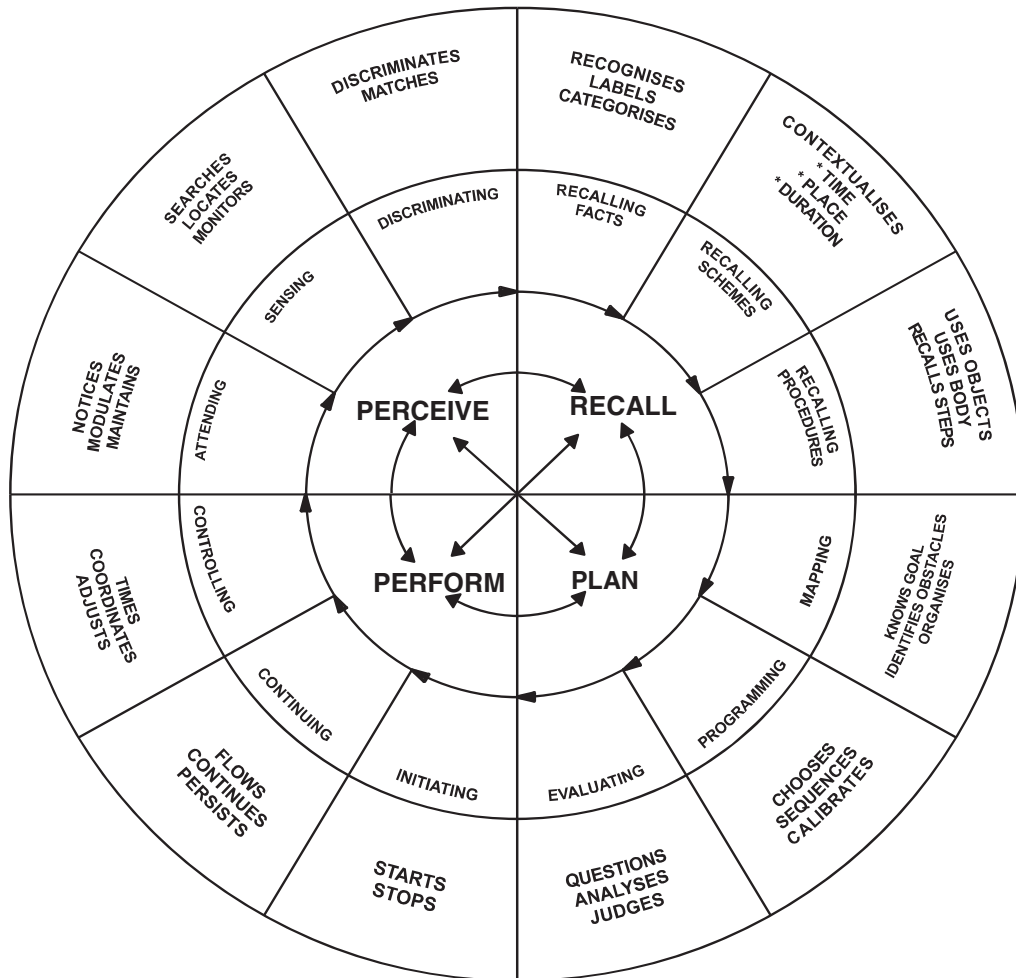


FIGURE 1: The Perceive, Recall, Plan and Perform System of Task Analysis.

Single-case study research designs have been acknowledged to contribute important information to the rehabilitation of adults with brain injury (Slifer *et al.*, 1993). In some instances, they are the preferred method of determining treatment efficacy because of the problems associated with group methodologies used with a larger, heterogeneous population (Swan & Alderman, 2004). A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context (Yin, 2002). Case study methodology is suited to situations where little is known about a new phenomenon, when studying problems of professional practice significance, involving a number of human factors (Salminen, Harra & Lautamo, 2006), or when generating an hypothesis for study (Ragin & Becker, 1992; Stake, 1995; Yin, 2002).

The focus of this study was to explore the changes in information processing in a client with severe agitation during one month of occupational therapy intervention, as measured by the PRPP System of Task Analysis. Occupational therapy intervention was

applied to a situation of practical significance that involved a number of human factors that had previously proved difficult to measure, namely information processing during task performance under conditions of severe agitation following brain injury. The purpose of the study was to generate further hypotheses about the nature of information processing deficits during agitation, and to determine whether the assessment tool used to measure treatment effectiveness could be used in research involving larger numbers. Specifically, this study used an embedded, critical case study design, whereby the researchers selected a 'typical' subject who represented the target client group to be studied in the future (Miles & Huberman, 1994; Yin, 2003). The client described in this study was thought of as a 'critical case', illustrating all the essential propositions under study (Yin, 2002). Repeated observation and assessment of this client ensured that the maximum amount of information was gathered about information processing and occupational performance according to the following selection criteria:

- First onset of traumatic brain injury
- Inpatient rehabilitation phase of recovery
- Severe agitation lasting more than 1 month
- Receiving daily occupational therapy within a multidisciplinary rehabilitation context
- Family permission to participate in the study

### Subject: AT

At the time of this study, AT was a 67-year-old man who sustained a TBI as a pedestrian hit by a motor vehicle. He sustained bilateral frontal bone fractures, sphenoid bone fractures, a base of skull fracture and a right orbital wall fracture. Computed tomography (CT) scans of the brain revealed a left frontal lobe contusion and subarachnoid haemorrhage, and a right parietal lobe subarachnoid haemorrhage. CT scans showed blood in the subarachnoid space, sphenoid and maxillary sinuses with presence of pneumoencephalous. These features indicated structural damage in the frontal area with increased intracranial pressure. AT's Glasgow Coma Score (GCS) at the accident scene fluctuated between 6 and 7/15 and remained at this level upon arrival at the Emergency Department. He was transferred to a specialist brain injury rehabilitation unit 2 months postinjury.

Assessment indicated that AT was in a state of PTA when admitted to rehabilitation. He was functioning at Rancho Level IV, demonstrating severely confused and agitated behaviour. This included motor restlessness, pacing and attempts to abscond, verbal aggression towards others, and physical aggression towards objects. AT's rehabilitation program focussed on developing a consistent, structured daily routine. Participation in this routine was reviewed weekly by all multidisciplinary team members.

AT's long-term rehabilitation goal was to live with minimal supervision in his own home with his wife, who worked part-time. In accordance with this goal, AT's occupational therapy program focussed on retraining of self-care and domestic skills. AT's agitated behaviour was limiting his participation in daily therapy activities aimed at meeting these goals.

### Data collection and interpretation

The impact of agitation on information processing abilities was measured using Stage 2 of the PRPP System of Task Analysis. Changes in processing abilities were scored for each quadrant and subquadrant of the PRPP system during performance of three tasks that were targeted for retraining: upper-body dressing, making a sandwich and making a cup of coffee. Upper-body dressing was selected to represent a routine, procedural task. This task was divided into eight steps, and was performed within the context of AT's morning hygiene routine. The sandwich-making task was

performed in a small kitchenette separate to the main dining room to minimise environmental distractions and maintain ecological validity. This task involved 11 steps, and sandwich fillings were preprepared, sliced and presented on a plate from which AT needed to make a selection. The final task, making a cup of coffee, was also performed in the kitchenette and involved 14 steps. This was the most complex task, involving searching for and locating all objects and tools for the task from the fridge and cupboards in the kitchenette.

This case study represents a 4-week period in AT's rehabilitation program, approximately 3 months postinjury and 1 month after admission to rehabilitation. The PRPP assessment tool enabled serial administration over short periods of time, during everyday performance of the tasks. The timing between each reassessment with the PRPP System was approximately 7–10 days.

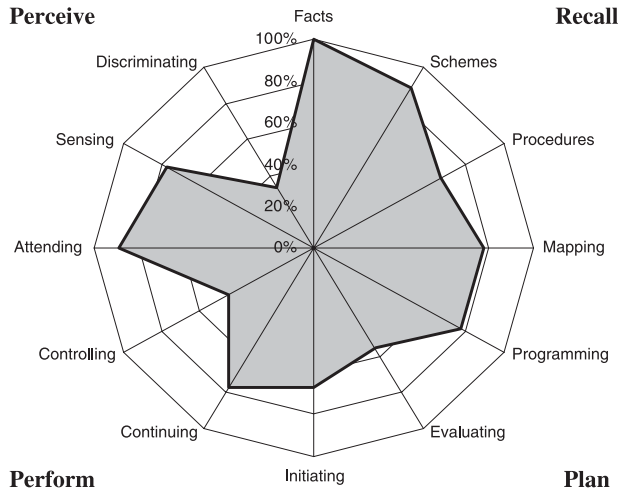
Results are presented using radial graphs (Figs 2–9) that are structured to conform to the PRPP conceptual model illustrated in Figure 1. The Perceive subquadrants are placed in the left-upper section; Recall subquadrants in the right-upper section; Plan subquadrants in the lower-right section and Perform subquadrants in the lower-left section. Each subquadrant has been assigned a percentage score. A score above 90% indicates efficient information processing for the target task (criterion referenced goal). The shaded area represents AT's PRPP scores as a percentage of the possible 100% score for each subquadrant. An increase in the shaded area indicates an improvement in AT's scores.

## Results

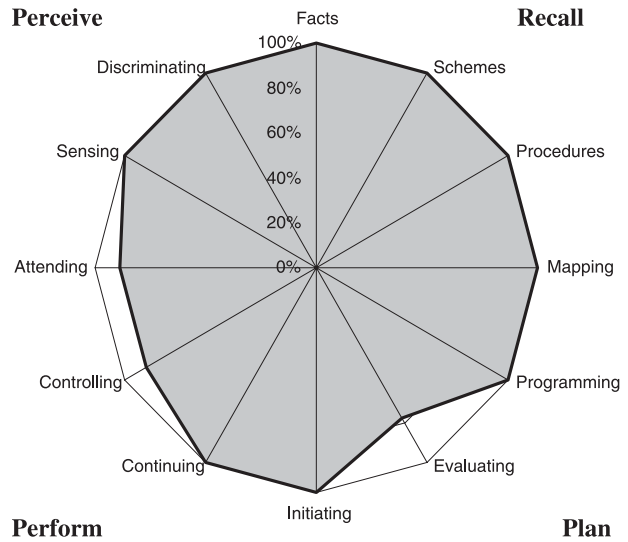
### Task 1: Routine performance on a procedural task: Upper-body dressing

Figure 2 represents AT's scores in each subquadrant during the initial attempt at the task of donning a t-shirt. Scores within the Perceive quadrant indicated that his ability to discriminate between aspects of objects and the environment was particularly poor. For example, he was unable to discriminate between the left sleeve and the main body of the t-shirt, resulting in repeated unsuccessful attempts to place his left arm in the left sleeve. This is consistent with descriptions of agitated behaviour where people are unable to process detailed information, or become overwhelmed by sensory information to the extent that meaningful interaction with the source of sensory information is not possible (Prigatano, 1992). Reassessment indicated a subsequent improvement over the period of the study to 70% at Time 2 (Fig. 3), then 100% at Time 3 (Fig. 4) at which time AT no longer needed prompts to notice or discriminate sensory details of the task.

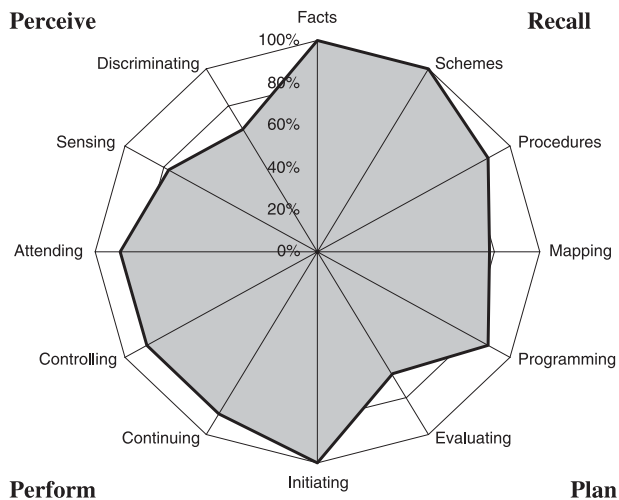
AT's performance in the Recall quadrant was an area of strength at Time 1 with scores between 70–90%



**FIGURE 2:** Information processing during upper-body dressing: Time 1.



**FIGURE 4:** Information processing during upper-body dressing: Time 3.



**FIGURE 3:** Information processing during upper-body dressing: Time 2.

on all subquadrants. This is expected on a habitual, procedural-based task such as dressing and is one reason for choosing these types of tasks for retraining early in the rehabilitation of people with agitation. Alternately, planning was difficult for AT, as was monitoring his responses, as indicated by information processing scores in the Plan and Perform quadrants. When reassessed at Times 2 and 3, AT's abilities gradually moved towards the perimeter of the circle, indicating improved information processing skills.

Figures 2–4 clearly show the progressive acquisition of information processing skills across all quadrants between Time 1 and 2 and from Time 2 to 3. Total information processing ability (represented by the total

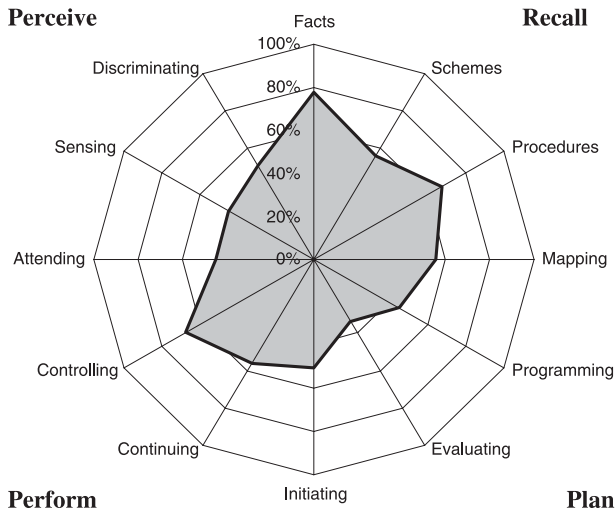
shaded area of Figures 2–4) increased during upper-body dressing from 74% at Time 1 to 96% at Time 3, representing a clinically significant improvement in information processing and task performance.

**Task 2: Novel task performance with limited choice: Making a sandwich**

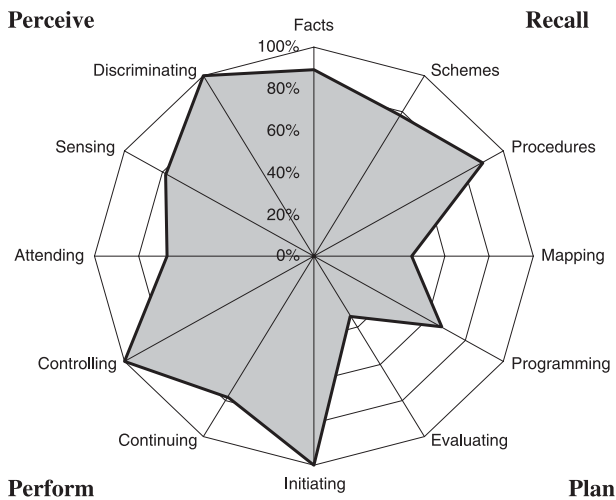
The second task involved making a sandwich from a limited choice of preprepared fillings. There were an increased number and complexity of task steps in this task compared to the previous upper-body dressing task. AT had opportunity to practise this activity only 2 days per week; therefore this is a novel rather than routine task.

Specific difficulties were observed at Time 1 (Fig. 5) in the Attending, Sensing and Discriminating sub-quadrants of Perceive. AT's ability to attend to the task was severely limited during his agitated state. He was distractible and unable to sustain his attention to support task completion. Inability to modulate and allocate attention to suit task performance is commonly seen in people with agitation, with reports indicating that although they are able to attend to the environment for short periods of time, they are unable to selectively attend to people or objects within that environment in a sustained manner, demonstrating severe attentional disturbances (Katz, 1992). On measures of attentional capacity, people with agitation show slow reactions to the presence of objects in the environment, and when choosing between objects, make repeated errors (Corrigan, Mysiow, Gribble & Chock, 1992). Processing skills in the Attending subquadrant demonstrated a 20% improvement by Time 2 (Fig. 6).





**FIGURE 5:** Information processing during sandwich-making: Time 1.



**FIGURE 6:** Information processing during sandwich-making: Time 2.

Similar improvements were observed in the Sensing subquadrant. The processing skills attributed to this subquadrant include searching for, locating and monitoring sensory information needed for the task by focussing, looking, listening, and feeling during task performance. It is hypothesised that the kitchen was a more cognitively complex sensory environment, involving higher level attention, searching and monitoring strategies, resulting in increased processing demand during this task. This may have contributed to AT’s low initial scores in this subquadrant (Fig. 5). These sensing skills were targeted during intervention firstly by using gestural prompts to widen AT’s attentional field (as he demonstrated a very narrow field of attention and was unable to modulate his

attention), then by modelling a systematic searching strategy and using verbal labels at the same time as searching such as ‘fridge’, ‘drawer’ and ‘pantry’. This additional information cut down on the repeated attempts to search the same area. AT’s searching, locating and monitoring abilities within the Sensing subquadrant showed improvement to 80% by Time 2 (Fig. 6).

As would be expected of someone in PTA, AT’s recall of Facts, Schemes and Procedures indicated poor memory in the initial PRPP assessment (Fig. 5, Time 1). He required specific intervention using directed prompts to teach him to recognise and group objects for use, as well as prompts about when and where parts of the task should be completed. There was improved recall of task schemes and procedures by Time 2 PRPP assessment (Fig. 6). All areas of Planning were difficult for AT when performing this task. These information processing deficits did not change during the study period. AT’s overall information processing ability during this sandwich-making task improved from 54% at Time 1 to 75% at Time 2 (represented by the total shaded area of Figures 5 and 6).

**Task 3: Novel task performance with unlimited choice: Making coffee**

The task of making a coffee placed very high demands on planning and decision-making, requiring that AT engage in making choices, planning and sequencing actions, problem-solving and making judgements about his performance.

Figure 7 represents the first time this task was scored using the PRPP System. AT experienced similar processing difficulties in the Perceive quadrant during this task as with sandwich-making. Difficulties in the Recalling Procedures subquadrant were evident when AT demonstrated difficulty recalling the appropriate use of objects, body parts and task steps. These types of memory deficits have been reported in agitated patients and are identified as a contributory factor in the need for assistance completing functional tasks (Plylar, 1989). Recall of procedures was targeted as a specific area for intervention during performance of more complex tasks. This clinical decision was based on the hypothesis that long-term knowledge of procedures is the most robust of memory strategies in people with TBI. However, although procedural knowledge may remain largely intact, there is inaccurate retrieval when the client is required to allocate cognitive resources more widely in complex tasks such as this one. Recall of Procedures improved to 100% by Time 3 (Fig. 9), as measured by the PRPP.

AT experienced difficulties in all subquadrants of Plan when performing this task. The information processing skills represented in the PRPP Plan

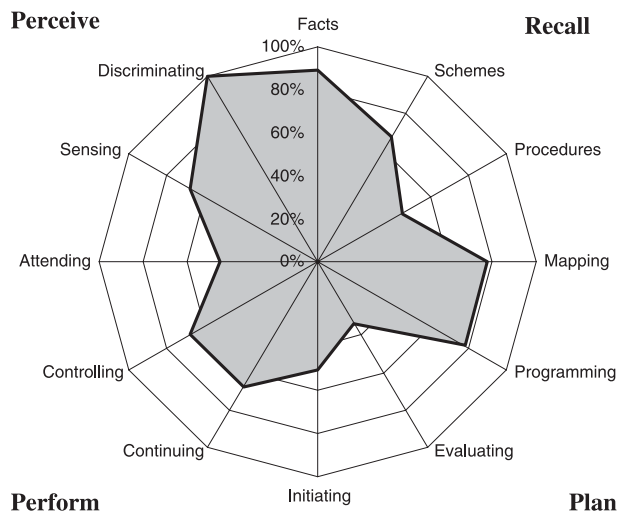


FIGURE 7: Information processing during coffee-making: Time 1.

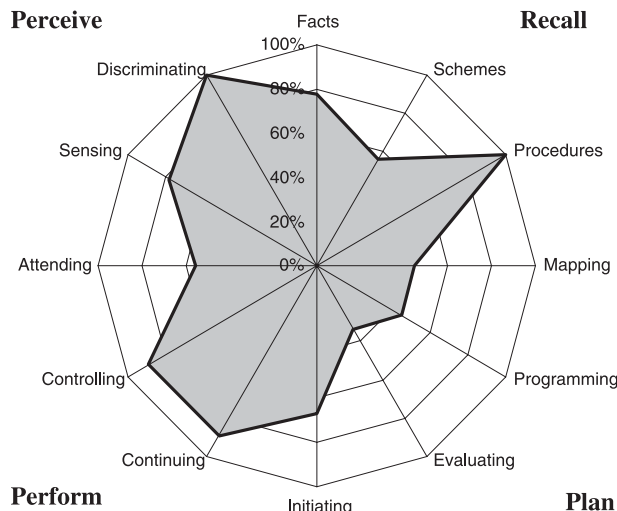


FIGURE 9: Information processing during coffee-making: Time 3.

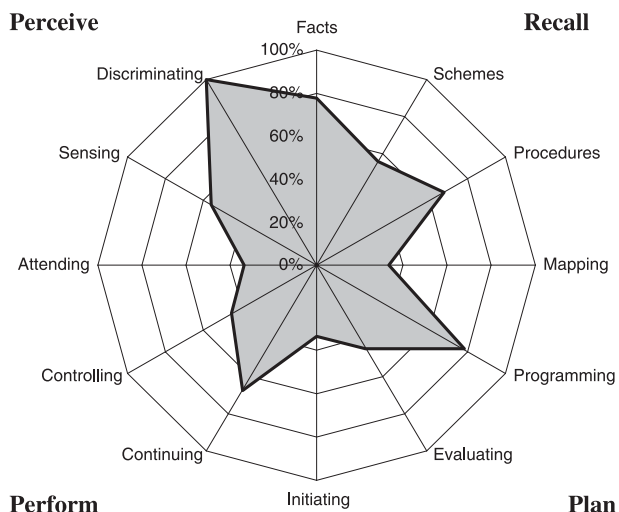


FIGURE 8: Information processing during coffee-making: Time 2.

quadrant are thought to be necessary for complex, multistep and novel tasks, particularly in an open environment containing choice, such as in this task. Information processing within the Plan quadrant appears to be most vulnerable in people with agitation who find tasks that have elements of novelty and complexity difficult to process, often resulting in exacerbation of agitated behaviour (Radomski, 2002).

AT's overall information processing ability (represented by the total shaded area of Figures 7–9) remained similar from Time 1 (64%) to Time 3 (68%). This highlights the importance of measuring each quadrant and subquadrant for changes in ability. The overall information processing percentage gives the impression of stable performance that masks the significant improvements gained by AT in the Recall and Perform

quadrants and the concomitant difficulties evident in the Plan quadrant.

## Discussion and summary

This case study used one-client situation to describe how information processing difficulties can be identified during task performance using the PRPP System of Task Analysis. In relation to the first research question: Can the PRPP System of Task Analysis identify information processing problems during task performance of a severely agitated adult following TBI? The findings indicated the following. First, the PRPP assessment format was effectively applied to one client with severe agitation following TBI, who was otherwise unable to participate in formal testing of cognitive capacity. Difficulties previously reported in the use of standardised, language-based assessments with adults in early stages of rehabilitation following TBI were overcome by the observational, task based nature of this assessment (Fry & O'Brien, 2002). Second, the assessment indicated specific areas of processing strengths and weaknesses during occupational performance. Information processing in two of the PRPP quadrants, Perceive and Plan, were least effective during everyday performance in this case of extreme agitation. Specifically, noticing and attending to sensory information, modulating the focus of attention to suit the task, and maintaining attention for the duration of the task were areas of difficulty in all tasks. The capacity to process sensory aspects of the environment by searching, locating and monitoring appear most challenged during tasks that occur in complex sensory environments.

Information processing within the Plan quadrant relates to the higher executive skills involved in

goal-directed behaviour, selecting appropriate objects and environments in which to perform tasks, accurately sequencing tasks, questioning, analysing and evaluating one's own performance in respect of the originally intended plan. These information processing capacities were particularly vulnerable in this client, a finding that is consistent with TBI literature (Radomski, 2002; Togli, 1998). Preservation of these abilities was evident only during automatic and habitual tasks when cued. This is consistent with findings showing evidence of preserved memory for procedural task performance in adults after TBI, but persistent difficulty with elaboration of the same tasks, or performance of known tasks in changed contexts (Schacter, Wagner & Buckner, 2000; Shum, Sweeper & Murray, 1996; Yamadori, Yoshida, Mori & Yamashita, 1996).

In relation to the second question: Is the PRPP System of Task Analysis sensitive to changes in task performance over a 4-week period during brain injury rehabilitation? The following findings emerged. First, the PRPP System of Task Analysis was sensitive to changes in information processing during everyday performance across three tasks. This indicates the potential validity of its use as a rehabilitation outcome measure of context-based performance. Use of visual representation of change as illustrated in the figures in this article may be an effective method of demonstrating assessment findings to members of the multidisciplinary team, clients and families. Second, specific patterns of decline and improvement in task performance were evident over time that are consistent with information processing theory in general, and research on recovery of cognition after TBI. While planning and self-evaluation processing strategies remained poor, attention and sensory processing capacity, memory for task performance, and performance monitoring capacity all showed some improvement in this particular case. This may indicate that, while measures of independence remain low during this phase of recovery, there is some learning that occurs during the agitation and post-traumatic amnesic state following TBI, raising questions about a commonly held view that learning, and therefore active rehabilitation, is not effective (Radomski, 2002).

In relation to the third question: What guidance does the PRPP System of Task Analysis provide for occupational therapy intervention for an adult with severe agitation following TBI? The following might be hypothesised. The PRPP System provides direct guidance to occupational therapy intervention by categorising errors under four stages of the information processing model, Perceive, Recall, Plan and Perform. This enables therapists to choose intervention methods that match the mechanisms of information processing in each stage of the model. While this study did not attempt

to measure the impact of occupational therapy, it was noted that over the course of 1 month, during which time the client was engaged in daily intervention, information processing in the areas of Perceive, Recall and Perform was most conducive to change while planning skills showed less change. This has implications for occupational therapy practice with severely agitated adults. Techniques designed to target planning-processing strategies need to be trialled with this population to determine the potential for their use in clinical guidelines. Concomitant measurement of information processing abilities and agitated behaviour is required in any future research in this area to determine if intervention can lead to improvements in information processing and at the same time reduce agitated behaviour.

The limitations of this study are largely associated with case study research. One client only was examined. While this client illustrated many of the characteristics that are associated with clients who are severely agitated post-TBI, assessment of other clients may generate different information processing profiles. It was not the intent of this study to demonstrate the effects of intervention, therefore the changes in information processing described effects of intervention. Changes in information processing abilities were not subjected to inferential statistical analysis. While one of the aims of this case study was to determine if the PRPP System of Task Analysis was sensitive to changes in task performance, future studies involving more participants will be used to employ statistical methods to determine the extent and direction of changes in performance. The aim of this study was not to measure the significance of the observed changes in statistical or clinical terms. Further research is required to link intervention with information processing change. There was no attempt to control variables related to medical, therapeutic and nursing input, or the hospital living context that may have influenced this client's information processing capacity; however, the processing profile described in this article finds resonance with descriptions of severely agitated behaviour in TBI literature. While it is not possible to generalise the findings of this study to the broader population of people with severe agitation, the following discussion points can contribute to targeting of future research in this area of practice.

This study highlights the effectiveness of the PRPP System in identifying information processing difficulties in adults with TBI-related agitation and has been shown to be sensitive to changes over a 4-week period. Future studies using the PRPP might be able to more clearly indicate the extent to which particular types of information processing capacity can be enhanced at this stage in rehabilitation, and by what specific intervention strategies. The findings of the current

study support the use of the PRPP System as an assessment tool to measure treatment effectiveness in research involving larger numbers of participants.

## References

- Alberto, P. A. & Troutman, A. C. (2002). *Applied behaviour analysis for teachers* (6th ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.
- Bailey, D. M. (1998). Quantitative research designs. In: D. M. Bailey (Ed.). *Research for the health professional: A practical guide* pp. 61–77. Philadelphia, PA: FA Davis Co.
- Bogner, J. A., Corrigan, J. D., Fugate, L., Mysiw, W. J. & Clinchot, D. (2001). Role of agitation in prediction of outcomes after traumatic brain injury. *American Journal of Physical Medicine and Rehabilitation*, 80, 636–644.
- Chapparo, C. & Ranka, J. (1998). *PRPP research: Training manual* (4th Ed.). Lidcombe, NSW: Occupation and Leisure Sciences, Faculty of Health Sciences, The University of Sydney.
- Chapparo, C. & Ranka, J. (2005). *The PRPP system of task analysis: User's training manual*. Lidcombe, NSW: Occupation and Leisure Sciences, The University of Sydney.
- Corrigan, J. D. & Bogner, J. A. (1994). Factor structure of the Agitated Behavior Scale. *Journal of Clinical and Experimental Neuropsychology*, 16, 386–392.
- Corrigan, J. D., Mysiw, W. J., Gribble, M. W. & Chock, S. K. (1992). Agitation, cognition and attention during post-traumatic amnesia. *Brain Injury*, 6, 155–160.
- Fry, K. & O'Brien, L. (2002). Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: A case study. *Australian Occupational Therapy Journal*, 49, 182–187.
- Galski, T., Palasz, J., Bruno, R. L. & Walker, J. E. (1994). Predicting physical and verbal aggression on a brain trauma unit. *Archives of Physical Medicine and Rehabilitation*, 75, 380–383.
- Giles, G. M. & Shore, M. (1989). A rapid method for teaching severely brain injured adults how to wash and dress. *Archives of Physical Medicine and Rehabilitation*, 70, 156–158.
- Gordon, W. A., Zafonte, R., Cicerone, K., Cantor, J., Brown, M., Lombard, L. et al. (2006). Traumatic brain injury rehabilitation: State of the science. *American Journal of Physical Medicine and Rehabilitation*, 85, 343–369.
- Greve, K. W., Sherwon, E., Standord, M. S., Mathias, C., Love, J. & Ramzinski, P. (2001). Personality and neurocognitive correlates of impulsive aggression in long-term survivors of severe traumatic brain injury. *Brain Injury*, 15, 255–262.
- Hagen, C. (2001). The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *Re-Learning Times*, 8, 1.
- Hagen, C., Malkmus, D. & Durham, P. (1979). Levels of cognitive functioning. In *Rehabilitation of the head injured adult: Comprehensive cognitive management* (pp. 87–88). Downey, CA: Professional Staff Association of Rancho Los Amigos Hospital, Inc.
- Katz, D. I. (1992). Neuropathology and neurobehavioral recovery from closed head injury. *Journal of Head Trauma Rehabilitation*, 7, 1–15.
- Katzmann, S. & Mix, S. (1993). Improving functional independence in a patient with encephalitis through behaviour modification shaping techniques. *American Journal of Occupational Therapy*, 28, 259–262.
- Kirwan, B. & Ainsworth, L. K. (1992). *A guide to task analysis*. London: Taylor & Francis.
- Lazaro, F., Butler, R. & Fleminger, S. (2000). In-patient neuropsychiatric brain injury rehabilitation. *Psychiatric Bulletin*, 24, 264–266.
- Miles, M. & Huberman, A. M. (1994). *An expanded sourcebook. Qualitative data analysis* (2nd ed.). California, CA: Sage Publications.
- Montgomery, P., Kitten, M. & Niemiec, C. (1997). The agitated patient with brain injury and the rehabilitation staff: Bridging the gap of misunderstanding. *Rehabilitation Nursing*, 22, 20–23.
- Nicholls, J. & Chapparo, C. (1993). *OPM(A): Improving performance of occupational tasks and routines in clients with extreme agitation after traumatic brain impairment*. Retrieved 31 July 2004, from <http://www.occupationalperformance.com/oldsite/appimprove01.html>.
- Perino, C., Rago, R., Ciolini, A., Torta, R. & Monaco, F. (2001). Mood and behavioural disorders following traumatic brain injury: Clinical evaluation and pharmacological management. *Brain Injury*, 15, 139–148.
- Plylar, P. A. (1989). Management of the agitated and aggressive head injury patient in an acute hospital setting. *Journal of Neuroscience Nursing*, 21, 353–356.
- Prigatano, G. P. (1992). Personality disturbances associated with traumatic brain injury. *Journal of Consulting and Clinical Psychology*, 60, 360–368.
- Radomski, M. V. (2002). Traumatic brain injury. In: C. A. Trombly & M. V. Radomski (Eds.). *Occupational therapy for physical dysfunction* (5th ed., pp. 855–884). Philadelphia, PA: Lippincott Williams & Wilkins.
- Ragin, C. C. & Becker, H. S. (Eds.) (1992). *What is a case? Exploring the foundations of social inquiry*. Cambridge, UK: Cambridge University Press.
- Salminen, A. L., Harra, T. & Lautamo, T. (2006). Conducting case study research in occupational therapy. *Australian Occupational Therapy Journal*, 53, 3–8.
- Sandel, M. E. & Mysiw, W. J. (1996). The agitated brain injured patient. Part 1: Definitions, differential diagnosis, and assessment. *Archives of Physical Medicine and Rehabilitation*, 77, 617–623.
- Schacter, D. L., Wagner, A. D. & Buckner, R. L. (2000). Memory systems of 1999. In: E. Tulving & F. I. M. Craik (Eds.). *The Oxford handbook of memory* (pp. 627–643). Oxford, UK: Oxford University Press.
- Shum, D., Sweeper, S. & Murray, R. (1996). Performance on verbal implicit and explicit memory tasks following traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 11, 43–53.
- Slifer, K. J., Cataldo, M. D., Babbitt, R. L., Kane, A. C., Harrison, K. A. & Cataldo, M. F. (1993). Behavior analysis and intervention during hospitalization for brain trauma rehabilitation. *Archives of Physical Medicine and Rehabilitation*, 74, 810–817.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
- Swan, L. & Alderman, N. (2004). Measuring the relationship between overt aggression and expectations: A methodology

- for determining clinical outcomes. *Brain Injury*, 18, 143–160.
- Toglia, J. (1998). A dynamic interactional model to cognitive rehabilitation. In N. Katz (Ed.). *Cognition and occupation in rehabilitation* (pp. 5–50). Bethesda, MD: AOTA.
- Webb, D. (1991). Increasing carryover and independent use of compensatory strategies in brain injured patients. *Cognitive Rehabilitation*, May/June, 29–35.
- Westling, D. & Fox, L. (2004). *Teaching students with severe disabilities*. Upper Saddle River, NJ: Pearson, Merrill, Prentice Hall.
- Wilson, B. & Evans, J. J. (1996). Error-free learning in the rehabilitation of people with memory impairments. *Journal of Head Trauma Rehabilitation*, 11, 54–64.
- Yamadori, A., Yoshida, T., Mori, E. & Yamashita, H. (1996). Neurological basis of skill learning. *Cognitive Brain Research*, 5, 49–54.
- Yin, R. K. (2002). *Case study research: Design and methods* (3rd ed.). Applied Social Research Methods Series, Vol. 5. Thousand Oaks, CA: SAGE Publications.
- Yin, R. K. (2003). *Applications of case study research* (2nd ed.). Applied Social Research Methods Series, Vol. 34. Thousand Oaks, CA: SAGE Publications.

## CHAPTER SIX

### VALIDITY OF THE PRPP SYSTEM OF TASK ANALYSIS

#### RESEARCH PHASE THREE

Chapter Six reports on the findings from the first aspect of Research Phase Three.

This paper outlines an investigation into the validity of the PRPP System of Task Analysis for measuring application of information processing strategies during task performance of adults with agitated behaviour following TBI. This study used a Rasch modelling approach to generate a hierarchy of information processing strategies and to determine unidimensionality of the PRPP System

This chapter is currently under review with the *Journal of Applied Measurement*. The manuscript was submitted in November 2007 as: Nott, M. T., Chapparo, C., & Linacre, J. M. Exploring the validity of an information processing assessment for measuring occupational performance in adults with brain injury. *Journal of Applied Measurement, (Under review; submitted December 2007)*. All sources cited in the manuscript are referenced at the end of the chapter.

Authorship statements attesting to the contribution of the researcher are included in Appendix II.

## ABSTRACT

**Objective:** Preliminary examination of construct validity and internal consistency of the Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis, used to assess task embedded information processing during occupational therapy assessment of severely agitated adults following traumatic brain injury (TBI).

**Method:** Occupational therapists observed and scored client performance using the PRPP System of Task Analysis. Rasch analysis methods were used to generate a hierarchy of test items and to propose a linear continuum along which, the difficulty of test items, raters, clients and tasks could be simultaneously measured.

**Results:** Strong parallels were found between the Rasch generated hierarchy of PRPP descriptor items, and the theories of human cognition and information processing that underpin the PRPP System. PRPP items demonstrated acceptable fit with the Rasch model and high levels of internal consistency.

**Recommendations for further research:** This quantification of test item difficulty, rater and task characteristics, and client abilities requires replication with larger samples of therapists and clients to advance the knowledge base regarding the clinical utility of the PRPP System of Task Analysis with severely agitated adults following TBI.

**Keywords:** agitation, information processing, occupational performance, Rasch analysis, validity

## 6.1 INTRODUCTION

Effective information processing for occupational performance depends on a person's ability to select processing strategies that result in efficient use of information. An information processing approach to assessment examines the 'cognitive' and 'behavioural' aspects of performance. Disturbances in information processing reported in people with severe agitation following brain injury are cognitive rather than sensory, with allocation of attention, planning, sequencing complex tasks, and self-monitoring performance the most vulnerable (Duncan, Kosmidis & Mirsky, 2005; Radomski, 2002; Toglia, 1998).

Information processing models are based on the premise of sequential information flow, from the initial reception of information, through a processing function, culminating in an action (Lerner, 2002). Integral to this sequence is a mechanism for behavioural control, termed the supervisory or executive system (Norman & Shallice, 1986), which is responsible for regulation of attention, and selection of motor and verbal responses appropriate to the immediate task demands (Critchley, 2005, Hart & Jacobs, 1993). Models of working memory include a controlling attentional system, which supervises and coordinates two subsidiary systems for auditory and visual processing (Baddeley, 1990; Carter & Wang, 2007). The specific actions by which the supervisory system modulates behaviour have been proposed by Miyake, Friedman, Emerson, Witzki and Howertzer (2000) to include three distinct processes: mental set shifting, information monitoring, and inhibition of responses.

Through these specific processes, links between breakdown in information processing and agitated behaviour can be hypothesised (Goldstein, Levin, Goldman,



Clark & Altonen, 2001; Seeley et al, 2007). Difficulty maintaining attention and shifting attentional set to new stimuli is evident in agitated patients (Fugate et al., 1997), who are unable to selectively attend to people or objects within the task environment, or switch attention between stimuli (Hagen, Malkmus, & Durham, 1979; Nott & Chapparo, 2008). The ability to constantly update and monitor information related to a task or activity is deficit in agitated adults who demonstrate poor attention and memory (Harmsen, Geurts, Fasotti, & Bevaart, 2004). The need for assistance with completing functional tasks has been attributed to this lack of short-term memory in agitated patients (Pylar, 1989). The third process attributed to supervisory control of behaviour is the ability to inhibit unwanted responses. Disinhibition has been described as a feature of agitation since Levin and Grossman (1978) first defined agitation post brain injury as an activated display of motor and verbal behaviour released from normal inhibitory control. The concept of disinhibition forms the basis of Bogner and Corrigan's (1995) definition of agitation, as an excess of one or more behaviours that occurs during an altered state of consciousness. In the clinical context, agitation has been attributed to disinhibition of behaviours that are normally suppressed (Fugate et al., 1997; Lequerica, 2004).

The role of impaired cognition as a factor in the expression of agitation following TBI is clear. Deficits in attention, memory, and executive functioning appear to be a factor in agitated behaviour; however objective measurement of these cognitive processes in the context of severe confusion and agitation is complex. The use of written, language based assessments can be limited in their application and validity for assessing adults with TBI during the period of post-traumatic amnesia (PTA) (Fry & O'Brien, 2002), a stage of recovery typically associated with poor agitation. In

contrast, the method of assessment under investigation in this study, The PRPP System of Task Analysis, is driven by task-embedded observation methods rather than written assessment procedures as the core test ‘item.’

In a recently published case study the Perceive, Recall, Plan and Perform (PRPP) System was applied to a measurement situation that involved a number of human factors that had previously proved difficult to measure, namely information processing during task performance under conditions of severe agitation following brain injury (Nott & Chapparo, 2008). This case study provides preliminary evidence for the clinical utility of the assessment approach with agitated adults following TBI. Further validation of the underlying test construct, use by multiple therapists, different task contexts and application to the agitated client group is specifically addressed in this study using Rasch Analysis methods.

### **6.1.1 The PRPP System of Task Analysis**

The PRPP System is a process-oriented, criterion referenced assessment that employs task analysis methods to determine problems with cognitive information processing (Chapparo & Ranka, 1997a). An underlying assumption of the assessment system is that an individual’s capacity to process the cognitive demands inherent in everyday tasks can be observed, identified and used to determine the need for occupational therapy intervention (Chapparo & Ranka, 1997a; Chrenka, Hutton, Klinger & Aptima, 2001). The purpose of the assessment is to identify difficulties in specific information processing strategies during task performance and to provide a focus for intervention (Fry & O'Brien, 2002; Nott & Chapparo, 2008).

The PRPP is one of the measures associated with the Occupational Performance Model (Australia), which defines occupational performance as a product of the interaction between humans and their environment (Chapparo & Ranka, 1997b). The PRPP System differs from existing occupational therapy assessments for adults with brain impairment in the structure of the assessment, which enables simultaneous assessment of occupational performance and the underlying performance components that afford or inhibit performance. This contrasts with assessments measuring cognitive and/or perceptual skills in isolation from occupation (for example the Rivermead Perceptual Assessment Battery and the Rivermead Behavioural Memory Test; Wilson, Cockburn & Baddeley, 2003; Whiting, Lincoln, Bhavnani, & Cockburn, 1985; Donnelly, 2002) and also contrasts with assessments such as the Assessment of Motor and Process Skills (AMPS), designed to measure activity participation and restriction without specifically evaluating underlying impairments or capacities within the cognitive domain (Bowman, Lindstedt, Hemmingsson, & Bartfai, 2004).

The PRPP test procedures can be applied to any occupational role, routine, activity or task and is not limited to a pre-determined set of assessment tasks (in contrast to A-ONE and AMPS: Arnadottir, 1990; Fisher, 1995). This improves the ecological validity of the assessment and provides direct guidance for intervention in relevant and meaningful areas of occupational performance (Fry & O'Brien, 2002).

### **6.1.2 The PRPP System of Task Analysis: Development and Procedures**

The PRPP System of Task Analysis is conducted in two stages. In Stage 1, clinicians use a *behavioural* task analysis to break down everyday task performance into steps for the purpose of identifying errors. An overall measure of mastery for specific and relevant occupations (Kirwan & Ainsworth, 1992) is computed. Stage 2 focuses on information processing strategies required for performance by using a *cognitive* task analysis. Cognitive task analysis is a family of assessment methods that describe the cognitive processes that underlie performance of tasks and the cognitive strategies used to respond adeptly to complex situations (Militello & Hutton, 1998; Schraagen, Chipman, & Shalin, 2000).

The PRPP conceptual model (Figure 6.1: Chapparo & Ranka, 2005) roughly mirrors the multi-staged flow of information that is found in most theoretical models of information processing (Lerner, 2002). Studies undertaken during model development involved microanalysis of over 4000 performance errors, observed during occupational performance of 45 adults with brain impairment (Chapparo & Ranka, 1997a). Errors were categorised into four broad types: errors of perception, recall, planning, and performance. These are depicted in the central quadrants of the PRPP System (See Figure 6.1).

The PRPP System was adapted from an information processing model in the field of instructional design (Romiszowski, 1984). The four central quadrants were divided by Romiszowski (1984) into 12 subcategories. The PRPP Subquadrants are similar but not identical to Romiszowski's subcategories, with three distinct Subquadrants identified in each of the four main quadrants (See Figure 6.1).

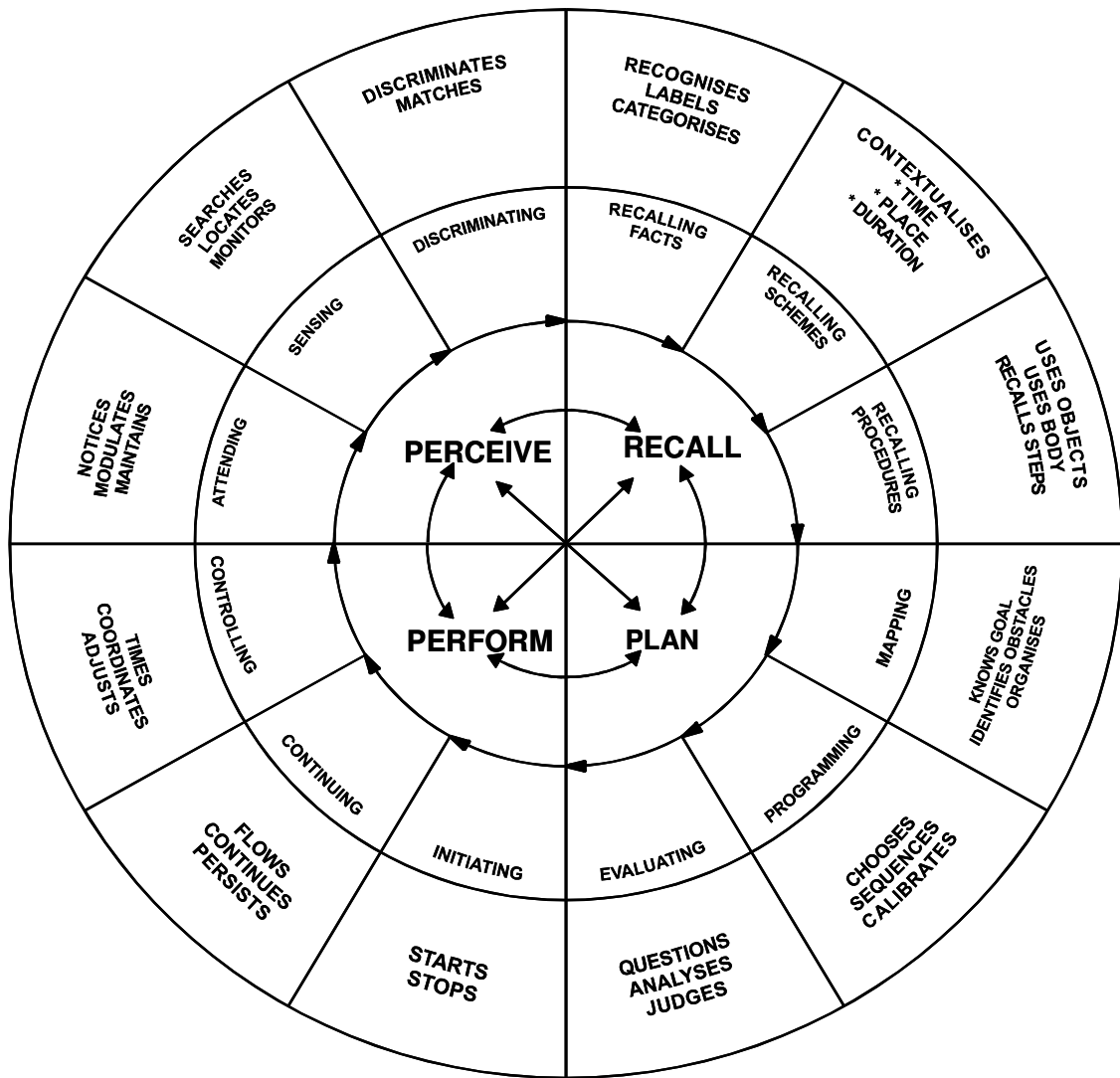


Figure 6.1 The PRPP System of Task Analysis (Chapparo & Ranka, 2005)

Initial investigation of construct validity involved 25 adults and adolescents with brain impairment who were videotaped performing eating, drinking, meal preparation and dressing tasks. 2001 errors were identified in this sample of task performances. The key descriptive words used to name and frame errors within each of the subcategories were studied and finally termed 'descriptors'. These form the outer layer of the system (See Figure 6.1). All 2001 performance errors could be described using the model, thereby lending initial face validity of the constructs used in the model to describe cognitive performance errors (Osbourne, 1995).

Therapists rate the extent to which each of the descriptors afford or inhibit desired performance. A three point rating scale is used to determine whether the behaviour is effective for task performance (3), questionable (2), or not effective (1).

The use of the PRPP System of Task Analysis is expanding in clinical practice, therefore it is timely to review the measurement properties of this criterion referenced measure. There has been limited statistical examination of internal validity since early development stages of the measure. The objective of the current study is to examine the internal validity of the PRPP System using Rasch analysis, traditional test measures and rating scale analysis. Specifically this study aimed to answer the following research questions:

1. Do items measured by the PRPP System of Task Analysis demonstrate acceptable 'fit' with a single underlying construct named 'information processing'?
2. Does the hierarchy of items agree with conceptual models of information processing and occupational performance?
3. Do items demonstrate internal consistency within the four main quadrants and twelve Subquadrants of the PRPP System?
4. Does rating scale analysis support the use of a three-point rating scale for measuring information processing behaviours during occupational performance?

## **6.2 METHOD**

This study was conducted with the approval of respective Human Ethics Committees. Informed consent was obtained from legal guardians for each patient videotaped, and from participant raters (occupational therapists).

### **6.2.1 Participants**

Ten occupational therapists, considered to be expert clinicians in the area of neurological rehabilitation who had also undertaken additional training to use the PRPP System of Task Analysis participated in the study. Recruitment occurred on a voluntary basis in response to advertising in a national occupational therapy newsletter and via Internet list serves in two states. The mean age of therapists was 31 years (SD = 7.6; range 23-50). On average, therapists had participated in PRPP training 3.7 years prior to the study (SD = 1.9; range 1-6 years). One therapist reported using the PRPP System daily, one reported weekly use, three reported monthly use, and five reported occasional use. Half the sample (n=5) worked in the practice area of adult rehabilitation, one third (n=3) worked in acute care settings with adults, with the remaining sample working in paediatrics (n=1), and in a community based role (n=1). All participants had participated in training to use the PRPP System of Task Analysis involving a five-day training workshop in Perth, Melbourne or Sydney Australia.

Participants were hospital patients, aged greater than 18 years, admitted for brain injury rehabilitation, and demonstrating agitation and confusion as identified by the treating occupational therapist. Clinical assessment of agitation was confirmed using the Rancho Levels of Cognitive Functioning Scale (Hagen, 2001; Hagen et al, 1979).

Patients demonstrating behaviours consistent with Rancho Level IV- 'Confused and Agitated' were recruited to the study.

This highly specific sample of adults following brain injury, represent a small sub-group of the brain injury population, that present significant challenge to staff and family involved in the patient's care and rehabilitation (Lombard & Zafonte, 2005; Montgomery, Kitten, & Niemiec, 1997). The specificity of the sample renders the available sample size within the research project time period to be quite small.

### **6.2.2 Procedures**

Five adult in-patients (four males, one female) aged 19-58 years, who met the above selection criteria were recruited to the study. To increase data available for examination as part of this study, each participant was videotaped performing four to five self-care tasks during occupational therapy sessions. This resulted in 21 different task performances (four clients performed four tasks; one client performed five). Tasks were chosen by the treating occupational therapist in accordance with rehabilitation goals at the time of data collection and included eating, drinking, face washing, teeth brushing, hair brushing, upper-body dressing, and simple meal-preparation. Each therapy session lasted approximately 45 minutes. The treating occupational therapist and researcher jointly conducted each occupational therapy session. Videotaped footage of the patients' performance was copied to digital form for scoring. Research packages containing digital footage and PRPP scoring sheets were distributed by mail to all participants, who independently scored and returned these within a 6-8 week period. The use of videotapes of patients performing



activities has been shown to be effective in allowing multiple raters to observe and score the exact same performance (Portney & Watkins, 2000).

### 6.2.3 Data analysis

Twenty-one task performances were each scored by ten therapist raters producing 210 unique data rows for entry into FACETS (Rasch measurement software; Linacre, 2007). A four-faceted Rasch model was generated with facets measuring patients, tasks, PRPP test items, and the raters.

The standard Rasch model for dichotomous data with persons and items is:

**Equation 6.1: Dichotomous form of the Rasch model**

$$\log(P_{ni}/(1 - P_{ni})) = B_n - D_i$$

where  $P_{ni}$  is the probability that person  $n$  will succeed on item  $i$ , where person  $n$  has ability  $B_n$  and item  $i$  has difficulty  $D_i$ .

Among many other extensions to the Rasch model is the Many-Facet Rasch Model.

This extends the dichotomous form of the model:

**Equation 6.2: Multi-faceted form of the Rasch model with a rating scale**

$$\log(P_{nmijk}/P_{nmijk}(k - 1)) = B_n - A_m - D_i - C_j - F_k$$

The mathematical properties of the model are maintained, with additional components of the measurement situation being introduced. In this example,  $B_n$  is the

ability of person  $n$ ,  $A_m$  is the challenge of task  $m$ ,  $D_i$  is the difficulty of item  $i$ ,  $C_j$  is the severity of judge  $j$ , and  $F_k$  is the barrier to being observed in category  $k$  relative to category  $k-1$ . FACETS is ideally suited to judgements of performance, and is employed to convert qualitative observations to linear measures in many areas of research and practice (Linacre, 2007).

The FACETS programme uses a logistic transformation of raw ordinal data from the PRPP rating scale into equal-interval units expressed as logits (log odds units: Bond & Fox, 2007). Measures for each facet are calibrated by the relationship between the ability of each patient, the complexity of each task, the difficulty of each individual test item and the severity of each rater. Measures are represented on a single common line from negative to positive infinity, which represents the underlying construct being measured: information processing during occupational performance.

#### **6.2.4 Construct validity**

Construct validity is established when sufficient evidence is provided to allow users to evaluate whether an instrument measures the intended construct. Construct validity focuses on the idea that the recorded performances are reflections of a single underlying construct that is made explicit by the investigator's attempt to represent it in each item or observation. Rasch analysis provides indicators of how well each item fits with the underlying construct in order to assess the meaning of the underlying construct. Items that do not fit the unidimensional construct are those that diverge unacceptably from the expected ability/difficulty pattern. In Rasch measurement, fit statistics are used to detect the discrepancies between the Rasch model prescriptions and the data collected in practice (Bond & Fox, 2007).

FACETS reports two different types of fit statistics: infit and outfit, as mean square values and standardised  $z$ -scores. Outfit is based on the conventional sum of squared residuals for that particular item, while Infit is an information-weighted sum. Infit statistics are reported to be the most informative of these indices as they indicate the extent to which a person responds as expected to items targeted at their ability level (Bode, Heinemann, & Semik, 2000). Infit and Outfit statistics are reported as mean squares in the form of chi-square statistics divided by their degrees of freedom, so that they have a ratio scale form with an expected value of +1 and a range from 0 to infinity (Bond & Fox, 2007). Wright and Linacre (1994) suggest that a reasonable range for mean-square fit values should be based on the nature of the testing situation rather than adopting a single standard fit range. For clinical observations, a mean-square range of 0.5-1.7 is considered acceptable; however, a fit range of 0.6-1.4 is suggested for survey style data. The more stringent parameters of 0.6-1.4 ( $1 \pm 0.4$ ) will be used in this study.

Infit and Outfit statistics are also reported in interval-scale forms (e.g.  $t$  or  $z$ ) in which their expected value is 0. The mean square fit statistics are transformed into a normalised  $t$  distribution by applying the Wilson-Hilferty transformation. FACETS refers to these normalised or standardised statistics as Infit  $z_{std}$  and Outfit  $z_{std}$ . Using the commonly accepted interpretation of  $t$  values, Infit and Outfit  $z$  values greater than +2 or less than -2 are generally interpreted as having less compatibility with the model than expected ( $p < .05$ ). Negative values indicate less variation than modelled, while positive values indicate more variation than modelled (Bond & Fox, 2007), and are generally considered more problematic during interpretation.

Evidence for construct validity will also be gained from examining the Rasch calibrated hierarchy of PRPP test items. This describes the ordering of test items from easiest to hardest. The generated hierarchy of items is compared to the expected ordering based on clinical experience (Bode et al., 2000; Whyte, Hart, Bode, & Malec, 2003) and the conceptual model that guided instrument development (Tham, Bernspång, & Fisher, 1999).

### **6.2.5 Internal consistency**

Internal consistency within the four main quadrants and twelve Subquadrants of the model was examined using traditional test methods to supplement the information gained using Rasch analysis. Readers may be more familiar with traditional test measures including Cronbach's alpha ( $\alpha$ ) as a measure of internal consistency. The widely accepted applied science cut-off applied in this study, is that  $\alpha$  must be greater than .70 for a set of items to be considered a scale.

## **6.3 RESULTS**

### **6.3.1 Construct validity**

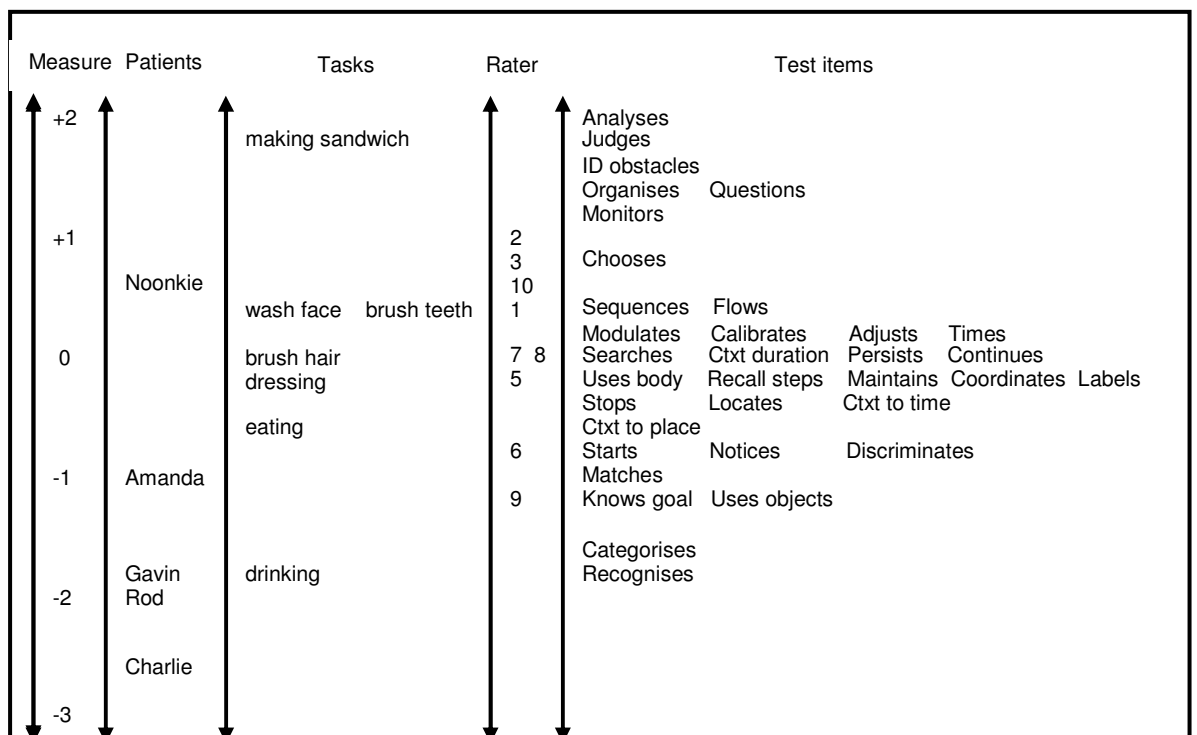
Rasch calibration of items produced a linear continuum of information processing descriptors from the PRPP System of Task Analysis. The difficulty of individual items ranged from +1.92 logits (*Analyses*) to -1.74 logits (*Recognises* – refer to Table 6.1). The distribution of items (seen in Figure 6.2) suggests fewer test items at the higher and lower end of the continuum, with a concentration of items near the mean of 0.0 logits. In particular, very few items target the extreme lower end of item difficulty.

**Table 6.1 PRPP Descriptors in hierarchical order**

Item	Difficulty		Infit		Outfit	
	Measure	SE	Mn Sq	zstd	Mn Sq	zstd
<i>Harder Items</i>						
Analyses	1.92	.22	.92	-.3	.49	1.13
Judges	1.69	.20	.97	-.1	.53	1.13
Identifies obstacles	1.47	.19	.71	-1.8	.59	1.12
Organises	1.27	.18	.89	-.6	.69	1.09
Questions	1.23	.18	1.07	.4	1.09	.97
Monitors	1.15	.17	1.14	.9	1.07	.97
Chooses	.71	.15	.93	-.5	.97	.95
Sequences	.43	.14	.93	-.5	.85	1.06
Flows	.37	.14	.79	-1.8	.62	1.23
Modulates	.29	.14	1.01	.1	1.02	.90
Calibrates	.27	.14	.89	-.9	.88	1.01
Adjusts	.24	.14	.80	-1.8	.75	1.13
Times	.14	.13	1.03	.2	.90	1.02
Searches	.09	.13	.99	.0	.97	.88
Contextualises to duration	.09	.13	.88	-1.1	.79	1.17
Persists	.07	.13	.98	-.1	.79	1.16
Continues	.03	.13	.79	-2.0	.64	1.29
Uses body	-.12	.13	.92	-.7	1.17	.87
Maintains	-.17	.13	1.02	.2	.96	1.04
Coordinates	-.23	.13	.9	-.5	.90	.99
Recalls steps	-.23	.13	1.20	1.8	1.10	.78
Labels	-.26	.13	1.19	1.8	1.20	.87
Stops	-.26	.13	.89	-1.0	.75	1.23
Locates	-.28	.13	1.17	1.6	1.22	.71
Contextualises to time	-.36	.13	1.05	.5	.95	1.05
Contextualises to place	-.56	.13	.85	-1.5	.75	1.29
Starts	-.70	.12	1.11	1.2	1.04	1.02
Notices	-.73	.12	1.09	.9	1.12	.79
Discriminates	-.83	.12	1.19	1.9	1.11	.86
Matches	-1.01	.17	.95	-.3	.86	1.24
Knows Goal	-1.19	.12	1.08	.8	1.04	.97
Uses objects	-1.26	.12	1.31	3.1	1.45	.51
Categorises	-1.51	.12	1.20	2.1	1.20	.75
Recognises	-1.74	.12	1.21	2.1	1.37	.67
<i>Easier Items</i>						

Notes: SE = Standard error; Mn Sq = Mean Square; zstd = standardised z score  
Fit parameters:  $MnSq = 1 \pm 0.4$ ;  $zstd = 0 \pm 2$

Goodness-of-fit parameters were applied to both mean square and standardised  $z$  score values to determine 'fit' with the unidimensional model ( $MnSq = 1 \pm 0.4$ ;  $z$  std =  $0 \pm 2$ ). One item violated *both*  $MnSq$  and  $z$ -std parameters. *Uses Objects* demonstrated higher than expected Infit and Outfit values suggesting some unexpected responses potentially due to idiosyncrasies of these patients or differing perspectives of the raters. Three items demonstrated Infit  $z$ -scores equal to or slightly higher than +2, with concomitant mean square values within stated parameters (*Continues, Categorises, Recognises*). As these items demonstrated mean square values within the acceptable range, these items were not considered for removal. Generally the PRPP test items demonstrated good fit with the Rasch generated model, supporting the underlying tenant of unidimensionality.



**Figure 6.2 FACETS hierarchical rulers for each modelled facet (Patients, Tasks, Raters and Test items)**

Vertical rulers for each facet represent the hierarchical order of each element within the facet (Patients, Tasks, Test Items, and Raters) as measured on the same linear continuum (Figure 6.2). On the right is the hierarchy of items from easiest (bottom) to most difficult (top). Items are symmetrically distributed two logits above and below the mean, and demonstrate excellent item separation (separation index = 6.03; reliability = .97). Patients with abilities close to the person mean (-1.41) and above were better targeted by the test items. That is, the most impaired patients in this sample were not as well targeted by the test items (see Figure 6.2). These findings may suggest the need for further item development targeting lower-order information processing strategies, and the need to recruit a more heterogeneous group of participants in future studies using this assessment tool, to include more patients functioning at higher levels of the continuum, where items are already targeted.

Further support for construct validity is derived from the ordering of items, or item hierarchy. The underlying model of information processing suggests that an inherent order, from low to high order information processing skills exists, whereby lower order skills, for example, reception of sensory information, is supervised or controlled by higher order skills, such as monitoring or evaluation (Lerner, 2002). The PRPP conceptual model resonates with this idea (refer to direction arrows in Figure 6.1), suggesting an inherent order from processing of sensory input, registration of information and comparison with stored knowledge (Perceive and Recall Quadrants), followed by planning, enacting then evaluating performance (Plan and Perform Quadrants).

Referring to Figure 6.2, the easiest items in the lowest portion of the hierarchy are *Recognising* and *Categorising* task objects/people/environments, followed by recalling the *Use of Objects* and *Knowing the Goal* of task performance. These items represent Recall Quadrant descriptors and the simplest descriptor within the Plan Quadrant. The next section of the hierarchy includes the Perceive Quadrant descriptors: *Matches*, *Discriminates*, and *Notices*, each representing a lower-order processing strategy upon which more complex perceptual and cognitive processes are built. The Recall Quadrant skills required to *Contextualise to Time* and *Place* for task performance are next in the hierarchy, enabling patients to form an appropriate task scheme in their mind against which performance can be planned, enacted and evaluated.

Plan and Perform Quadrant descriptors featured in this area of the hierarchy are core procedures, fundamental to task performance; knowing when to *Start*, *Stop*, and *Recalling steps* of the task. Attainment of these strategies ensures that more advanced skills such as *Flows* and *Sequences* can be attained higher in the continuum.

Strategies that may supervise or direct these fundamental procedures, and ensure performance continues to the end of the task are evident in the next section of the hierarchy; *Maintains* attention, *Continues*, *Persists*, and *Contextualises to duration*.

Recall of procedures for *Uses body* and *Coordinates* smooth musculoskeletal performance, form the basis for higher order processing strategies in the next hierarchical levels. Complex Perform Quadrant skills that require feedback such as *Times*, *Flows*, and *Adjusts*, as well as Plan Quadrant skills involved in the tactics of



task performance: *Chooses*, *Sequences* and *Calibrates* form the next level or order of skills. Information processing strategies from the Perceive Quadrant that support tactical performance are located nearby: *Searches* which is the active and systematic seeking of sensory information and *Modulates* attention which is the spontaneous narrowing, broadening or shifting of attention.

These items give way to the highest level of the Rasch generated hierarchy, where the most complex information processing skills are represented. These processing strategies are considered to be part of the 'Supervisory or Executive System' (Norman & Shallice, 1986) that controls, evaluates, and monitors skilled performance; *Monitors*, *Questions*, and *Organises* self and environment; *Identifies Obstacles* to performance, *Judges* and *Analyzes* the safety and effectiveness of task performance. The high separation index (Separation Index = 6.12; Reliability = .97) suggests that several strata can be identified within these 32 test items. These separate or break-up the test items and support the concept of ordered skill acquisition, as information processing strategies required to demonstrate each progressive test item become increasing more complex further along the hierarchy.

### **6.3.2 Internal Consistency**

Internal consistency measures using Cronbach's alpha suggest high correlation between all items of the PRPP System ( $n=34$ ;  $\alpha = .974$ ). Measures of internal consistency within separate quadrants and sub-quadrants (See Table 6.2) suggest moderate to high levels of internal consistency (quadrant  $\alpha = .89-.92$ ; Subquadrant  $\alpha = .69-.90$ ).

**Table 6.2 Internal consistency measures**

	<b>n of items</b>	<b><math>\alpha</math></b>
<b>TOTAL PRPP System</b>	32	.97
<b>QUADRANT ANALYSIS</b>		
Perceive	8	.90
Recall	9	.89
Plan	9	.89
Perform	8	.92
<b>SUBQUADRANT ANALYSIS</b>		
Attending	3	.79
Sensing	3	.82
Discriminating	2	.80
Recalling Facts	3	.82
Recalling Schemes	3	.90
Recalling Procedures	3	.74
Mapping	3	.69
Programming	3	.78
Evaluating	3	.89
Initiating	2	.72
Continuing	3	.90
Controlling	3	.87

Notes:  $\alpha$  = Cronbach's alpha

### 6.3.3 Rater Consistency

Rasch analysis procedures allowed each facet, or factor within the assessment situation (patient, task, rater and test item) to be evaluated for individual fit with the model. Prior to formal analysis of the Rasch results, the way in which the rating scale was used by each rater was examined for consistency. The PRPP System of Task Analysis is intended to be rated on a 3-point scale. Nine therapists demonstrated use of all three categories consistent with the proposed rating scale structure. One therapist demonstrated a strong tendency towards use of a 2-point scale, primarily using categories '1' and '3'. This rater was excluded from all analyses, which is

evident in Figure 2 where only nine raters are represented on the rater continuum. Raters recruited from similar facilities or rehabilitation services tended to cluster together, for example raters 2, 3, and 10 worked at the same facility, whilst raters 7 and 8 also worked together. Therapists reporting occasional use of the instrument for assessing clients were raters 9, 6, 7, 8, and 1; the raters in the lower portion of the continuum suggesting more lenient rating or identification of less impaired information processing. In contrast, raters 2, 3, and 10, at the higher end of the continuum, reported regular use (weekly) of the assessment procedure, perhaps suggesting a higher level of discrimination when applying the description of each strategy.

#### **6.3.4 Task choice**

Each patient performed a number of tasks identified as short-term goals of the patients' rehabilitation programme at the time of recruitment to the study. Tasks centred on the self-maintainer and home-maintainer roles. Drinking and eating were calibrated to be the simplest tasks, followed by the personal-care skills of upper-body dressing, hair brushing, face washing and teeth brushing, with simple meal preparation calibrated at the highest end of the continuum. This is consistent with ordered skill development and reflects the clinical reasoning and choice of occupational therapists when planning intervention with this client group. This study did not intend to measure or develop a hierarchy of tasks in respect to task difficulty, as the number of tasks was limited to those targeted as short-term therapy goals at the time of recruitment to the study.

## 6.4 DISCUSSION

Effective information processing for occupational performance relies upon a person's ability to select the most appropriate processing *strategies* that result in efficient use of information. The PRPP System enables clinicians to examine and measure the use of information processing strategies through observation of task embedded behaviour.

An assumed hierarchy or developmental order of skill acquisition within the area of cognitive rehabilitation exists. Cognitive theory organises human cognition into a hierarchy of basic and complex processes, in which basic processes include sensory perception, attention and memory mechanisms that are essential for execution of complex processes, such as planning, problem solving and abstract thought (Constantinidou, Thomas, & Best, 2004). The Rasch measurement approach adopted in this study shows great promise as an objective method for quantifying such a hierarchy along a linear continuum that can apply to many facets of the complex measurement contexts that occupational therapists aim to assess.

The Rasch calibrated PRPP descriptor items demonstrate a hierarchical order that is congruent with the inherent order of information processing theories (Lerner, 2002) and theories of human cognition (Constantinidou et al., 2004). While further validation on larger samples is necessary, this study suggests a clear order of strategy use evidenced by adults with agitation following brain injury. Information processing strategies that form the grounding or basis upon which occupational performance can occur, termed basic processes, appear in the lower order of the hierarchy. This includes strategies for sensory input and registration such as *Discriminating* and

*Matching* aspects of objects and the environment; *Recognising* and *Categorising* objects, and recalling how to *Use Objects* are ordered in the lower portion of the hierarchy. These skills parallel those identified by Stuss (1991) as forming the first component of his proposed hierarchical control system, corresponding to sensory and perceptual or knowledge based information, upon which automatic, rapid responses can be formed. These processes could also be equated to the initial stages of information processing models, involving the Sensory Register and Short Term Memory strategies that are necessary for progressing to higher order skills.

The second component of Stuss's (1991) hierarchy is the executive network, responsible for governing the bulk of cognitive processing. This system is also referred to as the central executive (Baddeley & Logie, 1999), or the supervisory attentional system (Norman & Shallice, 1986). The executive system is responsible for effective planning, problem solving and modulation; for switching attention between task components to different aspects of the situation and changing response selection strategies (Constantinidou et al., 2004) and also has been attributed with the specific abilities of mental set shifting, information monitoring, and inhibition of responses (Miyake et al., 2000). The construct validity of the Rasch generated hierarchy of PRPP descriptor items is further supported by the localisation of complex processing strategies such as *Analysing* and *Judging* aspects of behaviour, *Organising* oneself and the environment, *Identifying Obstacles* to performance, *Sequencing* and *Choosing* task actions to the upper portion of the hierarchy. These strategies, primarily derived from the Plan Quadrant, are accompanied in the higher portion of the hierarchy by the Perceive Quadrant strategies for *Modulating* attention and *Monitoring* sensory aspects of the task as the task progresses and changes.

The Rasch generated hierarchical order of items from the PRPP System reflect the theoretical constructs proposed by theories of organised human cognition and more specifically, the information processing models that underlie the PRPP System itself (Huitt, 2003; Lerner, 2002). This theoretical order is reflected in the clinical context, paralleling the order of skill acquisition described by cognitive outcomes from head injury rehabilitation (Gordon et al, 2006).

Items from each quadrant of the PRPP model cluster together in parts of the overall hierarchy with a degree of cross-over between quadrants. This may lend support to the hypothesis that information processing can act in both a linear fashion (input, throughout, output) but may also have a cyclic component whereby information is processed between quadrants in a non-linear fashion as depicted by the multi-directional arrows in the centre of the PRPP model (see Figure 6.1).

The results of both Rasch analysis and traditional test methods support the construct validity and internal consistency of the PRPP System as the assessment items work together to define a single construct. Thirty-one from thirty-two items demonstrate adequate 'fit' with the Rasch model. Unexpected responses on the item *Uses objects* usually occurred when a therapist rated a patient in a higher category than expected by the Rasch model. This suggests that misfit is more likely to occur when therapists are unexpectedly lenient, rather than unexpectedly severe. When taking into account the small sample, and the tendency for one or two unusual responses to produce large fit statistics, this single item will not be removed from the assessment on the sole basis of this study, however future research with larger samples will enable more stable fit statistics to be calculated.

The Rasch measurement approach shows great promise as an objective method for quantifying a linear continuum that can apply to many facets of the complex measurement contexts that occupational therapists aim to assess. A measurable hierarchy of test items has the potential for accurate repeated measures of clients, and outcome measurement following specific interventions. This study provides a preliminary analysis of how such a hierarchy may be constructed, based on five clients only. For stable fit statistics a minimum of 30 clients would be required, therefore further research is required. However, this study is important in pilot testing the procedure and approach of Rasch analysis for measuring task embedded information processing with the PRPP System of Task Analysis.

This study represents preliminary efforts to measure the validity of the PRPP System of Task Analysis with a highly specific client group. As such, the primary limitation of this study lies in the small sample from which data were collected. Future research should increase both the rater and patient sample size and representation across various stages of recovery from head injury, engaged in a wider variety of functional tasks and activities. Future research with a larger sample of patients will enable analysis of the rating scale structure, which is not possible with the present sample size.

## **6.5 CONCLUSION**

The Rasch generated hierarchy of information processing strategies shows clear similarities to the previously documented organisation of human cognition and information processing models. This study provides preliminary evidence for the construct validity of the PRPP System of Task Analysis when used to measure

information processing in clients with post-brain injury agitation. Information processing strategies represented by the items on the PRPP System, demonstrated acceptable fit with the unidimensional Rasch model, and internal consistency within each PRPP quadrant and have been calibrated along a conceptually valid hierarchy of skill acquisition.



## 6.6 REFERENCES

- Árnadóttir, G. (1990). *The brain and behavior: assessing cortical dysfunction through activities of daily living*. St Louis: Mosby.
- Baddeley, A. D. (1990). *Human memory: theory and practice*. Hove: Lawrence Erlbaum Associates.
- Baddeley, A. D. & Logie, R. H. (1999). Working memory. The multiple-component model. In A. Miyake & P. Shah (Eds.), *Models of working memory: mechanisms of active maintenance and executive control* (pp. 28-61). Cambridge: Cambridge University Press.
- Bode, R. K., Heinemann, A. W., & Semik, P. (2000). Measurement properties of the Galveston Orientation and Amnesia Test (GOAT) and improvement patterns during inpatient rehabilitation. *Journal of Head Trauma Rehabilitation*, 15(1), 637-655.
- Bogner, J. A. & Corrigan, J. D. (1995). Epidemiology of agitation following brain injury. *Neurorehabilitation*, 5, 293-297.
- Bond, T. G. & Fox, C. M. (2007). *Applying the Rasch model: fundamental measurement in the human sciences*. (2<sup>nd</sup> ed). Mahwah: Lawrence Erlbaum Associates Inc.
- Bowman, I-L., Lindstedt, M., Hemmingsson, H., & Bartfai, A. (2004). Cognitive training in home environment. *Brain Injury*, 18(10), 985-995.
- Carter, E. & Wang, X. (2007). Cannabinoid-mediated disinhibition and working memory: Dynamical interplay of multiple feedback mechanisms in a continuous attractor model of prefrontal cortex. *Cerebral Cortex*, 17, 16-26.
- Chapparo, C. & Ranka, J. (1997a). The Perceive, Recall, Plan and Perform System of Task Analysis. In C. Chapparo & J. Ranka (Eds.) *Occupational Performance Model (Australia), Monograph 1*. Sydney: Total Print Control pp. 189-198.
- Chapparo, C. & Ranka, J. (1997b). *Occupational Performance Model (Australia), Monograph 1*. Sydney: Total Print Control.
- Chapparo, C. & Ranka, J. (2005). *The PRPP System of Task Analysis: user's training manual*. The University of Sydney.
- Chrenka, J., Hutton, R. J., Klinger, D. W., & Aptima, D. A. (2001). *Focusing cognitive task analysis in the cognitive function model*. *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting*, 5: 1738-1742.
- Constantinidou, F., Thomas, R. D., & Best, P. J. (2004). Principles of cognitive rehabilitation: an integrated approach. In M. J. Ashley (Ed.), *Traumatic brain injury: rehabilitative treatment and case management* (2nd ed). (pp. 337-363). Boca Raton: CRC Press.

- Critchley, H. D. (2005). Neural mechanisms of autonomic, affective, and cognitive integration. *Journal of Comparative Neurology*, 493(1):154–166.
- Donnelley, S. (2002). The Rivermead Perceptual Assessment Battery: can it predict functional performance? *Australian Occupational Therapy Journal*, 49(2), 71-81.
- Duncan, C. C., Kosmidis, M. H., & Mirsky, A. F. (2005). Closed head injury-related information processing deficits: An event-related potential analysis. *International Journal of Psychophysiology*, 58(2), 133-157.
- Fisher, A. G. (1995). *AMPS manual*. Fort Collins: Three Star Press.
- Fry, K. & O'Brien, L. (2002). Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: a case study. *Australian Occupational Therapy Journal*, 49(4), 182-187.
- Fugate, L. P., Spacek, L. A., Kresty, L. A., Levy, C. E., Johnson, J. C., & Mysiw, W. J. (1997). Definition of agitation following traumatic brain injury: I. A survey of the Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation. *Archives of Physical Medicine & Rehabilitation*, 78(9), 917-923.
- Goldstein, F., Levin, H., Goldman, W. P., Clark, A.N., & Altonen, T. (2001). Cognitive and neurobehavioral functioning after mild *versus* moderate traumatic brain injury in older adults. *Journal of the International Neuropsychological Society*, 7, 373–383.
- Gordon, W. A., Zafonte, R. D., Cicerone, K., Cantor, J., Brown, M., Lombard, L. A., Goldsmith, R., & Chandna, T. (2006). Traumatic brain injury rehabilitation: state of the science. *American Journal of Physical Medicine & Rehabilitation*, 85(4), 343-382.
- Hagen, C. (2001). The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *re-Learning Times*, 8(1), 1.
- Hagen, C., Malkmus, D., & Durham, P. (1979). Levels of cognitive functioning. In *Rehabilitation of the head injured adult: Comprehensive cognitive management* (pp. 87-88). Downey: Professional Staff Association of Ranchos Los Amigos Hospital, Inc.
- Harmsen, M., Geurts, A.C.H., Fasotti, L., & Bevaart, B. J. W. (2004). Positive behavioural disturbances in the rehabilitation phase after severe traumatic brain injury: an historic cohort study. *Brain Injury*, 18(8), 787-796.
- Hart, T. & Jacobs, H. E. (1993). Rehabilitation and management of behavioural disturbances following frontal lobe injury. *Journal of Head Trauma Rehabilitation*, 8(1), 1-12.
- Huitt, W. (2003). The information processing approach to cognition. *Educational Psychology Interactive* Retrieved 10 April, 2006, from <http://chiron.valdosta.edu/whuitt/col/cogsys/infoproc.html>

- Kirwan, B. & Ainsworth, L. K. (1992). *A guide to task analysis*. London: Taylor and Francis.
- Lequerica, A. H. (2004). *Agitation and disinhibition in acquired brain injury: Impact of progress in acute rehabilitation therapies*. PhD thesis. Wayne State University.
- Lerner, J. W. (2002). *Learning disabilities. Theories, diagnosis, and teaching strategies* (8th ed). Boston: Houghton Mifflin Company.
- Levin, H. S. & Grossman, R. G. (1978). Behavioral sequelae of closed head injury. A quantitative study. *Archives of Neurology*, 35(11), 720-727.
- Linacre, J. M. (2007). FACETS Rasch measurement computer program [computer software]. Chicago: Winsteps.com.
- Lombard, L. A. & Zafonte, R. D. (2005). Agitation after traumatic brain injury: considerations and treatment options. *American Journal of Physical Medicine & Rehabilitation*, 84(10), 797-812.
- Militello, L. G. & Hutton, R. J. B. (1998). Applied Cognitive Task Analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41(11): 1618-1641.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: a latent variable analysis. *Cognitive Psychology*, 41(1), 49-100.
- Montgomery, P., Kitten, M., & Niemiec, C. (1997). The agitated patient with brain injury and the rehabilitation staff: bridging the gap of misunderstanding. *Rehabilitation Nursing*, 22(1), 20-23.
- Norman, D. A. & Shallice, T. (1986). Attention to action: willed automatic control of behavior. . In R.J. Davidson, G.E. Schwartz & D. Shapiro (Eds.), *Consciousness and self regulation: advances in research* (Vol. 4). (pp. 1-18). New York: Plenum Press.
- Nott, M. T., Chapparo, C. (2008). Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 55(3), 188-198.
- Osbourne, K. (1995). Use of an information processing assessment model to evaluate functional performance of persons with brain injury: A criterion study. Thesis. The University of Sydney.
- Plylar, P. A. (1989). Management of the agitated and aggressive head injury patient in an acute hospital setting. *Journal of Neuroscience Nursing*, 21(6), 353-356.
- Portney, L. G. & Watkins, M. P. (2000). *Foundations of clinical research: applications to practice* (2nd ed.). New Jersey: Prentice Hall.

- Radomski, M. V. (2002). Traumatic brain injury. In C. A. Trombly & M. V. Radomski, (Eds.). *Occupational therapy for physical dysfunction*. (5th ed.). (pp.855-884).Philadelphia: Lippincott Williams & Wilkins.
- Romiszowski, A. (1984). *Designing instructional systems*. London: Hogan Page.
- Schraagen, J. M., Chipman, S. F., & Shalin, V. (2000). *Cognitive task analysis*. Mahwah: Lawrence Erlbaum Associates.
- Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., Reiss, A. L., & Greicius, M. D. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience*, 27(9), 2349-2356.
- Stuss, D. T. (1991). Self, awareness and the frontal lobes: a neuropsychological perspective. In G. R. Goethaals & J. Strauss (Eds). *The self: an interdisciplinary approach*. New York: Springer-Verlang.
- Tham, K., Bernspång, B., & Fisher, A. G. (1999). Development of the assessment of awareness of disability. *Scandinavian Journal of Occupational Therapy*, 6(4), 184-190.
- Toglia, J. (1998). A dynamic interactional model to cognitive rehabilitation. In N. Katz (Ed). *Cognition and occupation in rehabilitation*. (pp. 5-50). Bethesda: AOTA.
- Whiting, S., Lincoln, N.B., Bhavnani, G., & Cockburn, J. (1985). *The Rivermead Perceptual Assessment Battery*. Windsor: NFER – Nelson.
- Whyte, J., Hart, T., Bode, R. K., & Malec, J. F. (2003). The Moss Attention Rating Scale for traumatic brain injury: initial psychometric assessment. *Archives of Physical Medicine & Rehabilitation*, 84(2), 268-276.
- Wilson, B. A., Cockburn J., & Baddeley, A. D. (2003). *Rivermead Behavioural Memory Test II*. Bury St Edmunds: Thames Valley Test Company.
- Wright, B. D., & Linacre, J. M. (1994). Reasonable mean-square fit values [Electronic version]. *Rasch Measurement Transactions*, 8. Retrieved from [www.rasch.org/rmt/rmt83b.htm](http://www.rasch.org/rmt/rmt83b.htm).

## CHAPTER SEVEN

### RELIABILITY OF THE PRPP SYSTEM OF TASK ANALYSIS

#### RESEARCH PHASE THREE

Chapter Seven reports on the findings the second aspect of Research Phase Three. This paper outlines the use of criterion referenced tests in TBI rehabilitation and discusses current issues related to reliability of this assessment form. The paper presents an investigation into the test and rater reliability of the PRPP System of Task Analysis, involving nine occupational therapists and five patients with TBI demonstrating agitated behaviour.

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Additional analysis related to this chapter is provided in Appendix III.

## Research Article

# Reliability of the Perceive, Recall, Plan and Perform System of Task Analysis: A criterion-referenced assessment

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**Objective:** To conduct preliminary examination of the rater and test-reliability of the Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis, an ecological measure designed to assess task-embedded information processing capacity during occupational therapy assessment of confused and agitated adults following traumatic brain injury.

**Methods:** Occupational therapists observed and scored client performance using the PRPP System of Task Analysis. Correlational analysis and measures of agreement were performed to determine interrater and intrarater reliability. Test procedures were examined for reliability and internal consistency.

**Results:** Interrater and test reliability considered three factors: therapists, clients and tasks. A moderate level of interrater reliability was achieved between trained therapists (intraclass correlation coefficient (ICC) = 0.60). Test procedures were highly reliable (ICC = 0.88). Across two measurement occasions, therapists showed a tendency towards harder rating on the second test occasion ( $\bar{d}$  -4.5%; 95% confidence interval for  $\bar{d}$ : -10.67% → 3.17%).

**Conclusion:** The findings of this study support the use of criterion-referenced tests in the area of occupational performance measurement. Occupational therapists achieved moderate interrater reliability when measuring the performance of adults with brain injury on various activities of daily living. Test procedures were found to be highly

reliable in measuring the occupational performance of adults demonstrating confusion and agitation typical to the stage of post-traumatic amnesia following head injury.

**KEY WORDS** agitation, assessment, brain injuries, occupational performance, reliability.

## Introduction

Measuring change in occupational performance of agitated adults following a traumatic brain injury (TBI) is a complex process. Agitated behaviour is associated with the post-traumatic amnesia (PTA) stage of recovery, and defined as an excess of behaviour characterised by disinhibition, aggression, restlessness or emotional lability (Corrigan & Bogner, 1994), that may include inappropriate vocalising, intolerance of medical management or equipment, and directed or diffuse aggression (Lombard & Zafonte, 2005). The confusion, disorientation, disinhibition and amnesia common to the PTA recovery phase often results in anxiety, agitation, non-compliance and combative behaviour (Slifer *et al.*, 1997) congruous with Level IV of the Rancho Levels of Cognitive Functioning Scale (Hagen, 2001). These cognitive and behavioural features of PTA, including agitated behaviour limit the patient's ability to engage in formal or standardised assessment procedures (Fry & O'Brien, 2002). In addition, many standardised cognitive assessments are deemed invalid during the period of PTA. Assessment of cognition and occupation performance in adults with agitated behaviour during PTA has to date received little investigation.

Occupational therapists require assessment methods that clearly distinguish the role of cognition in the performance of complex human occupations, particularly during the acute phase of recovery from TBI characterised by PTA and concomitant agitated behaviour. Ylvisaker *et al.* (2007) have identified poor outcome measurement and limited reporting of measurement reliability as one of the primary limitations to existing research on behavioural interventions following brain injury. Reliability of observation/measurement is especially critical in behavioural intervention studies because change is rarely measured using standardised tools with established reliability. Of the 65 studies reviewed by Ylvisaker *et al.*,

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89% used self-developed, context-specific behaviour counts or intensity measures to determine outcome. Only 8% used a standardised measure with documented reliability.

In view of the paucity of outcome measures suitable for use with adults following TBI who demonstrate behavioural and cognitive deficits, the current study is a preliminary investigation into the measurement properties of an occupational performance assessment tool, shown to be sensitive in measuring change over time in adults with severely agitated behaviour during PTA (Nott & Chapparo, 2007).

The Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis is a process-orientated, criterion-referenced assessment that employs task analysis methods to determine problems with cognitive information processing in the context of tasks and activities that are meaningful and relevant to the person (Chapparo & Ranka, 1997a). An underlying assumption of the assessment system is that a person's capacity to process the cognitive demands inherent in everyday tasks can be observed, identified and used to determine the need for occupational therapy intervention (Chapparo & Ranka). The purpose of the assessment is to identify difficulties in specific information processing strategies during task performance and to provide a focus for intervention (Fry & O'Brien, 2002; Nott & Chapparo, 2007). There has been little investigation into the instrument's reliability when used to measure performance of people who are confused and demonstrating agitated behaviour, characteristic of the PTA stage in brain injury recovery.

The PRPP System is an emerging assessment system that measures both task and information processing performance over time and in context, affording therapists a mechanism to measure intervention outcomes at both the level of body structure and function and at the level of activity and participation. This assessment system is particularly relevant for assessing adults following TBI during PTA, as the assessment is observation based. It utilises task performance as the context of the assessment, rather than the use of written or language-based assessments, which can have limited application to adults with TBI during the period of PTA (Fry & O'Brien, 2002). It enables simultaneous assessment of occupational performance and the underlying cognitive performance capacities that may afford or inhibit performance, where occupational performance is defined as carrying out roles, routines and tasks for the purpose of self-maintenance, productivity, leisure and rest in response to demands of the internal and/or external environment (Chapparo & Ranka, 1997a, 1997b). This contrasts with assessments measuring cognitive and/or perceptual skills in isolation from daily occupations; for example the Rivermead Perceptual Assessment Battery (Whiting, Lincoln, Bhavnani & Cockburn, 1985) and the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 2003). It is distinct from other functional evaluations using task observation (for example Arnadottir, 1990; Baum &

Edwards, 1993) in its synthesis of information processing theory and occupational performance. It also contrasts with other ecological assessments such as the Assessment of Motor and Process Skills (AMPS) which is designed to measure activity participation and restriction without specifically evaluating underlying impairments or capacities within the cognitive domain (Boman, Lindstedt, Hemmingsson & Bartfai, 2004).

## Development of the PRPP System of Task Analysis

The PRPP System uses a two-stage analysis process. Stage 1 employs a standard *behavioural* task analysis, whereby errors in everyday task performance are identified, generating an overall measure of mastery for specific and relevant occupations. Stage 2 focuses on information processing strategies required for performance by using a *cognitive* task analysis and is the primary focus of this paper. Cognitive task analysis is a family of assessment methods that describe the cognitive processes that underlie performance of tasks and the cognitive strategies used to respond adeptly to complex situations (Schraagen, Chipman & Shalin, 2000).

The conceptual model underlying the PRPP System of Task Analysis was adapted from an information processing model in the field of instructional design used to explain the process of learning tasks in the work place (Romiszowski, 1984). The PRPP model (Fig. 1) is centred around four quadrants that form the inner layer with multidirectional arrows that mirror the multistaged flow of information in theoretical models of information processing. These quadrants categorise cognitive processing strategies used during task performance into four areas: sensory perception (Perceive), memory (Recall), response planning and evaluation (Plan) and performance monitoring (Perform). These are depicted as the inner layer of the PRPP System (Fig. 1).

Each quadrant is broken down into three subquadrants (middle layer Fig. 1) and the underlying information processing strategies that support each of these areas of cognitive function (forming the outer layer Fig. 1). The assessment requires therapists to observe occupational performance, for example, a patient brushing his/her teeth or hair in the bathroom, and to systematically rate the extent to which the patient demonstrates each information processing strategy, as required for that task. A three-point rating scale is used to score the patient's performance of each processing strategy as (3) effective for task performance, (2) questionable or (1) not effective.

The PRPP is a criterion-referenced measure. Criterion-referenced measures assess what clients 'can do and what they know, not how they compare to others' (Anastasi, 1988, p. 102). In Stage 2 of the PRPP assessment, the processing strategies that form the outer ring of the model are specified as the criteria, which must be demonstrated relative to a predetermined performance level. The

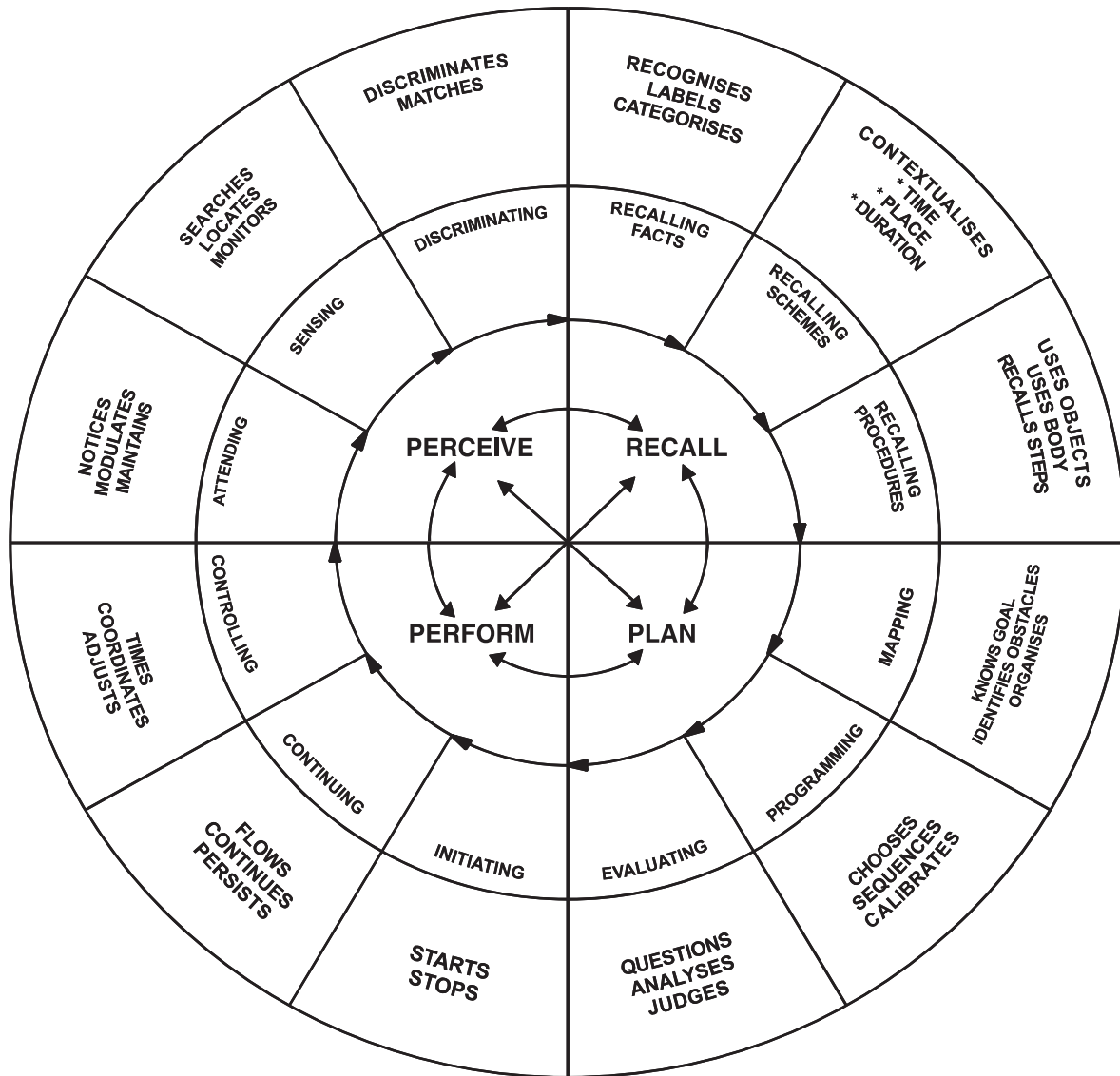


FIGURE 1: The Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis.

performance level may be determined by the task itself or in negotiation with the patient and family. For example, 'knows goal' requires the patient to demonstrate, through his/her actions or words, his/her understanding of the task intent, and to maintain this foremost in his/her mind, eliminating other distractions until the completion of the task. The PRPP is described as a standardised criterion-referenced assessment, as it uses uniform procedures for administration as outlined in the training manual and a standard scoring rubric that is representative of client performance.

**Criterion-referenced assessment and reliability**

Criterion-referenced interpretation of function, unlike norm-referenced interpretation, focuses on performance,

not on group membership. Glaser (1981) first defined criterion-referenced performance as 'assessment interpreted through tasks performed' (Glaser, p. 935) and reinterpreted the notion of 'tests' as any task performed under specified conditions. Three measurement foci are central to the notion of criterion-referenced assessment: the demands of the task; the capacity of the person to perform that task; and the context of performance (Griffin, 1995). This mirrors the domain of concern of occupational therapy, which focuses on the intersection between the occupations to be performed; the performance capacity of the client; and the context in which performance occurs (Chapparo & Ranka, 1997b).

Use of criterion-referenced assessment parallels concern in the occupational therapy profession for 'authentic' or ecologically valid assessment. Greater 'compatibility' is



required between standardised assessment procedures and realistic implementation in practice settings (Sudsawad, 2005). In criterion-referenced measures, such as the PRPP, this is achieved through using real-life contextual performance as the outcome of interest to increase the meaningfulness and relevance of findings for occupational therapy practice. The goal of the PRPP System, as a criterion-referenced measure, is to obtain a description of the specific information processing skills each patient can demonstrate, with no attempt to eliminate easy items or alter their difficulty.

While criterion-referenced measures may be ecologically valid, they present difficulties when attempting to determine the reliability of measuring human performance. Highly reliable assessments that focus on 'can/cannot' or 'mastery/non-mastery' interpretation often reduce the assessment to the level of trivial sets of skills that, while highly reliable, are of little use in interpreting overall performance (Griffin, 1995). Norm-referenced measures contain highly reliable, stable performance outcomes against which client performance can be judged; however, these are largely removed from everyday function. Moreover, most everyday tasks have not one single competency, but many. Competence for everyday function is not stable. In real world contexts, it depends on how well people can adapt to changes in the performance context, their capacities, and the complexity of task demands (Griffin). Evaluation of function involves recognition that task performance does not have one outcome, approach or solution only (Glaser, 1981; Griffin), and that assessor knowledge and background have an impact on the reliability of scores derived among assessors such as occupational therapists, who are assumed to have the same understanding of the performance criterion, the disability or illness inhibitors to performance. In these instances, the importance of well-defined 'rules' for judging performance, termed scoring 'rubrics' is paramount (Eisner, 1993).

A growing body of literature documents the use of criterion referencing in rehabilitation (see for example Rockwood, Joyce & Stolee, 1997) and education (see for example Carlson, MacDonald, Gorely, Hanrahan & Burgess-Limerick, 2000). Although the use of the PRPP System of Task Analysis is expanding in clinical practice and in research, the measurement properties of this criterion-referenced measure have not been widely published. A number of small, unpublished studies have been conducted across various client groups that support its use. For example, several studies report interrater and test-retest reliability ranging from 0.64 to 0.99 (Lohri, 2005; Munkhetvit, 2005). This study further investigated inter- and intrarater reliability of the PRPP System of Task Analysis for measuring information processing in adults with brain injury, in PTA, demonstrating agitated behaviour during self-care task performance, and the reliability of PRPP assessment procedures.

## Methods

This study was conducted with the approval of local human ethics committees. Informed consent was obtained from legal guardians for each patient videotaped, and from participant raters (occupational therapists).

### Participants

Nine occupational therapists who had previously been trained to use the PRPP System of Task Analysis participated in the study. Recruitment occurred on a voluntary basis in response to advertising in an Australian national occupational therapy newsletter and via internet list serves in two states. The mean age of therapists was 31 years (standard deviation (SD) = 8; range 23–50). On average, therapists had participated in PRPP training 3.4 years prior to the study (SD = 1.8; range 1–6). One therapist reported using the PRPP System daily, three reported monthly use, and five reported occasional use. Half the sample ( $n = 4$ ) worked in the practice area of adult TBI rehabilitation, one third ( $n = 3$ ) worked in adult acute neurology, with the remaining sample working in paediatrics ( $n = 1$ ), and in a community-based/case management role ( $n = 1$ ). All participants had undergone training to use the PRPP System of Task Analysis involving a five-day training workshop, and had experience working with adults with brain injury.

Patients who met the following selection criteria were considered for the study. Adults older than 18 years, admitted for neurosurgical rehabilitation following a brain injury and demonstrating agitation and confusion, were identified by the treating occupational therapist. Clinical assessment of agitation was confirmed using the Rancho Levels of Cognitive Functioning Scale (Hagen, 2001). Patients demonstrating behaviours consistent with Rancho Level IV were recruited to the study.

### Procedures

Five patients (four males, one female), aged 19–58 years, who met the above selection criteria were recruited to the study. Patients were videotaped performing self-care tasks during occupational therapy sessions. Tasks were chosen by the treating occupational therapist in accordance with rehabilitation goals at the time of filming and included eating, drinking, face washing, teeth brushing, hair brushing and upper-body dressing. The treating occupational therapist and researcher jointly conducted each 45-min therapy session. During filming, a least-to-most hierarchy of prompting and assistance was provided to ensure completion of each task with the least assistance from staff. Videotaped footage of the patients' performance was copied to digital form for scoring. Research packages containing digital footage and PRPP scoring sheets were distributed by mail to all participants, who independently scored and returned these within a 6 to 8-week period. A second DVD containing one client, performing one task, was sent two weeks later to all

participants for the purposes of measuring intrarater agreement. The use of videotapes of patients performing activities has been shown to be effective in allowing multiple raters to observe and score the exact same performance (Portney & Watkins, 2000).

## Data analysis

### *Interrater and test reliability*

Interrater reliability was concerned with the variation between the raters who measured the same group of people, while test reliability was focussed on the PRPP System itself and estimated how reliably the PRPP System measured the population from which the sample of patients came. A three-way intraclass correlation coefficient (ICC) (Wong & McGraw, 1999) was used to estimate interrater and test reliability. The three factors in this type of analysis are traditionally called persons ( $p$ ), items ( $i$ ) and judges ( $j$ ). In the current study, these factors were termed patients, tasks and raters, respectively.

Nine raters each assessed the same five patients on four tasks, totalling 180 ratings. The PRPP total percentage scores (summed total of all descriptors) and individual quadrant scores are used in these correlational analyses. Each patient was assessed on the four tasks most appropriate to him or her, meaning that tasks were not the same for every patient. In statistical terms, the factor of task was nested within the factor of patient, written as  $(i:p) \times j$  in Wong and McGraw's terminology.

Two ICCs were calculated for each of the four PRPP quadrant scores, and the PRPP total score. The first ICC was focussed on the raters, and was structured to assess the reliability of an average rater in the population from which the raters came. The second ICC was focussed on the PRPP test procedures, and was structured to assess the reliability of the PRPP assessment system as applied to the population from which the sample of patients came. This second ICC is analogous to the calculation of Cronbach's alpha, for measuring the internal consistency of a test. Three-way ICCs and their confidence intervals (CI) were calculated using a spreadsheet provided by McGraw based on the mathematical equations presented in Wong & McGraw (1999). ICCs were calculated based on data produced from a type IV sum of squares analysis of variance (ANOVA), where patients were nested with tasks, and crossed by all raters. In accordance with other measures of agreement, ICC = 0.41–0.60 is moderate agreement, and 0.61–0.80 is considered substantial agreement between raters or testing occasions (Landis & Koch, 1977). Measures of test reliability are interpreted as for Cronbach's alpha requiring at least 0.70 or higher for an adequate scale, and a cut-off of 0.80 for a good scale.

### *Intrarater agreement*

Intrarater agreement refers to the stability of measures recorded by one rater across two or more trials, and was measured for each individual rater following a 2-week interval between scoring occasions. Analysis of intrarater

agreement and disagreement was conducted using the Bland and Altman method to assess therapists' ratings on repeated scoring occasions (Bland & Altman, 1986). Calculations included the mean of scores at time 1 and time 2, against the difference between scores at time 1 and time 2, the 95% confidence intervals for this difference, and the SD of the difference ( $SD_{diff}$ ). A diagram was plotted to illustrate the distribution of results. In this study, mean total PRPP measures from time 1 and time 2 were plotted on the  $x$ -axis. The  $y$ -axis displays the difference between total PRPP measures at scoring time 1 and scoring time 2 (time 2–time 1). If ratings were completely reliable, the difference between therapist's ratings at time 1 and time 2 would be zero (0). If a therapist's time 2 rating was higher than his/her time 1 rating, the difference would be a positive value. Conversely, if a therapist's time 2 rating was lower than his/her time 1 rating, the difference would be a negative value. If therapists generally rated higher or lower at time 2, the average difference would be significantly different to 0, a situation referred to as 'bias'. The presence of bias was tested by calculating the SD and 95% CI of the difference between ratings at scoring time 1 and scoring time 2. We expect 95% of the difference to be less than 2 SDs from the mean (Bland & Altman). The potential for rater bias increases when using observational methods, and is best managed by developing objective scoring criteria and by rigorously training the raters (Portney & Watkins, 2000).

## Results

### **Interrater reliability**

The ICC coefficient for interrater reliability based on a three-way model was moderate, with a reliability estimate of 0.60 (see Table 1 for CIs). Each quadrant of the PRPP System of Task Analysis was then measured separately to determine the relative contribution of each quadrant to the reliability estimate. The quadrant-by-quadrant analysis indicated interrater reliability ranging from 0.51 to 0.59.

### **Test reliability**

The ICC coefficient for test reliability based on a three-way model was very high, with a reliability estimate of 0.88, ranging from 0.83 to 0.88 for each quadrant (see Table 1 for confidence intervals) meeting the above-identified cut-off (0.80) for achieving a 'good scale'.

### **Intrarater agreement**

The Bland and Altman test results are presented in Table 2. The mean percentage difference from time 1 to time 2 was  $-4.52$ , indicating a tendency towards lower ratings at time 2. A bias towards negative differences is evident in Figure 2, with the distribution of data points primarily below the zero reference line, the point at which the difference between scores from time 1 to time 2 is zero

**TABLE 1:** Intraclass correlation coefficients (ICC) with 95% confidence intervals (CI) for interrater reliability and test reliability

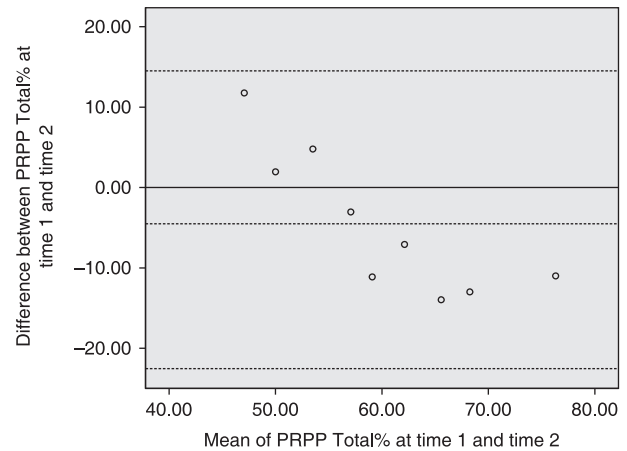
	ICC raters	95% CI	ICC test	95% CI
PRPP total	0.60	0.25 → 0.93	0.88	0.64 → 0.98
Perceive quadrant	0.59	0.26 → 0.93	0.88	0.64 → 0.99
Recall quadrant	0.59	0.23 → 0.93	0.86	0.59 → 0.98
Plan quadrant	0.51	0.18 → 0.91	0.83	0.51 → 0.98
Perform quadrant	0.53	0.19 → 0.91	0.88	0.65 → 0.99

(indicating perfect agreement). Six points lie below zero indicating a negative value for the difference between scoring time 1 and scoring time 2. A trend towards negative differences when the mean average is higher is also apparent from the plot. The 95% CI for mean difference was calculated to  $-10.67 \rightarrow 3.17$ , falling well within the 2 SD range of the mean difference ( $-4.52 \pm 18.00$ ), and crossed zero (the expected difference between time 1 and time 2 if exact agreement was achieved).

## Discussion

This study measured intrarater agreement, interrater reliability and test reliability of the PRPP System of Task Analysis, using data from the PRPP Stage 2 analysis. Criterion-referenced assessments have previously been criticised for their lack of reliability between raters and inherent subjectivity of criteria interpretation. In this study, the PRPP System of Task Analysis was seen to have moderate interrater reliability when used to measure agreement between trained therapists and good test reliability.

Occupational therapists have limited choice in assessment tools appropriate for use with adults in PTA following brain injury. The added complication of agitated behaviour during task performance prevents use of pen-and-paper-based screening tools or full assessment batteries. Beyond daily monitoring of PTA status, limited cognitive assessment occurs in the current clinical context of acute



**FIGURE 2:** Bland and Altman plot of differences between time 1 and time 2 with mean Perceive, Recall, Plan and Perform (PRPP) total percentage (Total%) scores with zero reference line (solid), mean difference and  $\pm 2$  standard deviation (SD) lines (dotted).

brain injury rehabilitation, prior to PTA emergence. Functional observation using structured methods for recording and measuring behaviour are effective in measuring change during PTA (Weir, Doig, Fleming, Wiemers & Zemljic, 2006). Tools that combine structured observation and measurement of task-specific information processing with an overall measure of functional performance, such as The PRPP System of Task Analysis, offer a unique assessment system to occupational therapists working in this area of clinical practice. The PRPP System has been shown to be sensitive to change during this stage of recovery (Nott & Chapparo, 2007) and instrumental in guiding intervention (Fry & O'Brien, 2002). The criterion-referenced procedures that underpin scoring and administration of the assessment have been shown to offer good reliability across raters and within the assessment procedures themselves.

Criterion-referenced assessments that rely on professional judgement when scoring across different tasks and different clients require good reliability to allay concerns about the transparency and consistency of scoring procedures (Dunn, Morgan, Reilly & Parry, 2004). In this study, the reliability of test procedures was measured concurrently with rater reliability and found to demonstrate

**TABLE 2:** Bland and Altman tests for intrarater agreement between scoring occasions

	Mean PRPP scores			Bland and Altman		
	Time 1	Time 2	$\bar{d}$	SD <sub>diff</sub>	SE of $\bar{d}$	95% CI for $\bar{d}$
Intrarater agreement	62.15%	57.63%	-4.52	9.00	3.00	-10.67 → 3.17

CI, confidence interval; PRPP, Perceive, Recall, Plan and Perform; SD, standard deviation; SE, standard error.

good reliability across therapists, tasks and patients. While raters should possess an understanding of the relevance of criteria to both the task being assessed and the person who is performing the task, rigorous scoring rubrics are essential in achieving high levels of test reliability. Therapists undergo intensive postgraduate training focussed on applying the scoring rubric to a range of behaviours, both during the assessment workshop and postworkshop in the clinical setting.

Stability in measurement is important when evaluating patients over time in order to monitor change. Therapists' observations and scoring procedures (intrarater agreement) were measured over a 2-week period, identifying that therapists tended to give slightly lower scores at time 2. Factors leading to this require further investigation; however, some suggestions are offered. The reallocation of a three-rating to a two-rating on one strategy within a subquadrant/quadrant was commonly associated with several lowered scores in the same subquadrant/quadrant. This tendency to allocate same scores to items within the same subquadrant or quadrant may have contributed to a type of 'consistency effect' or 'consistency motif' (Podsakoff, MacKenzie, Lee & Podsakoff, 2003) at time 2. Alternatively, the research study procedure may have contributed to an unexpected source of error during scoring at time 2. On the first scoring occasion, therapists viewed and scored five patients. On the second testing occasion, therapists were required to rescore one patient only. This difference in measurement procedure may have impacted on therapists' rating of this patient, who they may have perceived as performing well in comparison to the other four patients, but more impaired when viewed alone. This may indicate that therapists compared performance *between* patients on the first measurement occasion which was an unexpected source of error, and not the intended purpose of a criterion-referenced measure (Anastasi, 1988). If this did in fact occur, it would have reduced both inter and intrarater reliability.

### Limitations

In order to achieve this research design with a three-way correlational model, all therapists are required to observe and rate all clients. In clinical settings, this is only feasible via scoring of video footage. Participants reported that scoring via video reduced the opportunities for therapists to engage directly with the client and created an artificial 'distance' between the therapist and patient that would not usually be present during clinical contexts.

Second, while the small sample size of therapists and clients is a limitation of this study, the standardised procedures and initial examination of reliability across nine therapists is a large step forward in comparison to the self-developed outcome measures typically used to demonstrate change in adults with cognitive and behavioural difficulties following TBI (Ylvisaker *et al.*, 2007). In addition, the findings contribute to the published information available on the PRPP System of Task Analysis,

which is in itself, an emerging assessment method. Generalisation of findings may be limited to therapists with PRPP training, working with a similar client group of adults with brain injury.

### Conclusion

The PRPP System of Task Analysis is a two-stage criterion-referenced assessment that measures both task performance skill and cognitive information processing capacity over time and in context. Occupational therapists have limited choice in assessment tools appropriate for use with adults in PTA following brain injury. The PRPP System of Task Analysis offers a unique assessment system to fill this gap for therapists working in this area of clinical practice. The criterion-referenced procedures that underpin scoring and administration of the assessment have been shown to offer good reliability across raters and within the assessment procedures themselves.

### References

- Anastasi, A. (1988). *Psychological testing*. New York: MacMillan Publishing Co.
- Arnadottir, G. (1990). *Brain and behavior: Assessing cortical dysfunction through activity of daily living*. St Louis, MO: Mosby.
- Baum, C. & Edwards, D. F. (1993). Cognitive performance in senile dementia of the Alzheimer's type: The kitchen task assessment. *American Journal of Occupational Therapy*, 47, 431–436.
- Bland, J. M. & Altman, D. G. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*, 327, 307–310.
- Boman, I., Lindstedt, M., Hemmingsson, H. & Bartfai, A. (2004). Cognitive training in home environment. *Brain Injury*, 18, 985–995.
- Carlson, T., MacDonald, D., Gorely, T., Hanrahan, S. & Burgess-Limerick, R. (2000). Implementing criterion-referenced assessment within a multi-disciplinary university department. *Higher Education Research and Development*, 19, 103–116.
- Chapparo, C. & Ranka, J. (1997a). *The Perceive, Recall, Plan and Perform System of Task Analysis*. In: C. Chapparo & J. Ranka (Eds.). *Occupational Performance Model (Australia), Monograph 1* (pp. 189–198). Sydney, NSW: Total Print Control.
- Chapparo, C. & Ranka, J. (1997b). *Occupational Performance Model (Australia), Monograph 1*. Sydney, NSW: Total Print Control.
- Corrigan, J. D. & Bogner, J. A. (1994). Factor structure of the agitated behavior scale. *Journal of Clinical and Experimental Neuropsychology*, 16, 386–392.
- Dunn, L., Morgan, C., Reilly, M. & Parry, S. (2004). *The student assessment handbook. New directions in traditional and on-line assessment*. London: Taylor & Francis.
- Eisner, E. W. (1993). Reshaping assessment in education: Some criteria in search of practice. *Journal of Curriculum Studies*, 25, 219–233.

- Fry, K. & O'Brien, L. (2002). Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: A case study. *Australian Occupational Therapy Journal*, 49, 182–187.
- Glaser, R. (1981). The future of testing: A research agenda for cognitive psychology and psychometrics. *American Psychologist*, 36, 923–936.
- Griffin, P. (1995). Competency assessment: Avoiding the pitfalls from the past. *Australian New Zealand Journal of Vocational Education Research*, 3, 34–59.
- Hagen, C. (2001). The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *Re-Learning Times*, 8, 1.
- Landis, J. R. & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33, 159–174.
- Lohri, J. (2005). Information and sensory processing abilities of young children with autism spectrum disorder. Unpublished Thesis. Sydney, NSW: The University of Sydney.
- Lombard, L. A. & Zafonte, R. D. (2005). Agitation after traumatic brain injury: Considerations and treatment options. *American Journal of Physical Medicine and Rehabilitation*, 84, 797–812.
- Munkhetvit, P. (2005). Cognitive assessment in patients with acquired brain injury in Thailand. Unpublished PhD Thesis. Sydney, NSW: The University of Sydney.
- Nott, M. T. & Chapparo, C. (2007). Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 55, 188–198.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y. & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended practices. *Journal of Applied Psychology*, 88, 879–903.
- Portney, L. G. & Watkins, M. P. (2000). *Foundations of clinical research: Applications to practice* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.
- Rockwood, K., Joyce, B. & Stolee, P. (1997). Use of goal attainment scaling in measuring clinically important change in cognitive rehabilitation patients. *Journal of Clinical Epidemiology*, 50, 581–588.
- Romiszowski, A. (1984). *Designing instructional systems*. London: Hogan Page.
- Schraagen, J. M., Chipman, S. F. & Shalin, V. (2000). *Cognitive task analysis*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Slifer, K. J., Tucker, C. L., Gerson, A. C., Sevier, R. C., Kane, A. C., Amari, A. et al. (1997). Antecedent management and compliance training improve adolescents' participation in early brain injury rehabilitation. *Brain Injury*, 11, 877–889.
- Sudsawad, P. (2005). Concepts in clinical scholarship. A conceptual framework to increase usability of outcome research for evidence-based practice. *American Journal of Occupational Therapy*, 59, 351–355.
- Weir, N., Doig, E. J., Fleming, J. M., Wiemers, A. & Zemljic, C. (2006). Objective and behavioural assessment of the emergence from post-traumatic amnesia (PTA). *Brain Injury*, 20, 927–935.
- Whiting, S., Lincoln, N. B., Bhavnani, G. & Cockburn, J. (1985). *The Rivermead perceptual assessment battery*. Windsor UK: NFER – Nelson.
- Wilson, B. A., Cockburn, J. & Baddeley, A. (2003). *Rivermead Behavioural Memory Test II*. Bury St Edmunds, UK: Thames Valley Test Company.
- Wong, S. P. & McGraw, K. O. (1999). Confidence intervals and *F* tests for intraclass correlations based on three-way random effects models. *Educational and Psychological Measurement*, 59, 270–288.
- Ylvisaker, M., Turkstra, L., Coehlo, C., Yorkston, K., Kennedy, M., Sohlberg, M. M. et al. (2007). Behavioural interventions for children and adults with behaviour disorders after TBI: A systematic review of the evidence. *Brain Injury*, 21, 769–805.

# **CHAPTER EIGHT**

## **THE PRPP SYSTEM OF INTERVENTION**

### **RESEARCH PHASE FOUR**

Chapter Eight reports on the findings from Research Phase Four. This paper outlines an investigation into the effectiveness of occupational therapy intervention with adults demonstrating agitation following severe brain injury. It involves a case series of eight adults during early brain injury rehabilitation.

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Authorship statements attesting to the contribution of the researcher are included in Appendix II.

## Effective occupational therapy intervention with adults demonstrating agitation during post-traumatic amnesia

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### Abstract

**Objective:** To investigate the effectiveness of occupational therapy (OT) with adults demonstrating agitation and post-traumatic amnesia (PTA) following brain injury.

**Design:** Single-system experimental design (ABAB) across subjects.

**Methods:** Eight subjects were recruited during acute rehabilitation. Current OT intervention was alternated with the experimental Perceive, Recall, Plan and Perform (PRPP) System approach over 4-weeks. Therapy was conducted daily. Information processing capacity during occupational tasks was measured using the PRPP System of Task Analysis. PTA status was monitored with the Westmead PTA Scale.

**Experimental intervention:** The PRPP System is a dynamic assessment and intervention approach that directly links results of cognitive task analysis with strategies for intervention. PRPP Intervention adopts an information processing approach that simultaneously focuses on task training, strategy training and strategy application within occupational performance.

**Results:** Seven subjects significantly improved in their application of processing strategies during the PRPP Intervention in comparison to current OT Intervention phases. Large treatment effects favoured the PRPP Intervention. Subjects demonstrated improved information processing strategy use both prior to and following emergence from PTA.

**Conclusions:** Occupational therapy intervention based upon the PRPP System of Task Analysis and Intervention improved subjects' ability to apply information processing strategies during occupational performance when compared to current intervention approaches.

**Keywords:** *Agitation information processing, occupational therapy, post-traumatic amnesia*

### Background

Difficulty processing information from the environment and learning from it affects the occupational performance of people with head injuries [1]. Occupational performance is based upon the interaction between people and their environments, with effective performance thought to be supported by a number of cognitive capacities [2]. Of particular relevance to this study is the application of cognitive information processing strategies that support everyday task performance. These can include attending, perceiving, recognizing, remembering, judging,

learning, knowing and problem-solving. Cognitive capacity also contributes to self-regulation of emotions, mood, affect and rationality during task performance [2, 3].

Various conceptual and philosophical views about the recovery of cognitive function after brain injury have led to differing approaches to cognitive intervention [4]. Occupational therapy has focused on application of two broad intervention typologies. First, the majority of therapists use a task training approach consisting of systematic instruction in a sequence of steps leading to functional outcomes in specific tasks [5]. This approach, while effective

in achieving skill acquisition of selected tasks during the rehabilitation phase of intervention, has often resulted in limited generalization to functional performance in more open environments [6]. Secondly, therapists have focused on training of specific cognitive strategies such as scanning, attention and organization outside the context of everyday task performance [7]. While studies indicate that this approach may lead to improvement in the targeted skill, application of the cognitive strategy to everyday task performance is poor [8]. Controversy remains about the most effective intervention approach to assist processing of cognitive dimensions of task performance, particularly in people who experience post-traumatic amnesia and agitation [9].

### Description of Perceive, Recall, Plan and Perform (PRPP) Intervention

Recently, Chapparo and Ranka [10] proposed an intervention approach that deviates from the dichotomized functional vs remedial typologies, by integrating aspects of systematic instruction and information processing theory. The PRPP Intervention is a task-oriented information processing approach that simultaneously focuses on task training, strategy training and strategy application within the context of everyday performance. It is

part of a dynamic system of intervention that is associated with the Occupational Performance Model (Australia) [2], which directly links the results of behavioural and cognitive task analysis with strategies for intervention [11]. It is an extension of the ‘Stop Think Do’ programme developed for use with children and adolescents with intellectual disability [12], self-harm tendencies, impulsivity and anger management issues [13]. Table I defines the core intervention strategies in the PRPP System of Intervention.

Patients learn to apply a sequence of processing strategies to ‘*Stop, Sense, Think, Do*’, that is gain the required level of arousal/attention for the task (*Stop*), perceive sensory information relevant to the task (*Sense*), engage in recall or planning strategies to develop a plan of action (*Think*), then implement the plan (*Do*). Patients learn to apply these strategies to their task performance by initially observing and modelling the therapist. The role of the therapist is to act as a cognitive mediator between the patient and the task. The therapist’s participation fades as the patient internalizes the strategies and applies them across a range of tasks and settings. The prompts of ‘*Stop, Sense, Think, Do*’ (given via verbal, visual, gestural and/or physical modes) are initially used as content free ‘meta-prompts’ to alert patients to process information required for

Table I. Core intervention strategies in the PRPP System of Intervention: Definition.

Strategy	Definition
Intervention goal is task mastery	<ul style="list-style-type: none"> <li>• Expected outcome is improved functional performance in everyday tasks required by the person’s occupational roles and context.</li> <li>• Intervention success is therefore measured by increased functional performance.</li> </ul>
Application of evidence based principles of systematic instruction	<ul style="list-style-type: none"> <li>• Goal of intervention is clear to client.</li> <li>• Least to most prompt hierarchy is used.</li> <li>• Multiple opportunities for practice of the task and target cognitive strategy are offered and performance errors are prevented.</li> <li>• Learning occurs across natural contexts and tasks to promote generalization.</li> <li>• Feedback is specific to task mastery and the cognitive strategy that is the target of intervention.</li> </ul>
Target descriptors (cognitive strategies) are behaviourally defined and measurable	<ul style="list-style-type: none"> <li>• Descriptors required for task performance are identified using the PRPP system of task analysis (outer ring Figure 1) and their effectiveness measured before and throughout intervention.</li> </ul>
‘Chunking’ of descriptors across all PRPP quadrants is planned	<ul style="list-style-type: none"> <li>• Starting with ‘Stops’, one or two descriptors only are targeted from each processing quadrant for ‘Sense’ (Perceive Quadrant), ‘Think’ (Recall and Plan Quadrants), and ‘Do’ (Perform Quadrant).</li> <li>• Single descriptors are not used.</li> <li>• A line of processing required for the task mirrors the direction of arrows in the centre of the PRPP system (Figure 1).</li> </ul>
Focus of intervention is on application of cognitive strategies (descriptors) to real world performance	<ul style="list-style-type: none"> <li>• The descriptor behaviours form the central verbal, physical or visual prompts given during performance and are modelled by the therapist if required.</li> <li>• The patient is taught to self-instruct in the strategies.</li> </ul>



task performance. Content free prompts have been shown to improve executive dysfunction in adults following brain injury, by enhancing monitoring of current and future goals in performance, as well as the strategies necessary to achieve them [14]. These global prompts are followed up with more specific content based behavioural prompts selected by the therapist, based on findings from the assessment component of the system. These specific prompts mirror the descriptors that have been assessed in the PRPP System of Task Analysis and are pictured on the outer ring of Figure 1.

**Method**

*Design*

An ABAB experimental design was replicated across eight subjects to compare the current occupational therapy intervention approach with the experimental, PRPP Intervention. This design enabled intensive study of each subject and their response to both intervention approaches. Treatment could be specifically tailored to the patient’s needs while maintaining the controls necessary for determining the effects of treatment [15]. The clinical

context in which data was collected ensured the ecological validity of the results and provided a powerful decision-making tool for evidence-based practice [16]. In a heterogeneous population such as brain injury, single-case designs are often considered the ‘method of choice’ when evaluating therapeutic change in individuals [17, 18]. Implementing repeated baseline and intervention phases improved the internal validity of the study by controlling for history and maturation within subjects [16, 19, 20]. This type of reversal design is particularly relevant to neurological rehabilitation [21], as the effect of natural recovery can be more clearly differentiated from the effect of intervention [22].

*Target behaviours/dependent variables.* The primary target behaviour, or dependent variable, was information processing capacity during occupational performance. This was measured using the PRPP System of Task Analysis [11].

*Intervention/independent variable.* The independent variable in this study was occupational therapy intervention. Subjects received usual occupational therapy intervention during baseline phases,

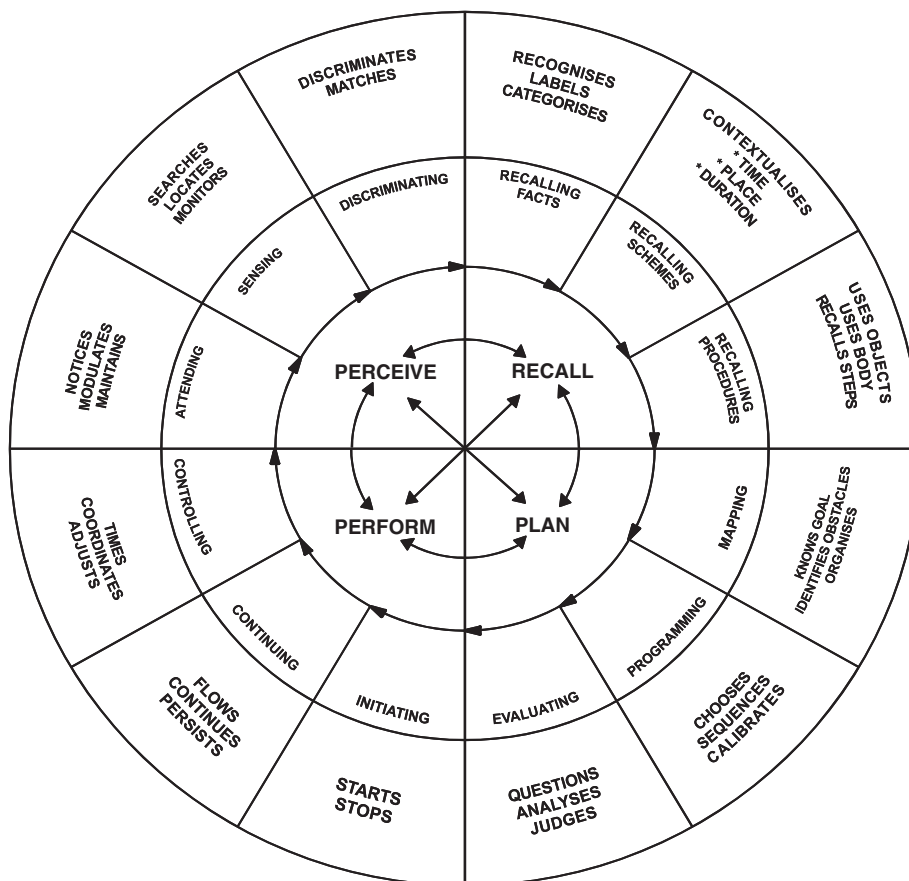


Figure 1. The Perceive, Recall, Plan and Perform System of Task Analysis.

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alternating with the PRPP Intervention during the experimental intervention phases. The effect of the experimental intervention was clear if performance improved from baseline ( $A_1$ ) to the first PRPP Intervention phase ( $B_1$ ), reverted back to or approached baseline level of performance when this intervention was withdrawn ( $A_2$ ) and improved again when the PRPP approach was reinstated in the second intervention phase ( $B_2$ ) [23].

### Subjects

Eight adults with brain injuries (seven traumatic brain injury (TBI); one hypoxic brain injury) participated in this study. Potential subjects were identified by clinicians and screened according to the following selection criteria: first onset brain injury; presence of post-traumatic amnesia; 17 years

of age or older; admitted/referred to the brain injury rehabilitation unit (BIRU); demonstrating behaviour consistent with Rancho Los Amigos Level IV 'Confused & Agitated' or V 'Confused & Inappropriate' [24]. All adults admitted to the BIRU during the 12-month period from November 2006–November 2007 were screened. Ten patients met all the above criteria and consent was gained from next of kin. Two patients were transferred to alternate rehabilitation facilities during the study period; therefore eight subjects were included in this case series. Demographic and injury related variables for these eight subjects are summarized in Table II.

### Intervention procedures

The study protocol involved four sequential phases, alternating between baseline and

Table II. Subject characteristics.

Subject	Age	Sex	CT scan/MRI results	GCS/15	Mode of injury	Recruitment (days since injury)	PTA (days)	Rancho level	Characteristic behaviours
1	35	F	DAI; Hyperdense foci in right hemisphere	8	CHI: Passenger in MVA	61	139	V	Restless, excessive response to external stimuli, poor attention, memory impairment
2	22	F	SAH; SDH; Multiple contusions; effacement of sulci	7	CHI: Driver in MVA	31	57	V	Heightened activity state, internal confusion, poor attention and memory, verbal outbursts
3	23	F	Multiple SAH; Frontal ICH; Left occipital haemorrhage	6	CHI: Driver in MVA	41	54	V	Excessive response to external stimuli, memory impairment, inappropriate responses
4	41	F	SAH with ventricular extension; facial fractures	4	CHI: Pedestrian hit by car	34	57	V	Restless, heightened activity state, memory impairment, non-purposeful behaviour
5	56	M	SAH; Right frontal contusions	3	CHI: Pushbike rider hit by car	59	U/A	IV	Aggressive, restless, responds primarily to internal stimuli, severe memory loss, confusion
6	25	M	Right frontal contusion; EDH; Fractured base of skull	3	CHI: Pedestrian hit by car	20	>60*	IV	Aggressive, restless, excessive response to internal & external stimuli, bizarre behaviours
7	47	M	Traumatic fronto-temporal lobectomy	12	Penetrating: GSW	34	57	IV	Non-purposeful behaviour, restless/wandering, fragmented responses, severe memory loss
8	24	M	Global ischaemic changes	N/A	Hypoxia	14	N/A	IV	Heightened activity state, poor attention, restless/wandering, severe memory loss

Notes: DAI = diffuse axonal injury; SAH = sub-arachnoid haemorrhage; SDH = sub-dural haematoma; ICH = intra-cranial haemorrhage; EDH = extra-dural haemorrhage; CHI = closed head injury; GSW = gunshot wound; MVA = motor vehicle accident; N/A = assessment not performed/appropriate due to non-traumatic nature of injury; U/A = unable to assess due to level of agitation and aggression; \*Subject 7 was transferred to an alternate rehabilitation facility 60 days post-injury and remained in PTA at this time.

experimental intervention. The study period (4-weeks) was established from previous research by the authors, identifying the average duration of agitation in patients at this rehabilitation facility to be 30 days [25]. Weekly alternation between phases enabled collection of at least six data points [19] on six consecutive days within each phase and served pragmatic purposes in treatment planning within the clinical context.

*Baseline intervention—current occupational therapy approach.* During baseline phases, subjects received daily occupational therapy from the clinical OT. The current approach is described as functional/compensatory with aspects of behavioural management. Therapy sessions targeted specific occupational tasks or activities selected by the clinical OT in accordance with rehabilitation goals (for example self-care, leisure, community participation, home management). Methods of intervention included systematic instruction; task adaptation; environmental modification; physical guidance; and facilitation. Intervention was conducted in each subject's hospital bedroom or bathroom, communal dining/leisure areas, ADL kitchen and local community settings, as part of a multi-disciplinary programme including medical and nursing care, physiotherapy, occupational therapy, speech pathology, clinical psychology and social work.

*Experimental intervention—PRPP System.* Occupational therapy was provided daily during the experimental intervention phases by the research OT (MN) using the PRPP intervention approach. The PRPP System, as outlined earlier, is a dynamic assessment and intervention approach, where intervention is based upon all stages of information processing. Intervention sessions specifically targeted learning of information processing strategies using graded prompts (verbal, visual, gestural, physical), progressing from content free meta-prompts to more specific content based behavioural prompts. Patients learnt to apply 'stopping', 'sensing/attending', 'thinking' (recalling and planning) and 'doing' strategies to their performance across various occupational tasks (including self-care, leisure, home management and community integration activities).

To minimize bias and maintain internal validity, the tasks/activities targeted during the experimental intervention phases were selected by the clinical OT. Multi-disciplinary rehabilitation continued as per the baseline phase, with the frequency of intervention remaining consistent across all phases. Subjects were informed they were to have different therapists on alternate weeks, with no further information

provided regarding similarities or differences in intervention procedures. Therapy sessions during the experimental phases were not observed by the clinical OT to minimize carry-over effects.

#### Measures

The primary target behaviour, information processing capacity during occupational performance, was measured using the PRPP System of Task Analysis. This tool forms part of the overall PRPP System of assessment and intervention. It is a criterion referenced assessment that employs task analysis methods to identify difficulties in information processing during task performance and provides a focus for intervention [11, 26]. The PRPP System of Task Analysis has demonstrated sensitivity in measuring information processing over time in a case study of severe agitation following TBI [27].

The subject receives a criterion-referenced score for 34 different information processing descriptors assessed during task performance. These descriptors are rated (3) effective for task performance, (2) questionable or (1) not effective. Ratings for each descriptor were summed and converted to a total percentage score, therefore a higher total score indicated that more effective processing strategies were being used by the subject during task performance.

Presence of post-traumatic amnesia (PTA) was an inclusion criterion of the study. PTA status was monitored daily using the Westmead PTA Scale [28]. Individuals were deemed to have emerged from PTA on the first day of scoring three consecutive scores of 12/12.

The PRPP System of Task Analysis was administered daily by the research OT, while the clinical OT or nursing staff conducted daily PTA monitoring. Phase length was set at a minimum of 6 consecutive days, with the intention to have one washout day between phases. Determining the length of baseline and experimental phases on an *a-priori* basis reduced assessor bias, thus the change from one phase to the next occurred irrespective of the research therapist's monitoring of the target behaviour. A small number of changes to phase length occurred in response to clinical decisions such as changing wards or clinical therapists.

#### Rater reliability

Common to single-system designs are potential methodological limitations due to observer bias [15]. In this study, the research OT completed daily measures of the target behaviour during both the baseline and experimental phases, in addition to providing the experimental intervention. Therapy sessions were videotaped to analyse intra-rater and

inter-rater reliability. Approximately one-quarter of all daily therapy sessions were videotaped; not all sessions could be videotaped due to the personal nature of many therapy sessions (focusing on self-care, dressing and showering retraining).

The research OT re-assessed each performance from the videotaped data. The second set of ratings was correlated with the initial ratings to measure *intra-rater* reliability. An independent rater also observed and scored the videotaped data. These ratings were correlated with the initial ratings by the research OT to measure *inter-rater* reliability [15]. The independent observer was an OT with extensive neurological rehabilitation experience, previously trained to administer the PRPP System of Task Analysis, with no relationship to the subjects or the study.

#### Data analysis

Visual and statistical analyses were performed. Change in performance level between adjacent phases, latency of change and trend/slope of plotted data were determined by visual analysis [23]. Linear regression lines are overlaid to assist the interpretation of visual data.

Prior to statistical analysis serial dependency of the data was checked using autocorrelation coefficients (refer to [17], p. 173 for specific procedures). Data were not serially dependent, meaning that ANOVA assumptions were not violated. Differences between the mean values obtained in each phase of the study were analysed using ANOVA, with a  $p$  value  $\leq 0.05$  used to determine statistical significance. Scheffé post-hoc tests were performed to localize significant differences between means of individual study phases. The effect size was measured using partial eta squared ( $\eta_p^2$ ), which estimates the amount of variance accounted for in the sample due to the treatment effect and the error variance [28]. Partial eta squared is a sample based statistic and therefore more appropriate to single-system designs than omega squared (a population based estimate of effect). Effect sizes above 0.26 were considered large [29, 30].

Rater agreement was measured using a type (3,1) intra-class correlation coefficient (ICC), with random subject factor and fixed rater factor, testing for absolute agreement [31, 32]. A coefficient  $\geq 0.85$  was considered acceptable for intra-rater and inter-rater agreement [19].

## Results

### Internal validity—observer bias

Intra-rater reliability was very high, ICC (3,1) = 0.97 (95% CI: 0.94–0.99), suggesting that the research

OT (MN) remained reliable over time in assessment of occupational performance using the PRPP System of Task Analysis. Level of agreement with an independent observer was examined through video analysis of one-quarter of all therapy sessions. The level of agreement, ICC (3,1) = 0.86 (95% CI: 0.73–0.93), supports the non-biased measurement procedures implemented by the research OT throughout the study.

### Individual subject results

Each figure in the following series presents one subject's daily PRPP scores expressed as a percentage, over the four phases of the study (ABAB). Time in days is represented on the  $x$ -axis. Where applicable, a vertical arrow from the  $x$ -axis indicates day of PTA emergence. The treatment protocol implemented with Subject 1 was replicated with three similar subjects (2, 3 and 4); then with two more severely injured subjects (5 and 6). Replication then occurred with Subject 7 who had an open head injury from a gunshot and Subject 8 who had sustained a hypoxic brain injury.

*Subject 1.* Subject 1's performance slowly declined during Baseline 1 from 35% to 20% on days 5 and 6 (see Figure 2). A large increase in performance level occurred on day 7 at the start of the first PRPP intervention phase (+38%). The performance trend clearly changes from deceleration to acceleration, which is maintained over Baseline 2 and Intervention 2. An immediate drop in performance level (–24%) occurred when the PRPP intervention was withdrawn at Baseline 2, followed by steady improvements across the phase. A second increase in performance level occurred on day 19 at the commencement of Intervention 2 (+22%). Clinically significant improvement in performance occurred over time despite Subject 1 remaining in PTA for the duration of the study.

Differences in performance across phases were statistically significant ( $F = 70.125$ ;  $p \leq 0.001$ ; see Table III). Post-hoc examination revealed statistically significant differences between Baseline 1 and Intervention 1 ( $p \leq 0.001$ ) and between Baseline 2 and Intervention 2 ( $p \leq 0.001$ ). A very large treatment effect ( $\eta_p^2 = 0.92$ ) was found with Subject 1, favouring the PRPP intervention approach.

*Subject 2.* During Baseline 1, Subject 2's performance fluctuated between 40–55%, achieving a stable level at 45% over days 4–6 (refer to Figure 3). Performance rapidly increased during the first Intervention phase, finishing near 80% on

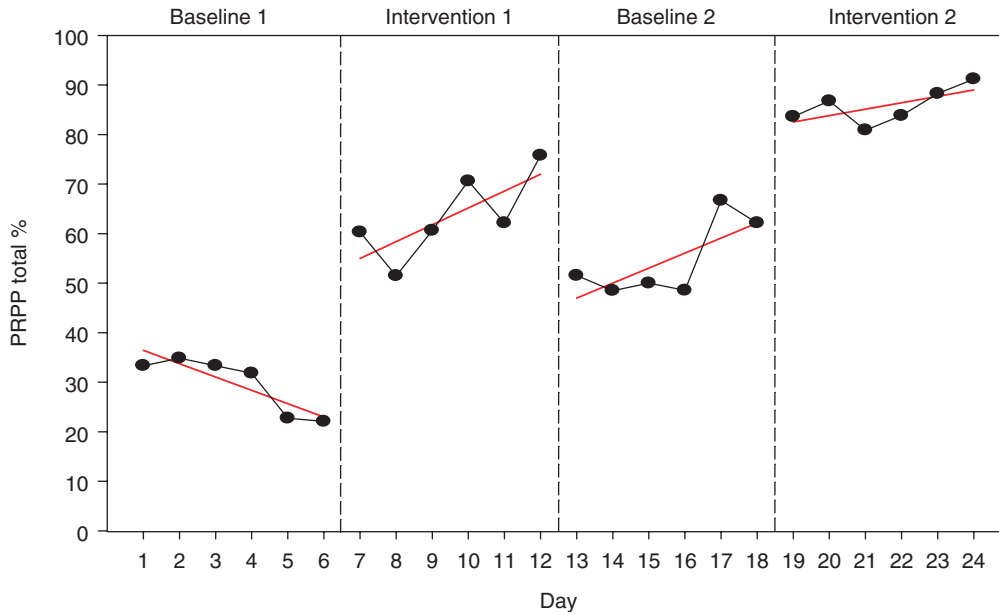


Figure 2. Subject 1—daily PRPP total % scores across each study phase.

Table III. Mean values with standard deviations for each subject across each phase, including ANOVA results and effect size.

Subject	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean	ANOVA		Effect size $\eta_p^2$
					F statistic	$\rho$	
1	29.7 (5.7)	63.5 (8.6)	54.7 (7.8)	85.8 (3.7)	71.38	0.001	0.92
2	46.8 (5.5)	74.5 (9.3)	66.3 (6.4)	89.9 (5.9)	41.59	0.001	0.87
3	74.0 (5.9)	84.6 (5.5)	80.1 (8.6)	95.3 (1.5)	13.84	0.001	0.68
4	23.3 (7.6)	74.4 (11.6)	54.6 (21.5)	85.3 (6.8)	31.72	0.001	0.81
5	4.0 (2.8)	16.2 (15.2)	3.8 (2.8)	13.4 (10.2)	2.77	0.068	
6	24.4 (5.9)	45.3 (9.0)	36.4 (6.6)	58.3 (6.4)	23.60	0.001	0.78
7	6.7 (5.1)	51.2 (23.0)	25.5 (5.9)	80.2 (15.1)	39.19	0.001	0.82
8	12.0 (5.4)	50.0 (4.9)	34.8 (13.4)	75.9 (6.5)	68.16	0.001	0.92

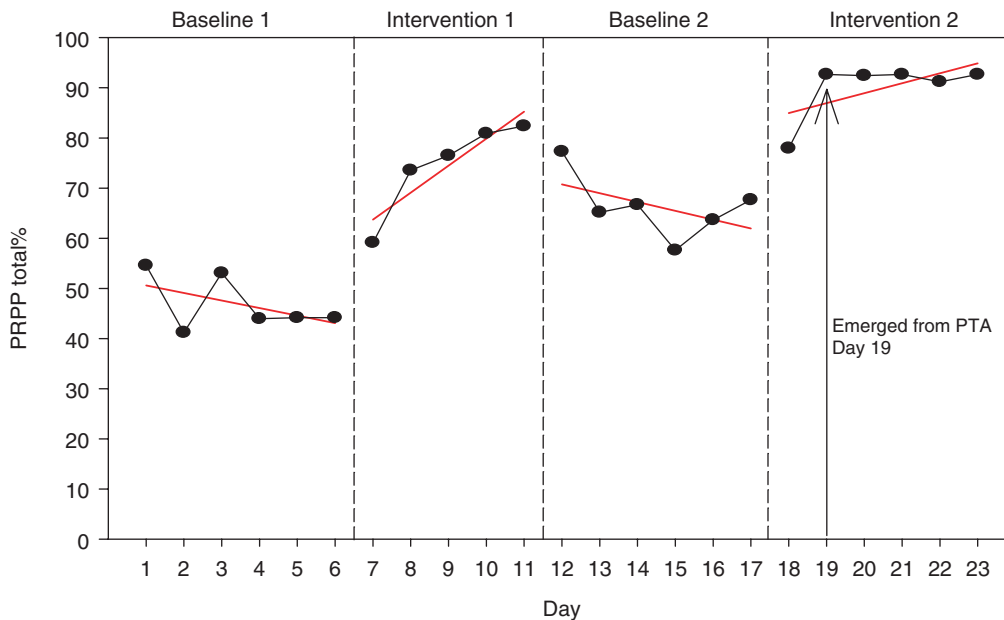


Figure 3. Subject 2—daily PRPP total % scores across each study phase.

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days 10 and 11. Performance slowly dropped away from this level during Baseline 2 when the PRPP intervention was withdrawn. A trend towards improvement was seen on the final 2 days of Baseline 2. This improvement was heightened during the second PRPP intervention phase with a plateau in performance near 95%, coinciding with emergence from PTA on day 19.

Differences in performance across phases were statistically significant ( $F=52.45$ ;  $p \leq 0.001$ ; see Table III). A very large treatment effect ( $\eta_p^2=0.87$ ) was again evident, favouring the PRPP intervention approach. Post-hoc examination revealed statistically significant differences between Baseline 1 and Intervention 1 ( $p \leq 0.001$ ) and between Baseline 2 and Intervention 2 ( $p \leq 0.001$ ). The effect of withdrawing PRPP intervention between Intervention 1 and Baseline 2 did not achieve statistical significance ( $p=0.277$ ); however, this finding should be interpreted with caution as the trend line changed direction between these two phases, that is performance improved during the intervention phase then declined during the adjacent baseline phase; therefore even though the difference between mean values may not be statistically significant, the clinical effect of withdrawing PRPP intervention is clear.

*Subject 3.* Subject 3's Baseline 1 performance was high (65–80%; refer to Figure 4) even though she remained in PTA and was demonstrating behaviours consistent with Rancho Level V such as out-of-proportion responses to external stimuli,

particularly auditory stimuli; confusion and conflation of events; memory impairment; and fragmented, often inappropriate responses during conversation. These behaviours were less evident during structured, functional task performance, though remained a challenge in the ward context. Even though changes in level between phases appeared small (see Figure 4), differences between mean Total PRPP% scores were statistically significant ( $F=14.26$ ;  $p \leq 0.001$ ; see Table III). Findings of the post-hoc examination revealed statistically significant differences between Baseline 1 and Intervention 1 ( $p=0.045$ ) and between Baseline 2 and Intervention 2 ( $p=0.002$ ). A large treatment effect ( $\eta_p^2=0.68$ ) was found with Subject 3, favouring the PRPP intervention approach.

*Subject 4.* Subject 4's Baseline 1 performance improved in steps from 15–35%. A large increase in performance level (+21%) occurred on day 9 and rapidly increased during the Intervention 1 phase, finishing at 85% on days 13 and 14, to coincide with emergence from PTA (see Figure 5). A large and immediate decrease in performance level occurred on day 15 at the start of Baseline 2, followed by a series of fluctuations between 25–79% over the remaining 5 days of Baseline 2. Performance increased consistently over the second PRPP intervention phase. These large changes in performance level between phases contributed to a statistically significant difference between phases ( $F=31.17$ ;  $p \leq 0.001$ ) and a very large treatment effect in favour of the PRPP intervention ( $\eta_p^2=0.81$ ).

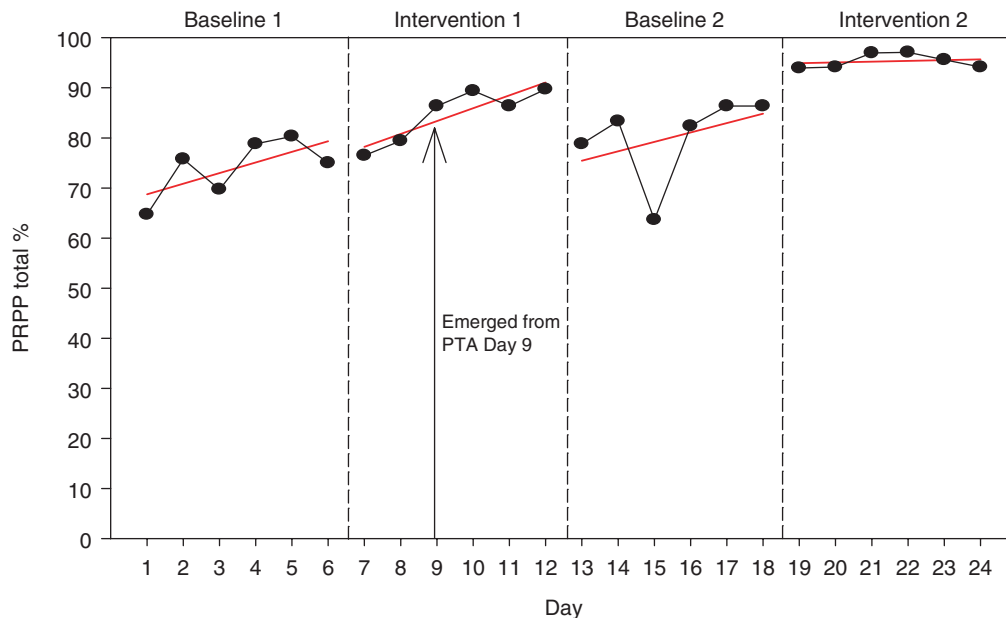


Figure 4. Subject 3—daily PRPP total % scores across each study phase.

Findings of the *post-hoc* examination reiterated findings from Subjects 1, 2 and 3, revealing a statistically significant difference between Baseline 1 and Intervention 1 ( $p \leq 0.001$ ) and between Baseline 2 and Intervention 2 ( $p \leq 0.001$ ).

*Subject 5.* The promising results observed with Subjects 1–4 prompted replication of the protocol with two more severely injured adults. As can be seen in Figure 6, Subject 5 demonstrated the lowest levels of functional performance throughout the study, with Total PRPP% scores between 0–45%.

He remained confused and in PTA throughout the study but was not formally tested due to his extremely agitated response to daily testing. Visual interpretation of data across study phases suggested highly stable baseline phases (both Baselines 1 and 2) with an accelerating trend during both PRPP intervention phases (Interventions 1 and 2). Due to the *a-priori* determined phase length, the upward trend at the end of each PRPP intervention phase was not investigated further. The change in performance level between Baseline and adjacent Intervention

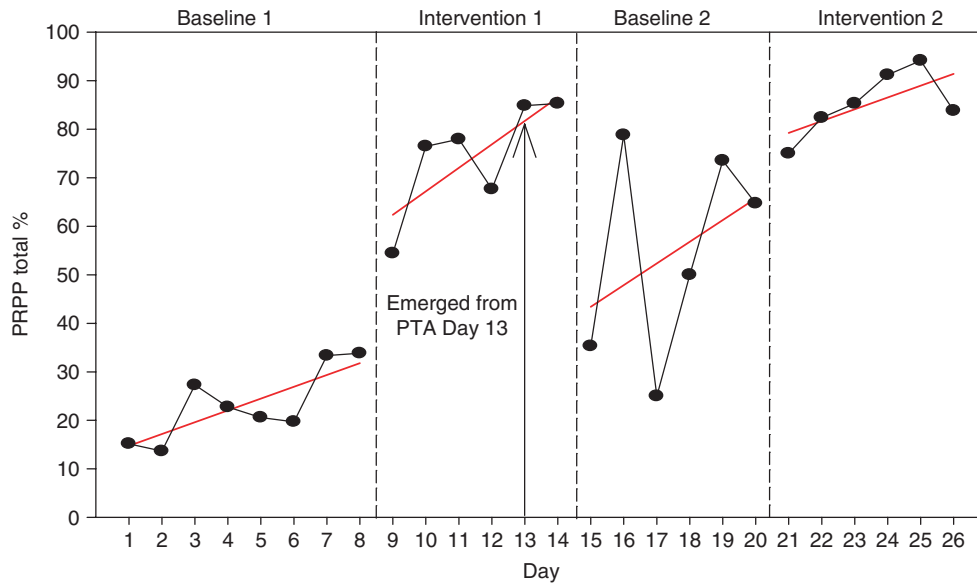


Figure 5. Subject 4—daily PRPP total % scores across each study phase.

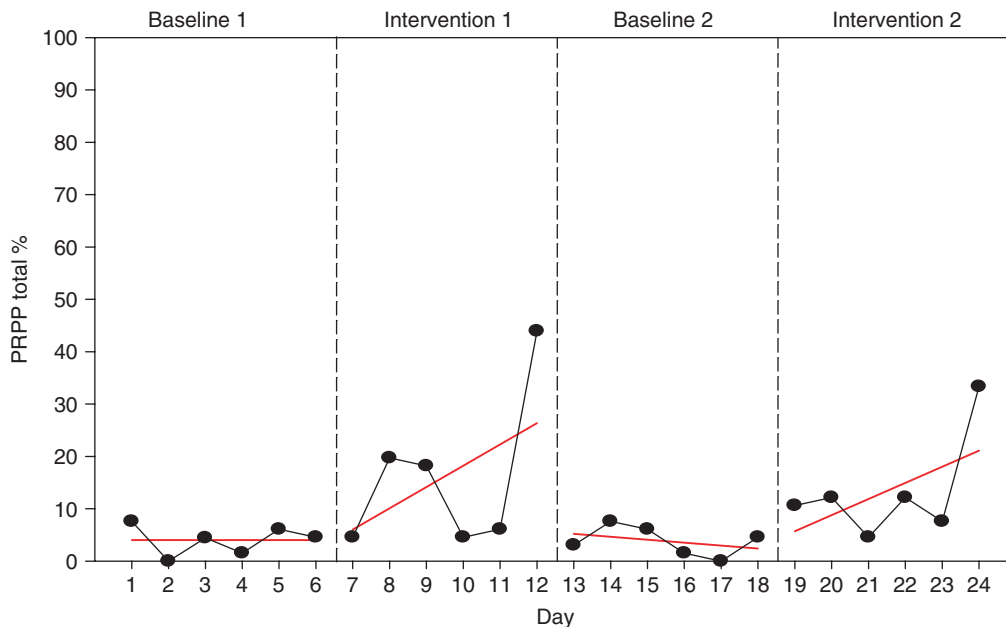


Figure 6. Subject 5—daily PRPP total % scores across each study phase.

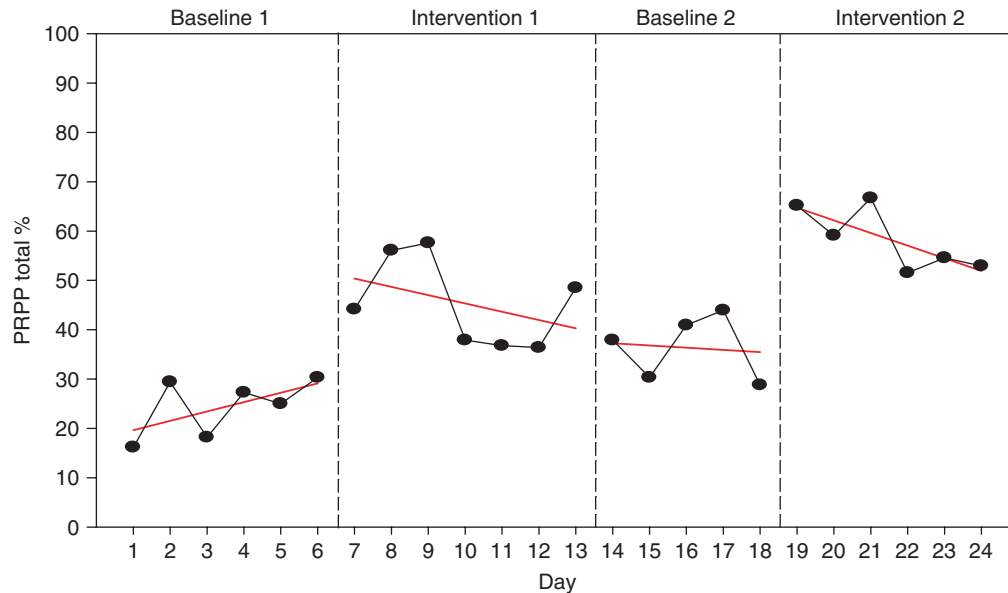


Figure 7. Subject 6—daily PRPP total% scores across each study phase.

phases was minimal. The effect of withdrawing the PRPP Intervention on day 13, at the start of Baseline 2, is quite clear. A drop in performance level by  $-41\%$  can be seen in Figure 6. The differences between means of Baseline and Intervention phases were not sufficient to reach statistical significance (refer to Table III), however a trend towards improvement was evident on the final day of both PRPP intervention phases, suggesting a clinically important deviation away from the baseline that could be further investigated with longer intervention phases.

**Subject 6.** Subject 6's performance slowly increased during Baseline 1 from 16–30%. A jump in performance level can be seen in Figure 7 on day 7 when the PRPP intervention was introduced (+14%). Performance continued to improve during the first few days of Intervention 1 then dropped to  $\sim 37\%$  before rising again on the last day of Intervention 1. This variable performance continued during Baseline 2, with an initial drop in performance level ( $-10\%$ ) and fluctuations in performance. A large increase in performance level occurred on day 19 at the commencement of the second PRPP Intervention phase (+36%), which was again followed by fluctuating performance across the phase. Large within-phase variation resulted in negative trend lines across the final three phases of the study. In spite of these variations in performance level *within* phases, the difference *between* phases was statistically significant ( $F=24.13$ ;  $p \leq 0.001$ ). Post-hoc measures

revealed statistically significant differences between Baseline 1 and Intervention 1 ( $p=0.001$ ) and between Baseline 2 and Intervention 2 ( $p=0.001$ ). A very large treatment effect ( $\eta_p^2=0.78$ ) was found with Subject 6, favouring the PRPP intervention approach.

**Subject 7.** Replication attempts then concentrated on subjects that were different to the preceding subjects, all of whom had sustained closed head injuries resulting from MVAs. In contrast, Subject 7 had sustained an open head injury from a gunshot and was initially managed on an acute surgical ward due to complications with the wound. The protocol was slightly modified for Subject 7 (refer to Figure 8). Baseline 1, Intervention 1 and the first 6 days of Baseline 2 were all conducted whilst Subject 7 remained in the acute ward setting. He was then transferred to the BIRU on day 19 and the protocol was modified to have an extended Baseline 2 period in order to collect 6 days of Baseline data in the BIRU prior to commencing Intervention 2. This ensured internal validity of comparing adjacent Baseline and Intervention phases within the same treatment context, i.e. acute and rehabilitation settings.

Subject 7's performance during Baseline 1 slowly accelerated from 0–13%. Performance then rapidly increased during Intervention 1, achieving performance scores of 76%. A large drop in performance level ( $-44\%$ ) occurred on day 13 when the PRPP intervention was withdrawn for Baseline 2. Minimal variation in performance was observed during



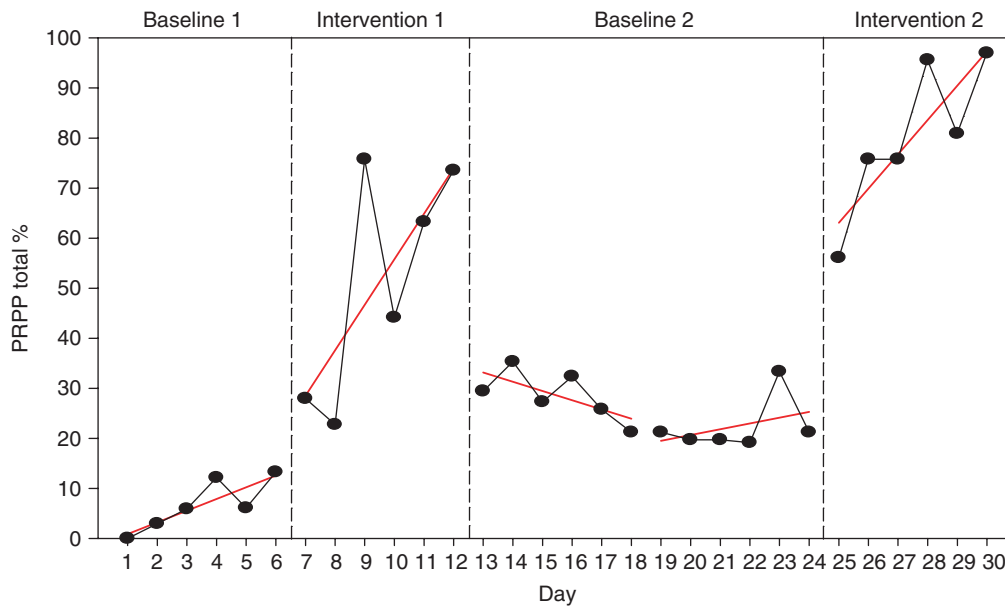


Figure 8. Subject 7—daily PRPP total % scores across each study phase.

Baseline 2, with performance scores ranging from 20–33% during both the acute and rehabilitation phases of Baseline 2. The performance level rapidly increased (+35%) at the start of Intervention 2 when the PRPP intervention was reintroduced. Subject 7 demonstrated a very strong response to the PRPP intervention approach in comparison to usual therapy, with a very large effect size ( $\eta_p^2 = 0.82$ ).

Differences between the mean values of phases were statistically significant ( $F = 39.51$ ;  $p \leq 0.001$ ). Post-hoc measures revealed statistically significant differences between all adjacent treatment phases: Baseline 1 and Intervention 1 ( $p \leq 0.001$ ), Baseline 2 and Intervention 2 ( $p \leq 0.001$ ) and Treatment 1 and Baseline 2 ( $p = 0.005$ ), the later highlighting the statistically significant effect of withdrawing the PRPP intervention.

*Subject 8.* Replication with non-TBI was then attempted. Subject 8 sustained a hypoxic injury secondary to cardiac failure. In contrast to all the preceding subjects who were managed in a highly specialized BIRU for all or part of the study period, Subject 8 remained in an acute cardiac ward for the duration of the study. In this case, Baseline intervention represents current occupational therapy intervention within the context of a general ward environment.

Visual analysis of Subject 8's performance (see Figure 9) indicates large changes in performance level between phases. A 29% increase in performance level occurred on day 7 when the PRPP intervention was first introduced. Subject 8's performance remained consistently high during

Intervention 1. His performance level clearly dropped (–38%) on day 13, at the start of Baseline 2, and again increased on Day 18 (+39%) when the PRPP Intervention was reintroduced. Performance was more variable during the final two phases with gradual improvement evident on the second Baseline and a downward trend evident during the final PRPP intervention phase. These large changes in performance level between phases were statistically significant ( $F = 67.87$ ;  $p \leq 0.001$ ) and produced one of the largest treatment effects of all subjects ( $\eta_p^2 = 0.92$ ) in favour of the PRPP intervention approach.

As seen with the previous subject, this large treatment effect size was associated with significant differences between all adjacent phases in the study. Post-hoc measures on Subject 8's data identified statistically significant differences between Baseline 1 and Intervention 1 ( $p \leq 0.001$ ), Baseline 2 and Intervention 2 ( $p \leq 0.001$ ) and Treatment 1 and Baseline 2 ( $p = 0.041$ ).

## Discussion

The results of this case series provide initial evidence for the immediate effectiveness of the PRPP System of Intervention during everyday performance of confused, agitated adults following severe brain injury. In eight cases, information processing strategies essential for daily occupational performance were identified and measured using the PRPP System of Task Analysis. Assessment findings directed the implementation of information processing strategies across a variety of occupational tasks.

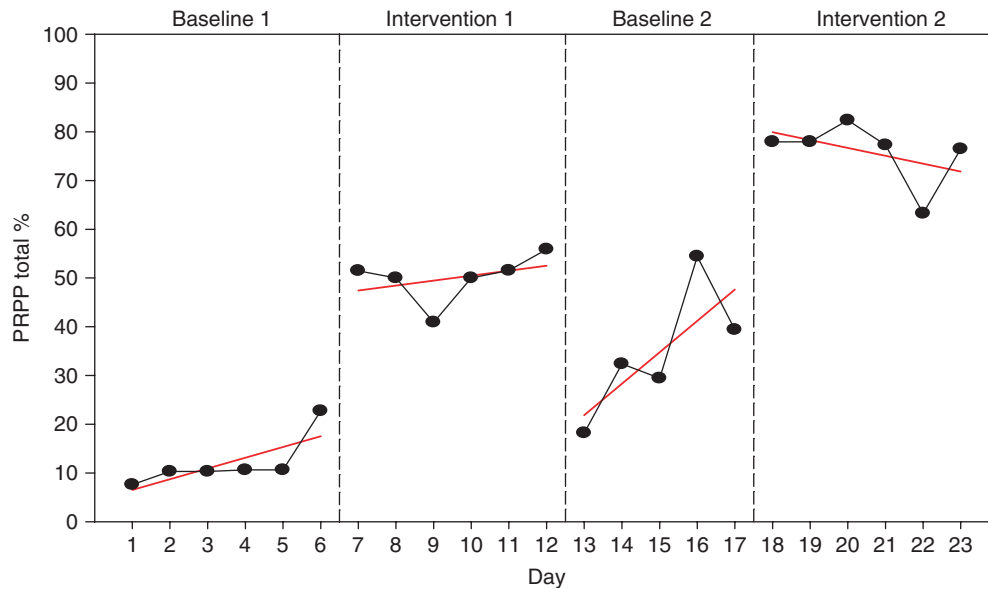


Figure 9. Subject 8—daily PRPP total % scores across each study phase.

This strategy focused approach appeared to be more effective than current occupational therapy instructional methods for improving information processing capacity within occupational tasks. Measures of treatment effectiveness suggest a large to very-large effect; with the PRPP Intervention explaining 68–92% of variance in task-based information processing capacity demonstrated by individual subjects.

Few published studies have attempted to evaluate occupational therapy intervention during the early stages of acute brain injury rehabilitation. In this study, subjects were specifically recruited whilst they remained in PTA and were functioning at Rancho Level IV or V. Three subjects emerged from PTA during the course of the study (Subjects 2, 3 and 4). All three demonstrated improved information processing strategy use during functional tasks both prior to and following emergence from PTA. After PTA emergence, Subjects 2 and 3 maintained quite high levels of performance with minimal variation, suggestive of a plateau reached coinciding with PTA emergence. In contrast, Subject 4 continued to demonstrate increases and decreases in PRPP scores with the introduction and withdrawal of the experimental intervention, even after PTA emergence. This may suggest that Subject 4's performance was more closely related to the effects of PRPP Intervention than PTA status.

Four subjects remained in PTA for the entire duration of the study (Subjects 1, 5, 6 and 7). Subject 5, who made least gains in this study, remained in PTA even though formal assessment was not conducted. All subjects demonstrated some improvement in ability to use information processing

strategies during occupational performance, particularly during the PRPP intervention phases of the study. Presence of PTA *per se* did not appear to limit these subjects' ability to acquire information processing strategies and to implement these in daily occupational tasks targeted by the PRPP intervention. These findings further support the commencement of active therapy prior to the emergence from PTA and add to the growing body of evidence that supports learning during PTA when therapy is targeted towards functional skill development [5, 33–35].

A characteristic feature of PTA in many cases is agitated behaviour. Clinicians report feeling challenged when working with agitated patients and feel these behaviours interfere with progress in therapy [36, 37], limiting potential gains during the critical early stages of recovery [38]. Subjects in this study demonstrated agitation across a spectrum from low-to-very high levels, in some cases for a short period of the study and in some cases for the entire duration of the study. The highest levels of agitation were evident in the most severely injured subjects (5 and 6), a finding supported by literature [38]. In particular, Subject 5 did not improve to the same level that other subjects did, in fact the overall effect of time and intervention was not statistically significant. An inherent baseline level of cognitive processing may be required to benefit from either of the intervention approaches adopted in this study. As found in a previous study of adults with severe cognitive deficits [39] strategy training or training of compensatory techniques places heavy demands on a person's already limited cognitive abilities, which may reduce the effectiveness

with severely impaired subjects. In spite of this, a promising trend towards improvement was seen with Subject 5 at the end of both PRPP Intervention phases. This highlights the potential for improvement and suggests that the effect of intervention may be gradual, requiring several days to consolidate the processing strategies that form the basis of the PRPP approach. In these cases, future research should consider extending the intervention period to better measure the effect of intervention.

The reversal design enabled repeated baseline measurements of the effect of current occupational therapy intervention and the contribution of natural recovery and therapeutic milieu. In all cases, processing strategy use during occupational tasks declined at the start of Baseline 2 (when the usual intervention approach was reintroduced), though it did not usually return to the level of Baseline 1. This effect may be accounted for in at least three ways. First, the process of natural recovery would predispose an individual to improved performance over time, even in the absence of therapy; therefore a complete return to Baseline 1 level of performance was not expected. Secondly, the Baseline phases represented current therapy, that is they *did not* represent an *absence* of therapy. Performance during both Baseline phases was expected to improve in response to current occupational therapy intervention. In general, Baseline 2 performance was characterized by an immediate drop in level at the time of withdrawing the PRPP Intervention, followed by several days of stable or gradually improving performance. This research design required an *additional* improvement in performance to demonstrate the effect of the PRPP Intervention approach. The third factor stopping performance levels returning completely to Baseline 1 levels is the potential effect of learning. Subjects who effectively learned information processing strategies during the first PRPP intervention phase may have applied these same strategies during therapy sessions in the second baseline. While there are methods for 'forcing a reversal' these practices are not recommended and were not included in the design of this study [15].

A frequently cited limitation of single-system research is poor generalization to other subjects within the same population. Several design features were in place to address generalization. The study protocol, that was highly effective with Subject 1, was systematically replicated across subjects and settings to accumulate evidence for external validity and generalization of findings [17, 19]. First the study protocol was replicated with three similar subjects (2, 3 and 4) and then with two more severely injured subjects (5 and 6). As expected, similar treatment effects were observed in Subjects 2, 3 and 4; whilst slightly lesser treatment effects

were observed with Subjects 5 and 6. The study protocol was then replicated with subjects who had sustained different types of brain injuries, via different injury modalities, in different rehabilitation contexts. Subject 7 had an open head injury from a gunshot and Subject 8 had sustained a hypoxic brain injury. Both demonstrated very strong treatment effects in favour of the PRPP Intervention, suggesting the effect of intervention may generalize to open and non-traumatic brain injuries. Subject 7 was recruited into the study whilst on an acute-surgical ward. He completed part of the study protocol in this acute setting and part in the BIRU. Subject 8 remained in an acute setting throughout the entire study period. The large treatment effects observed in these subjects suggests the PRPP Intervention may also generalize to an acute ward setting and may result in even greater effects in comparison to usual treatment than in a specialized BIRU setting. Other factors such as subject age, time to rehabilitation admission and time to commence intervention may contribute to a greater or lesser treatment effect from the PRPP Intervention approach, though these factors could not be clearly evaluated in such a small sample.

Calculation of effect size in single-system designs is rarely published, with researchers preferring to rely upon visual analysis. Concerns regarding autocorrelation of data from single-system designs increasing the likelihood of Type I errors appears to deter researchers from utilizing statistical methods of analysis [40]. Data were checked and only a slight degree of positive autocorrelation existed between data within individual subjects' study phases; this degree of autocorrelation was not sufficient to produce serial dependency when assessed using procedures outlined by Ottenbacher [17]. Several different measures of effect size were calculated based upon published recommendations for single-subject and repeated measures designs [29, 40, 41]. All lead to the same conclusions regarding effectiveness of treatment. Partial eta squared was finally selected as the preferred effect size measure in this study, where differences between phases were initially measured using ANOVA on data that were not serially dependent.

The limitations of this study are inevitably those inherent in a single-system experimental design. Procedures to minimize threats to internal and external validity were included in the study design. Intra-rater and inter-rater reliability was established using retrospective video-analytical methods. Agreement achieved between the independent observer and the research therapist suggested that observer bias was minimal during this study, based upon the available video data representing one-quarter of all therapy sessions. Replicating the

protocol across subjects and settings strengthened external validity.

## Conclusion

This study evaluated the effectiveness of the PRPP System of dynamic assessment and intervention in comparison to current occupational therapy approaches with brain injured adults. Both approaches were shown to be effective, with the PRPP Intervention being significantly more effective than current intervention approaches. Adults in early stages of brain injury rehabilitation effectively learned and applied information processing strategies to improve task performance, in the presence of agitation and post-traumatic amnesia.

Using both the assessment and intervention components of the PRPP System enabled intervention to be directed by assessment findings specific to the person, task and environment. Previous studies have highlighted the clinical utility of the assessment component of the PRPP System [26, 27]. This case series presents the first published findings supporting the intervention component of the PRPP System. Future studies using the PRPP System of Assessment and Intervention are required to build on these initial findings, through examination of treatment effect across a broader range of patients at various stages of TBI recovery, in a variety of settings (for example post-acute rehabilitation) and with a larger group of therapists.

## Acknowledgements

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**Declaration of interest:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

## References

1. Adamovich BB, Henderson JA, Auerbach S. Cognitive rehabilitation of closed head injured patients: A dynamic approach. Boston: Little: Brown & Company; 1985.
2. Chapparo C, Ranka J. Occupational performance model (Australia), Monograph 1. Sydney: Total Print Control; 1997.
3. Kielhofner G. Conceptual foundations of occupational therapy. Philadelphia: F.A. Davis Company; 2004.

4. Lee SS, Powell NJ, Esdaile S. A functional model of cognitive rehabilitation in occupational therapy. *Canadian Journal of Occupational Therapy* 2001;68:41–50.
5. Giles GM, Clark-Wilson J. Functional skills training following severe brain injury. In: Giles GM, Clark-Wilson J, editors. *Rehabilitation of the severely brain-injured adult*. 2nd ed. Cheltenham: Stanley Thornes (Publishers) Ltd; 1999. pp 97–134.
6. van den Broek MD. Why does neurorehabilitation fail? *The Journal of Head Trauma Rehabilitation* 2005;20:464.
7. Radomski MV, Davis ES. Optimizing cognitive abilities. In: Trombly Latham CA, Radomski MV, editors. *Occupational therapy for physical dysfunction*. 6th ed. Baltimore: Lippincott: Williams & Wilkins; 2008. pp 748–773.
8. Kinney A. Cognitive therapy and brain-injury: Theoretical and clinical issues. *Journal of Contemporary Psychotherapy* 2001;31:89.
9. Wilson BA. Towards a comprehensive model of cognitive rehabilitation. *Neuropsychological Rehabilitation* 2002;12: 97–110.
10. Chapparo C, Ranka J. The PRPP system: Intervention. Lidcombe, NSW, Australia: Available from the Discipline of Occupational Therapy, Faculty of Health Sciences, The University of Sydney; 2007.
11. Chapparo C, Ranka J. The perceive, recall, plan and perform system of task analysis. In: Chapparo C, Ranka J, editors. *Occupational performance model (Australia)*, Monograph 1. Sydney: Total Print Control; 1997. pp 189–198.
12. Beck J, Horne D. A whole school implementation of the Stop, Think, Do! social skills training program. In: Willis B, Izard J, editors. *Student behavior problems: Directions, perspectives and expectations*. Hawthorn, Victoria: Australian Council for Educational Research; 1992.
13. Murphy DP, Cooke J. Traffic light lessons: Problem solving skills with adolescents. *Community Practitioner* 1999;72: 322–324.
14. Fish J, Evans JJ, Nimmo M, Martin E, Kersel D, Bateman A, Wilson BA, Manly T. Rehabilitation of executive dysfunction following brain injury: 'content-free' cueing improves everyday prospective memory performance. *Neuropsychologia* 2007;45:1318–1330.
15. Thompson CK. Single subject controlled experiments in aphasia: The science and the state of the science. *Journal of Communication Disorders* 2006;39:266–291.
16. Zhan S, Ottenbacher KJ. Single subject research designs for disability research. *Disability and Rehabilitation* 2001;23: 1–8.
17. Ottenbacher KJ. Evaluating clinical change: Strategies for occupational and physical therapists. Baltimore: Williams & Wilkins; 1986.
18. Polatajko HJ, Mandich AD, Miller LT, Macnab JJ. Cognitive orientation to daily occupational performance (CO-OP): Part II—the evidence. *Physical and Occupational Therapy in Pediatrics* 2001;20:83–106.
19. Backman CL, Harris SR, Chisholm J-AM, Monette AD. Single-subject research in rehabilitation: A review of studies using AB, withdrawal, multiple baseline, and alternating treatments designs. *Archives of Physical Medicine and Rehabilitation* 1997;78:1145–1153.
20. Ottenbacher KJ, Hinderer SR. Evidence-based practice: Methods to evaluate individual patient improvement. *American Journal of Physical Medicine & Rehabilitation* 2001;80:786–796.
21. Alderman N. Individual case studies. In: Priebe SP, Slade M, editors. *Evidence in mental health care*. Hove: Brunner-Routledge; 2002. pp 142–157.

22. Barlow DH, Hersen M. Single case experimental designs. Strategies for studying behavior change. 2nd ed. Elmsford, New York: Pergamon Press Inc; 1984.
23. Kazdin AE. Research design in clinical psychology. Boston: Allyn & Bacon; 2003.
24. Hagen C. The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *Re-Learning Times* 2001;8:1.
25. Nott MT, Chapparo C, Baguley IJ. Agitation following traumatic brain injury: An Australian sample. *Brain Injury* 2006;20:1175–1182.
26. Fry K, O'Brien L. Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: A case study. *Australian Occupational Therapy Journal* 2002;49:182–187.
27. Nott MT, Chapparo C. Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 54. Published article online: 27-Sep-2007. doi: 10.1111/j.1440-1630.2007.00685.x
28. Shores EA, Marosszeky JE, Sandanam J, Batchelor J. Preliminary validation of a clinical scale for measuring the duration of posttraumatic amnesia. *Medical Journal of Australia* 1986;144:569–572.
29. Bakeman R. Recommended effect size statistics for repeated measures designs. *Behavior Research Methods* 2005;37:379–384.
30. Tabachnick BG, Fidell LS. Using multivariate statistics. Boston: Pearson Education Inc; 2007.
31. Shrout PE, Fleiss JL. Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin* 1979;86:420–428.
32. Rankin G, Stokes M. Reliability of assessment tools in rehabilitation: An illustration of appropriate statistical analyses. *Clinical Rehabilitation* 1998;12:187–199.
33. Gasquoine PG. Learning in post-traumatic amnesia following extremely severe closed head injury. *Brain Injury* 1991;5:169–175.
34. Weir N, Doig EJ, Fleming JM, Wiemers A, Zemljic C. Objective and behavioural assessment of the emergence from post-traumatic amnesia (PTA). *Brain Injury* 2006;20:927–935.
35. Glisky EL, Delaney SM. Implicit memory and new semantic learning in posttraumatic amnesia. *Journal of Head Trauma Rehabilitation* 1996;11:31–42.
36. Lequerica AH, Rapport LJ, Loehner K, Axelrod BN, Jr Vangel SJ, Hanks RA. Agitation in acquired brain injury: Impact on acute rehabilitation therapies. *Journal of Head Trauma Rehabilitation* 2007;22:177–183.
37. Sandel ME, Mysiw WJ. The agitated brain injured patient. Part 1: Definitions, differential diagnosis, and assessment. *Archives of Physical Medicine & Rehabilitation* 1996;77:617–623.
38. Corrigan JD, Mysiw WJ. Agitation following traumatic head injury: Equivocal evidence for a discrete stage of cognitive recovery. *Archives of Physical Medicine & Rehabilitation* 1988;69:487–492.
39. Sohlberg MM, Mateer CA. Training use of compensatory memory books: A three stage behavioural approach. *Journal of Clinical & Experimental Neuropsychology* 1989;11:871–891.
40. Olive ML, Smith BW. Effect size calculations and single subject designs. *Educational Psychology* 2005;25:313–324.
41. Parker RI, Brossart DF. Evaluating single-case research data: A comparison of seven statistical methods. *Behavior Therapy* 2003;34:189–211.



## **CHAPTER NINE**

### **SUPPLEMENTARY ANALYSIS**

#### **RESEARCH PHASE FOUR**

This chapter presents further analysis of the data collected in the ABAB case series of Chapter Eight. In particular, a quadrant-by-quadrant breakdown of the Stage 2 PRPP data will be presented, followed by Rasch calibration of the information processing hierarchy as per Chapter Six. These findings provide more detail than what was possible to include in the published journal format of Chapter Eight.

Data from Stage 1 of the PRPP System of Task Analysis is provided in Appendix IV. This research focused on changes to strategy applications as measured by Stage 2 of the PRPP System, therefore Stage 1 data is presented for the reader's interest in Appendix IV and is not elaborated on within the body of the thesis.

The research design, subjects, and data collection procedures are consistent with the previous chapter (Section 8.2.1, 8.2.2, and 8.2.3 respectively).

All sources cited in this Chapter are referenced in the main reference list following Chapter 11.

## **9.1 SUPPLEMENTARY RESEARCH QUESTION**

This supplementary analysis addresses the specific research question:

*How do processing strategies across the different PRPP quadrants change in response to PRPP Intervention with adults demonstrating agitated behaviour during acute TBI rehabilitation?*

## **9.2 DATA ANALYSIS**

### **9.2.2 Visual analysis**

For this supplementary analysis, PRPP Total % scores have been broken down into quadrant % scores reflecting the application of information processing strategies from each separate quadrant: Perceive, Recall, Plan and Perform.

As per Chapter 8, data were first checked for serial dependency using autocorrelation coefficients (refer to Ottenbacher, 1986, p.173 for specific procedures). A statistically significant level of autocorrelation was present, therefore data analysis was limited to visual interpretation of change in performance level between adjacent phases, latency of change, and trend/slope of plotted data (Kazdin, 2003). Phase mean values have been calculated and plotted on the graphs to assist visual interpretation.

### **9.2.3 Rasch analysis**

A multi-faceted Rasch model, as per Equation 6.2 (Chapter 6) was again used. Data were entered into FACETS (Linacre, 2007) and analysed as per Chapter 6 Section 6.2.3 to generate a Rasch modelled hierarchy of PRPP descriptors for the purpose of

confirming the ordering of items from Chapter 6, and to examine the effect of PRPP Intervention on hierarchical ordering of descriptor items.

A confirmatory correlational analysis was conducted between individual descriptor item values from the Rasch calibrated hierarchies in Chapter 6 and this chapter.

## 9.3 RESULTS

### 9.3.1 Visual quadrant-by-quadrant analysis

Each figure in the following series presents one subject's daily PRPP scores expressed as a percentage for each quadrant, over the four phases of the study (A<sub>1</sub>B<sub>1</sub>A<sub>2</sub>B<sub>2</sub>).

#### 9.3.1.1 Subject 1

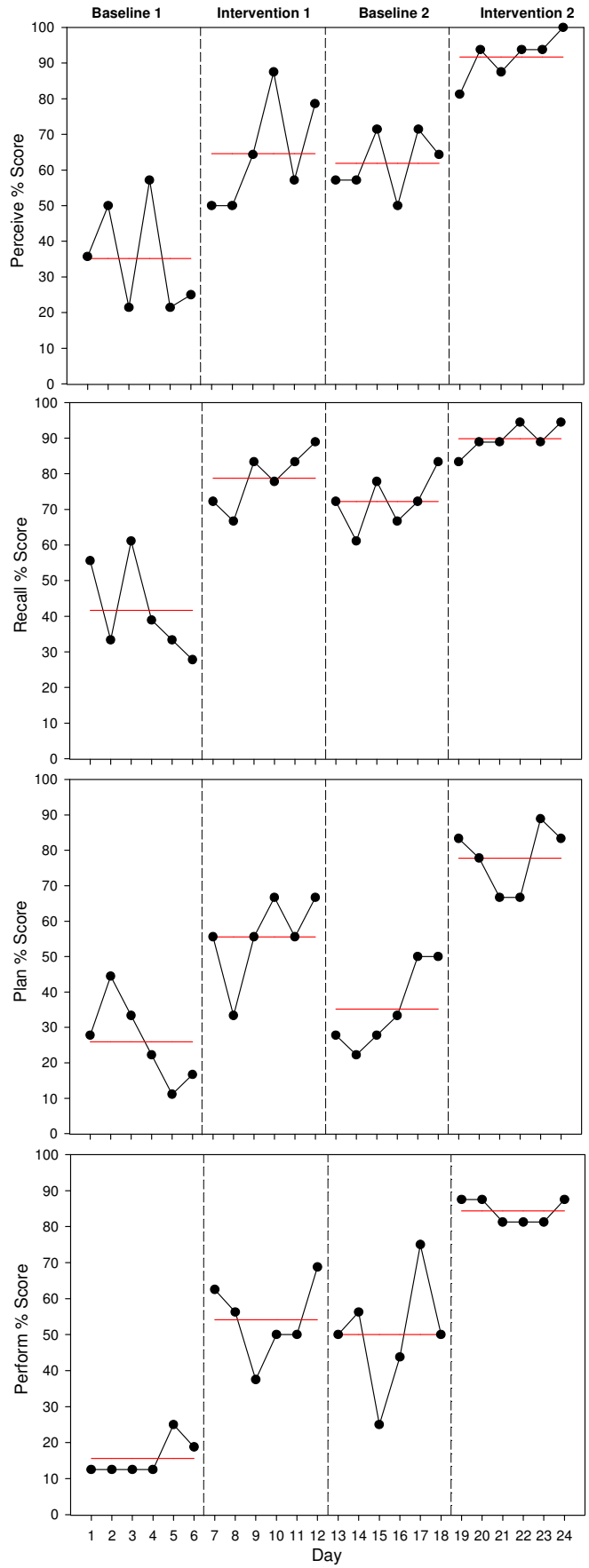
At the time of recruitment, Subject 1 was demonstrating poor attention and memory, restlessness, impulsivity, and agitation in response to external stimuli. A moderate degree of within phase variability is evident in Figure 9.1. Application of information processing strategies in all quadrants progressively improved (see Table 9.1), showing greatest improvement during the PRPP Intervention phases (B<sub>1</sub> & B<sub>2</sub>).

**Table 9.1 Subject 1: Quadrant mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	35.1 (15.4)	64.6 (15.5)	61.9 (8.7)	91.7 (6.5)
RECALL	41.7 (13.5)	78.7 (8.2)	72.7 (7.9)	89.8 (4.2)
PLAN	25.9 (12.0)	55.6 (12.2)	35.2 (12.0)	77.8 (9.3)
PERFORM	15.6 (5.2)	54.2 (10.9)	50.0 (16.3)	84.4 (3.4)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**





**Figure 9.1 Subject 1: Quadrant breakdown by study Phase**

The general pattern of change across study phases was similar for all quadrants. In general, application of processing strategies during Baseline 1 was low. A large change in level performance occurred at the start of PRPP Intervention 1, with an upward trend evident across Intervention Phase 1. In all quadrants, strategy application almost doubled between Baseline Phase 1 and Intervention Phase 1. Strategy application remained at this level for Perceive, Recall and Perform during Baseline 2, and declined for Plan Quadrant strategies when usual intervention was reintroduced. A second level change occurred when PRPP Intervention was reintroduced in Intervention Phase 2, achieving very high levels of performance in Perceive and Recall.

PRPP Intervention targeted processing strategies across all quadrants. In the first PRPP intervention phase, strategies for modulation of attention, improved search strategies, and monitoring of sensory information during task performance were targeted, along with strategies for improved timing and continuation to the task endpoint. In the second phase of PRPP Intervention, additional strategies were targeted for recall of correct body position and movements during tasks such as dressing and eating, along with identifying obstacles to performance, and evaluating task performance.

### ***9.3.1.2 Subject 2***

When recruited to this study, Subject 2 exhibited a heightened activity state, internal confusion, poor attention and memory, and occasional verbal outbursts with confabulation. Her Perceive and Recall Quadrants were comparatively stronger than the Plan and Perform Quadrants. Application of information processing strategies in

all quadrants improved most during the PRPP Intervention phases (see B<sub>1</sub> & B<sub>2</sub> phase means in Table 9.2).

**Table 9.2 Subject 2: Quadrant mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	71.4 (7.7)	84.3 (9.5)	67.4 (16.7)	92.6 (6.1)
RECALL	60.2 (6.5)	83.3 (3.9)	82.4 (8.2)	93.5 (5.5)
PLAN	32.4 (10.2)	62.2 (7.2)	50.0 (10.5)	80.6 (7.7)
PERFORM	25.0 (19.4)	68.8 (23.4)	65.6 (11.7)	93.8 (6.8)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

The pattern of change across the Perceive and Recall Quadrants was quite similar, starting from a high level of Baseline 1 performance, increasing slightly during PRPP Intervention Phase 1, and remaining near this level or slightly lower for Baseline 2. Strategy application again improved at the start of the second PRPP Intervention phase in both quadrants, achieving 100% performance in the later stage of this phase.

The processing pattern for Plan and Perform was different to that seen above. Both quadrant scores were initially low. Plan strategy difficulties included identifying obstacles, organising herself prior to task commencement, choosing tactics during task performance, sequencing task steps and evaluating her own performance, while Perform strategy deficits included continuing and persisting with task performance, coordinating and adjusting body movements and positions.

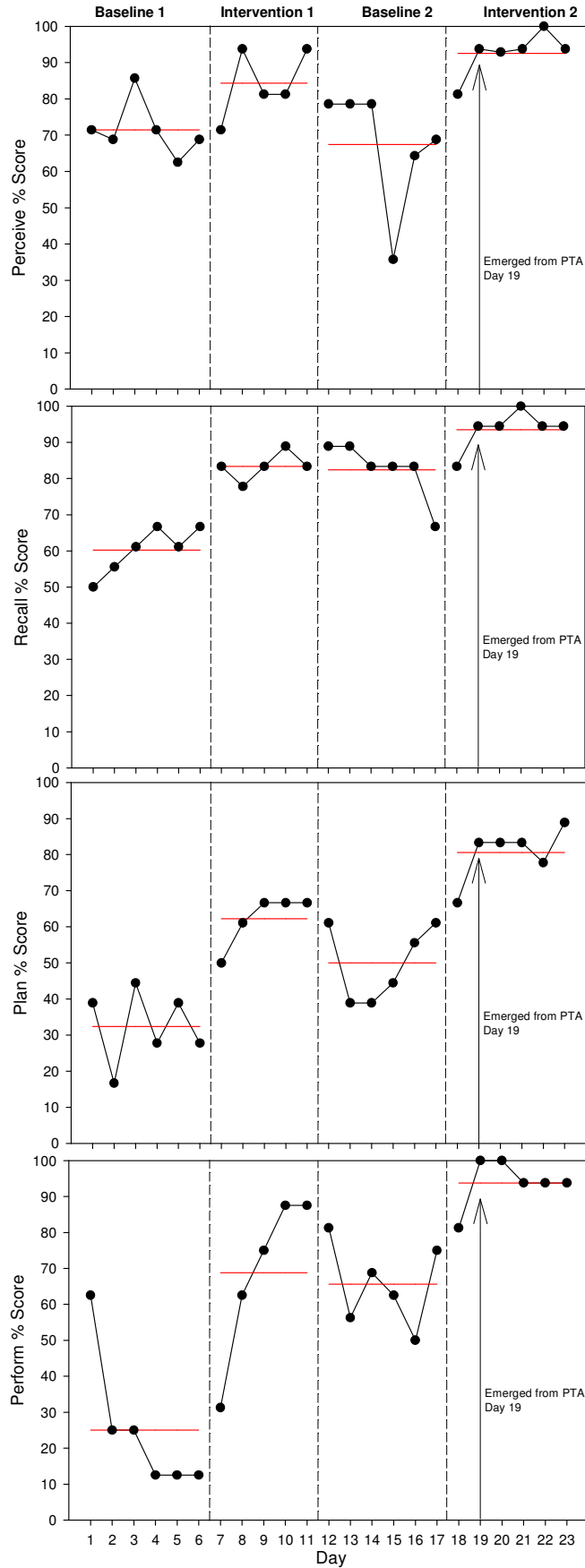


Figure 9.2 Subject 2 – Quadrant breakdown by study Phase

Plan and Perform Quadrant scores increased on the first day of PRPP Intervention Phase 1 and continued to increase across the intervention phase. Application of Plan strategies dropped considerably when the PRPP Intervention was withdrawn at Baseline 2, and Perform strategies reduced slightly. Performance in both quadrants again increased when the PRPP Intervention was reintroduced for Intervention Phase 2, to coincide with emergence from PTA.

### 9.3.1.3 Subject 3

When recruited to the study, Subject 3 was demonstrating internal confusion, poor memory, agitation in response to external stimuli, and verbal outbursts. She was able to participate in highly structured functional tasks but demonstrated fragmented responses. As can be seen in Table 9.3, Subject 3 had the highest Baseline (A<sub>1</sub>) scores of this case series.

**Table 9.3 Subject 3: Quadrant mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	77.1 (8.8)	86.3 (13.3)	86.0 (13.6)	96.9 (3.4)
RECALL	79.6 (7.6)	88.9 (5.0)	88.0 (6.5)	98.2 (4.5)
PLAN	68.5 (5.7)	83.3 (6.1)	69.4 (5.8)	92.6 (5.7)
PERFORM	70.8 (17.5)	80.2 (9.2)	78.1 (18.0)	93.8 (0.0)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

In general, quadrant scores progressively increased across consecutive study phases. In this case, changes in strategy application associated with introduction and withdrawal of the PRPP Intervention are less clear than the previous two Subjects. Subject 3 emerged from PTA on Day 9 of this study.

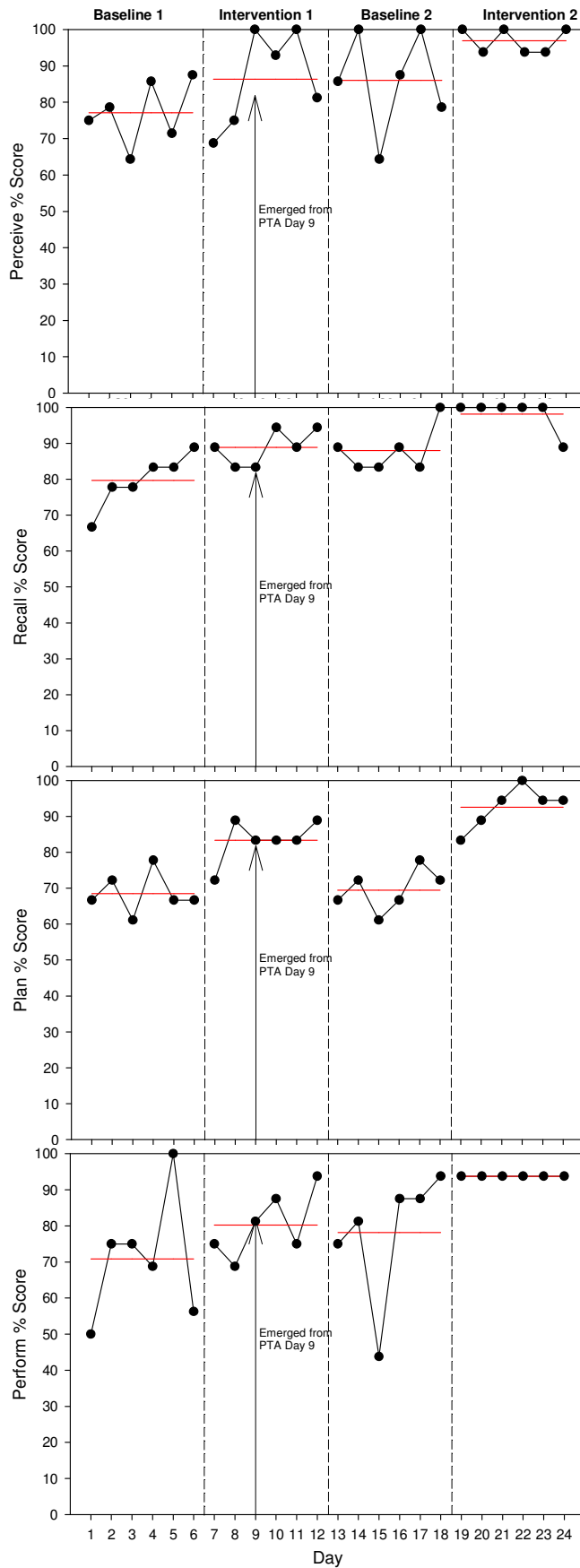


Figure 9.3 Subject 3 – Quadrant breakdown by study Phase

Figure 9.3 shows the Plan Quadrant strategies to be most responsive to the ABAB study design. Specific Plan strategies targeted during PRPP Intervention included organising, sequencing, choosing tactics, and identifying obstacles to task performance. An upward trend was evident during Intervention 1, with a mean increase of 15% from Baseline 1 to Intervention 1. An immediate drop in performance level occurred on Day 13 when the PRPP Intervention was withdrawn. Mean performance during Baseline 2 decreased by 14%, and then increased again by 23% during Intervention 2 when PRPP Intervention was re-introduced. A clear upward trend was again evident during the final intervention phase.

#### 9.3.1.4 Subject 4

Subject 4 was in PTA when recruited to the study, demonstrating restlessness, non-purposeful motor behaviour, and memory impairment. Use of information processing strategies during task performance was variable across all four quadrants during Baseline phases of the study (Refer to Figure 9.4). Performance improved during both PRPP Intervention phases (B<sub>1</sub> & B<sub>2</sub>) across all quadrants (See Table 9.4).

**Table 9.4 Subject 4: Quadrant mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	27.8 (13.0)	76.8 (13.8)	57.0 (24.4)	90.6 (7.7)
RECALL	36.8 (18.8)	80.6 (11.0)	71.3 (9.6)	90.7 (4.5)
PLAN	15.3 (6.5)	71.3 (10.8)	44.4 (26.8)	75.9 (13.0)
PERFORM	13.3 (7.0)	68.8 (16.3)	44.8 (31.2)	84.4 (10.3)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

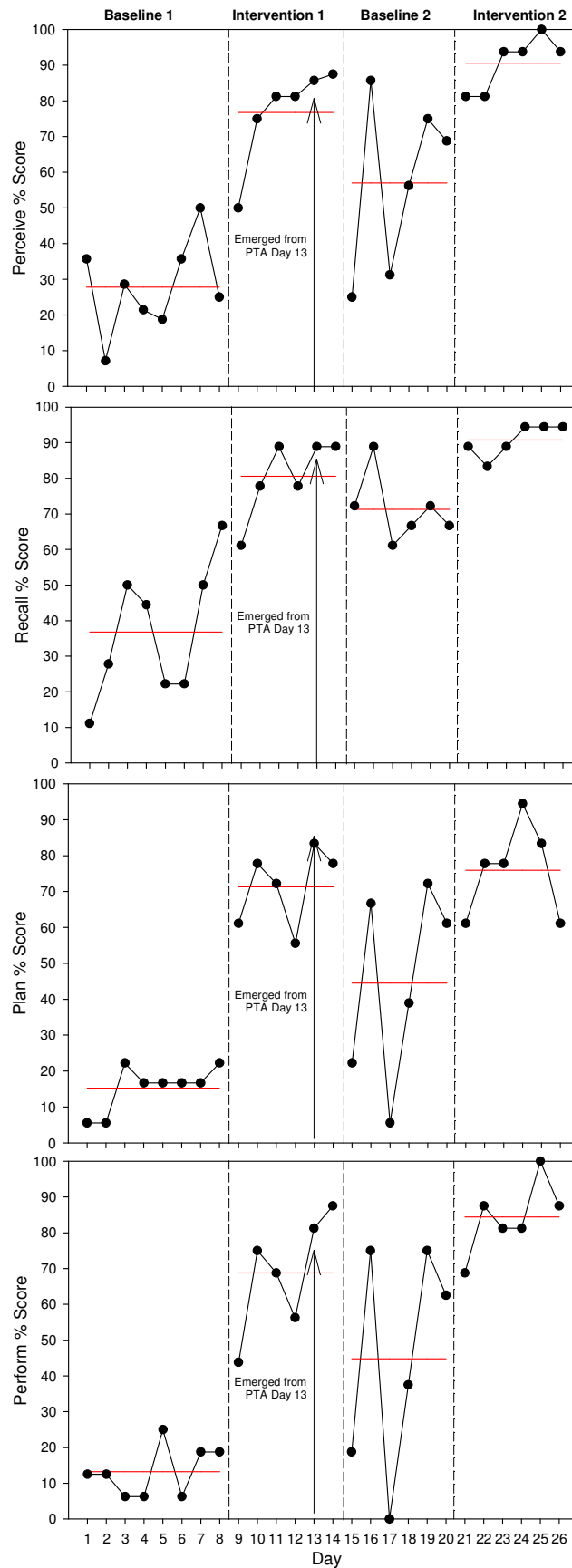


Figure 9.4 Subject 4 – Quadrant breakdown by study Phase



In general, application of processing strategies during Baseline 1 was low, particularly for the Plan and Perform Quadrants with mean scores of 15% and 13% respectively. A large increase in level performance occurred at the start of PRPP Intervention 1 across all quadrants, with an upward trend evident across Intervention Phase 1. In the areas of Perceive, Plan and Perform, strategy application nearly tripled between Baseline Phase 1 and Intervention Phase 1. Quadrant performance declined during Baseline 2 when usual intervention was reintroduced, even though Subject 4 had emerged from PTA on day 13. A second performance level increase occurred when PRPP Intervention was reintroduced in Intervention Phase 2.

Subject 4 was clearly very responsive to the introduction and withdrawal of PRPP Intervention, demonstrating clear between phase differences in application of processing strategies during task performance. Processing strategies targeted with Subject 4 included recall for use of objects and use of body parts/movements to perform necessary task steps, choosing tactics, calibrating movements, questioning and analysing performance outcomes.

#### ***9.3.1.5 Subject 5***

Subject 5 demonstrated the lowest level of information processing throughout the study (refer to Figure 9.5 and Table 9.5), with the highest levels of agitated behaviour. He remained confused and in PTA throughout the study, was verbally and physically aggressive, physically restless, had severe memory loss, and very limited attention.

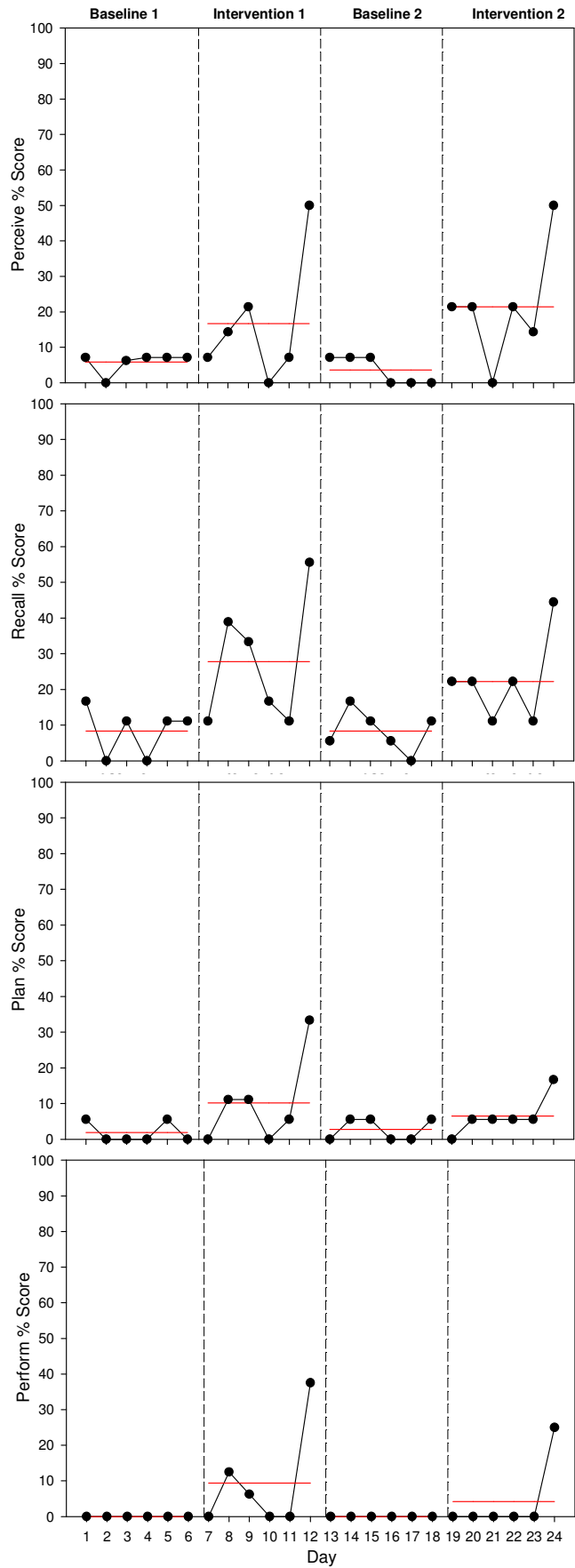


Figure 9.5 Subject 5 – Quadrant breakdown by study Phase

**Table 9.5 Subject 5: Mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	5.8 (2.9)	16.7 (17.9)	3.6 (3.9)	21.4 (16.3)
RECALL	8.3 (6.8)	27.8 (17.9)	8.3 (5.8)	22.2 (12.2)
PLAN	1.9 (2.9)	10.2 (12.4)	2.8 (3.0)	6.5 (5.5)
PERFORM	0.0 (0.0)	9.4 (14.7)	0.0 (0.0)	4.2 (10.2)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

A common pattern of performance emerged across all quadrants and phases.

Performance during Baseline 1 was very low (<10%) in all PRPP quadrants.

Typically Subject 5 engaged in very limited task performance, tending to become quickly agitated and aggressive. Strategy application was targeted in the Perceive and Recall areas as these are typically less complex strategies and are associated with performance of routine, habitual tasks. Perceive Quadrant strategies targeted during PRPP Intervention included focusing attention, noticing, searching and discriminating sensory aspects of objects and his own body in order to facilitate correct use of body and objects during task performance. In conjunction, Recall strategies for recognising objects and body parts, as well as recalling how to use objects and move his body during functional tasks were targeted.

An increase in performance level occurred between Baseline 1 and Intervention 1 in all quadrants, but more significantly in the Perceive and Recall Quadrants that were the focus of intervention. All performance returned to Baseline 1 levels during Baseline 2, suggesting the observed changes in the previous phase were not related to spontaneous recovery, but were more likely to be associated with the PRPP Intervention. Performance again increased for Perceive and Recall when the PRPP

Intervention was reintroduced in the second intervention phase, with minimal change in the Plan and Perform areas that were not specifically targeted. This provides further evidence that observed changes were closely associated with the PRPP Intervention, rather than processes of natural, or spontaneous recovery.

### 9.3.1.6 Subject 6

Subject 6 demonstrated a wide range of agitated behaviours including verbal and physical aggression directed at staff, physical restlessness, out-of-proportion responses to both internal and external stimuli, and bizarre behaviours. Strategy application by Subject 6 was more variable than previous subjects as can be seen by the phase means in Table 9.6 and the graphical display of daily performance in Figure 9.6.

**Table 9.6 Subject 6: Mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	29.8 (12.7)	47.5 (16.0)	50.0 (20.8)	69.9 (5.8)
RECALL	43.5 (10.8)	66.7 (7.9)	60.0 (2.5)	67.6 (4.2)
PLAN	7.4 (4.5)	32.4 (8.9)	21.1 (7.2)	46.3 (15.2)
PERFORM	16.7 (6.5)	31.3 (16.3)	15.0 (7.1)	51.0 (7.3)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

Application of processing strategies was initially low during Baseline 1, particularly in the Plan and Perform Quadrants. Task performance was characterised by very slow performance of task steps, poor flow between steps, and inability to contextualise to the duration of the task. Eating lunch and breakfast meals often exceeded 30 minutes and in some cases 1 hour.

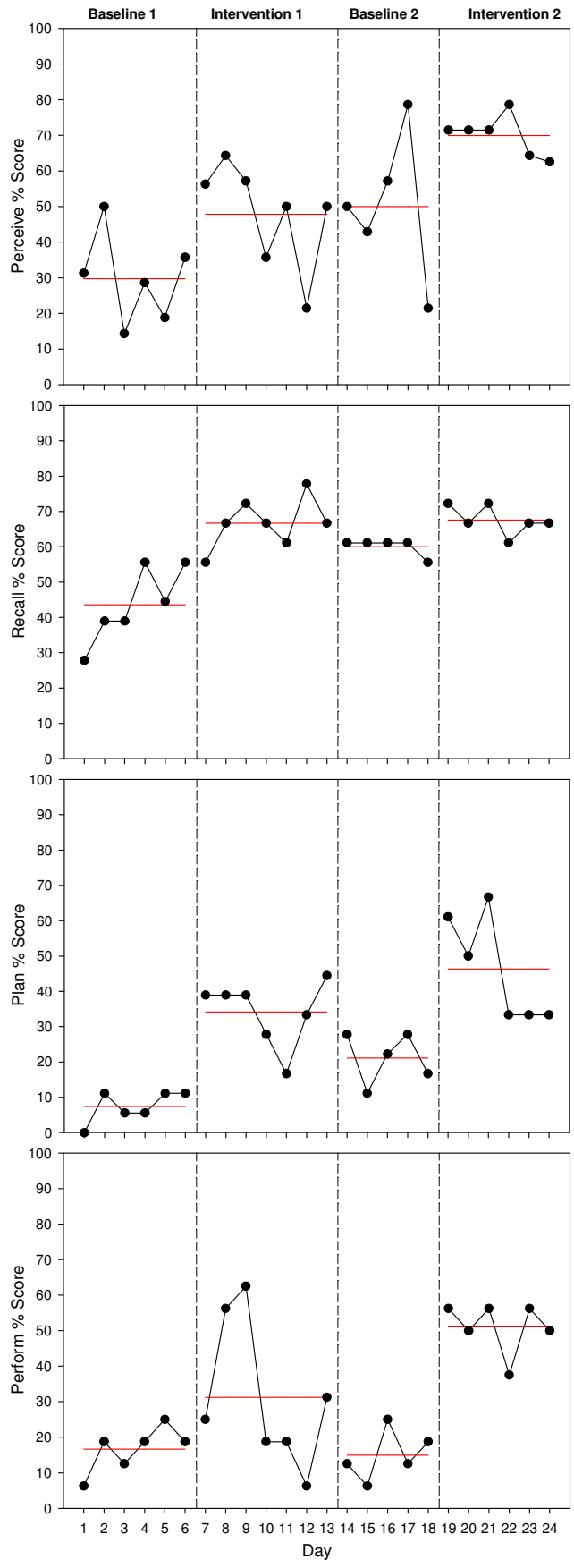


Figure 9.6 Subject 6 – Quadrant breakdown by study Phase

Application of processing strategies in all quadrants increased from Baseline Phase 1 to Intervention Phase 1. This performance level was maintained during Baseline Phase 2 for Perceive and Recall strategies, while Plan and Perform strategy application declined in Baseline 2 when PRPP Intervention was withdrawn. Strategies targeted from the Plan Quadrant included knowing the goal, organising, sequencing, questioning and analysing performance. PRPP Intervention for Perform Quadrant strategies focused on improved task timing, reducing frequent stops and improving his ability to persist. Application of strategies from all quadrants improved during Intervention Phase 2, with greatest improvements associated with the Plan and Perform Quadrants being targeted during the PRPP Intervention.

### 9.3.1.7 Subject 7

At the time of study recruitment, Subject 7 demonstrated agitated behaviour including repetitive non-purposeful behaviour, motor restlessness, and absconding from the ward area. His responses were fragmented, with evidence of severe memory loss and confabulation. Subject 7 was transferred to the rehabilitation unit on Day 19. Strategy use across all quadrants was very low during Baseline 1 (A<sub>1</sub>), with steady improvements observed during the study. Large increases in performance level occurred between adjacent Baseline and Intervention phases (refer to Table 9.7).

**Table 9.7 Subject 7: Mean and SD values by study phase**

SUBJECT 7	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	8.8 (5.4)	57.4 (19.9)	29.2 (14.1)	82.6 (16.7)
RECALL	10.2 (12.4)	59.3 (24.3)	36.6 (12.2)	80.6 (16.0)
PLAN	1.9 (2.9)	38.9 (26.8)	16.7 (4.1)	71.3 (20.0)
PERFORM	6.3 (7.9)	50.0 (24.4)	19.3 (9.0)	87.5 (11.2)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

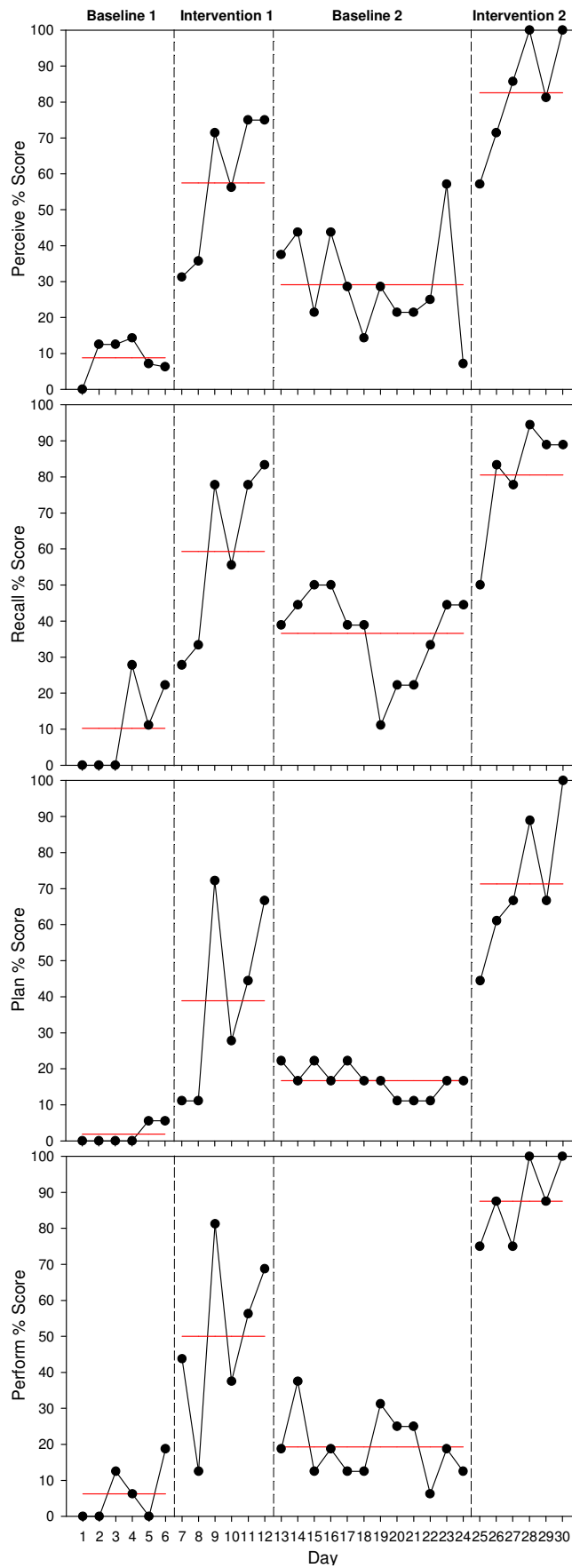


Figure 9.7 Subject 7 – Quadrant breakdown by study Phase

Performance in all quadrants started from 0% in Baseline 1. A very large increase in performance level occurred during PRPP Intervention Phase 1, with mean performance levels varying between 40-60%. A rapid drop in performance level occurred during Baseline 2 when the PRPP Intervention was withdrawn. A second large increase in level was observed when PRPP Intervention was reintroduced for Intervention Phase 2. Information processing strategies across all quadrants were targeted with Subject 7.

Perceive Quadrant strategies targeted during PRPP intervention included modulating attention, particularly focusing in on the current task step, searching for and discriminating sensory aspects of objects and his own body during performance of self-care tasks such as grooming and eating. Perform Quadrant strategies for starting and stopping at the correct time, and adjusting motor performance were linked with the Perceive Quadrant strategy of monitoring and the Plan Quadrant strategy of questioning. Recall strategies for recognising and labelling objects, recalling object use and task steps were also targeted, particularly during Intervention Phase 1, while Plan Quadrant strategies for questioning, analysing and evaluating performance were included in the second PRPP Intervention phase.

#### ***9.3.1.8 Subject 8***

Subject 8 sustained a hypoxic injury secondary to cardiac failure. In contrast to all the preceding subjects, Subject 8 remained in an acute cardiac ward for the duration of the study. Steady progress was made across all study phases as seen in Table 9.8 and Figure 9.8, with clear between phase differences in performance level.



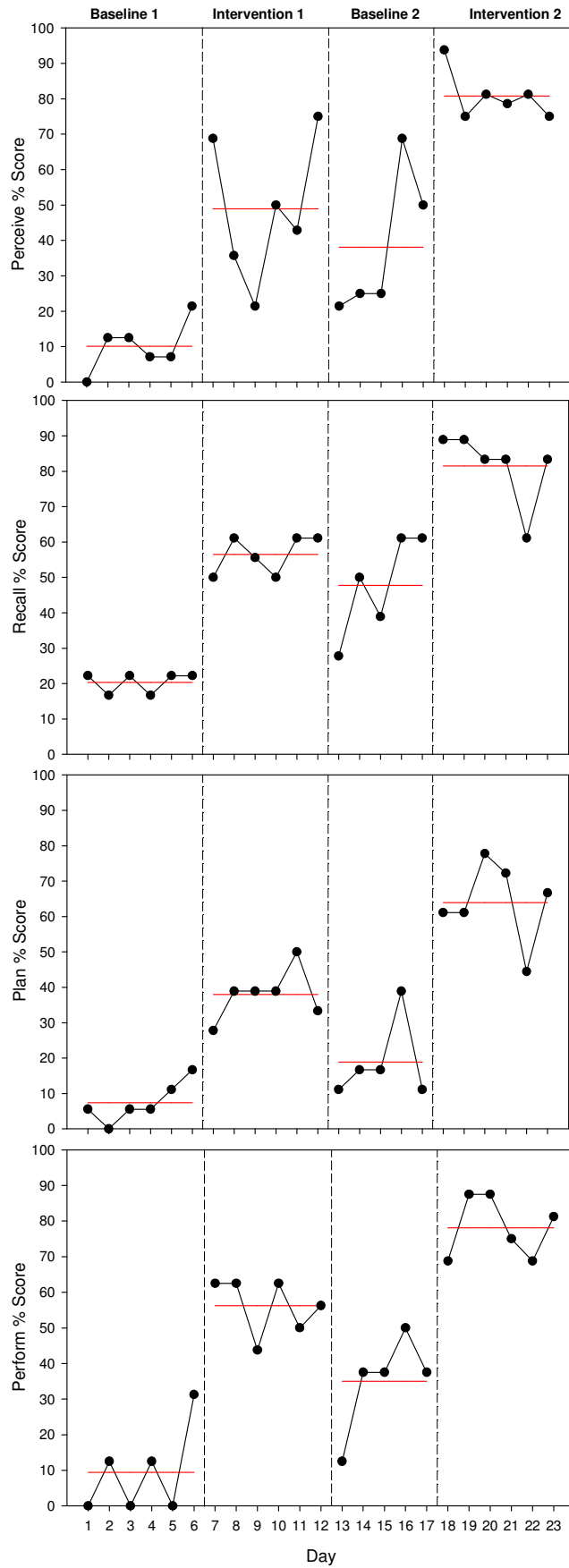


Figure 9.8 Subject 8 – Quadrant breakdown by study Phase

**Table 9.8 Subject 8: Mean and SD values by study phase**

	A <sub>1</sub> mean	B <sub>1</sub> mean	A <sub>2</sub> mean	B <sub>2</sub> mean
PERCEIVE	10.1 (7.2)	49.0 (20.2)	38.0 (20.6)	80.8 (6.9)
RECALL	20.4 (2.9)	56.5 (5.5)	47.8 (14.5)	81.5 (10.3)
PLAN	7.4 (5.7)	38.0 (7.4)	18.9 (11.5)	63.9 (11.5)
PERFORM	9.4 (12.3)	56.3 (7.9)	35.0 (13.7)	78.1 (8.6)

**Notes: A<sub>1</sub> = Baseline 1; B<sub>1</sub> = PRPP Intervention phase 1; A<sub>2</sub> = Baseline 2; B<sub>2</sub> = PRPP Intervention phase 2; SD = standard deviation**

The general pattern of change across study phases was similar for all quadrants. In general, application of processing strategies during Baseline 1 was low. A large change in performance level occurred at the start of PRPP Intervention 1, with an stable trend evident across Intervention Phase 1. In the areas of Perceive, Plan and Perform, mean % scores quadrupled between Baseline Phase 1 and Intervention Phase 1. In all quadrants, processing strategy application declined during Baseline 2 when PRPP Intervention was withdrawn, and increased again when PRPP Intervention was reintroduced in Intervention Phase 2.

Recall strategies were heavily focussed upon as Subject 8 demonstrated severe memory difficulties even with routine procedural tasks. In particular strategies for recalling task steps, place within the task, and steps already performed were targeted during PRPP Intervention. Plan Strategies specifically targeted included knowing and maintaining the task goal, organising and sequencing task performance, analysing and judging performance in comparison to the initial goal.

#### 9.4 SUMMARY OF QUADRANT ANALYSIS

In all subjects, across all quadrants, performance was better during the PRPP Intervention phases than during Baseline phases. The PRPP Intervention approach involved *chunking* together strategies that crossed multiple quadrants rather than focusing on discrete areas of processing. As can be seen by Figures 9.1-9.8, improvements were typically observed across more than one quadrant. Differences between Baseline and Intervention phases were greatest for the Plan Quadrant, suggesting that PRPP Intervention with this series of adults was particularly useful for increasing strategy use from the Plan Quadrant in comparison to current or conventional instructional approaches used by occupational therapists in TBI rehabilitation. Recall strategies were most likely to increase during the first PRPP Intervention phase, building on existing strengths to create a scaffold for more complex strategy application. Plan strategies improved most during the second Intervention phase, perhaps suggesting these complex strategies require a more solid processing base, or platform upon which to build or develop strategies than what is typically available during the first week of intervention.

#### 9.5 RASCH ANALYSIS

Rasch calibration of PRPP processing items produced a linear continuum of information processing strategies from Stage 2 of the PRPP System of Task Analysis. Item difficulty ranged from +1.9 to -2.7 logits around a mean of 0.0 logits. Goodness-of-fit parameters were applied to both mean square and standardised  $z$  score values to determine 'fit' with the unidimensional model ( $MnSq = 1 \pm 0.4$ ;  $z$  std =  $0 \pm 2$ ). Three items simultaneously violated MnSq and  $z$ -std parameters. *Recalls steps* demonstrated higher than expected Infit and Outfit values, while *Calibrates* and

*Coordinates* demonstrated higher than expected Outfit values, suggesting some unexpected responses in the outlying observations. A full summary of item Infit and Outfit values is presented in Table 9.9.

**Table 9.9: PRPP Descriptors in hierarchical order**

Item	Difficulty		Infit		Outfit	
	Measure	St error	Mean Sq	zstd	Mean Sq	zstd
<b><i>Harder Items</i></b>						
Analyses	1.89	.15	.61	-4.0	.47	-2.1
Identifies obstacles	1.47	.14	.67	-3.5	.58	-1.9
Chooses	1.33	.14	.72	-2.9	.68	-1.5
Judges	1.26	.14	1.00	.0	.84	-.6
Organises	1.18	.14	.79	-2.2	.77	-1.0
Monitors	.92	.14	.93	-.7	.83	-.8
Flows	.86	.13	.72	-3.0	.65	-2.1
Adjusts	.67	.13	.93	-.6	.91	-.4
Persists	.63	.13	.97	-.3	.85	-.8
Contextualises to duration	.60	.13	1.01	.1	.89	-.6
Times	.60	.13	1.00	.0	.89	-.6
Coordinates	.58	.13	1.11	1.0	1.40	2.1
Sequences	.37	.13	.86	-1.4	.76	-1.5
Modulates	.35	.13	.74	-2.9	.69	-2.1
Contextualises to time	.35	.13	1.00	.0	.85	-.9
Calibrates	.26	.13	1.17	1.6	1.43	2.5
Stops	.26	.13	1.15	1.5	1.00	.0
Questions	.10	.13	.81	-2.0	.71	-2.1
Contextualises to place	.04	.13	1.29	2.7	1.38	2.3
Searches	-.03	.13	.86	-1.5	1.01	.1
Discriminates	-.16	.13	1.22	2.1	1.10	.6
Continues	-.17	.13	1.11	1.1	1.08	.5
Starts	-.30	.13	1.10	1.0	.97	-.1
Maintains	-.49	.13	1.14	1.3	1.14	.9
Recalls steps	-.51	.13	1.42	3.8	3.01	5.4
Labels	-.62	.13	1.23	2.1	1.18	1.1
Uses body	-.62	.13	1.16	1.5	1.24	1.5
Locates	-.78	.14	.89	-1.0	.86	-.8
Matches	-1.27	.23	1.36	1.9	1.42	1.2
Uses objects	-1.39	.14	1.07	.6	1.25	1.2
Notices	-1.49	.14	.94	-.5	1.10	.5
Categorises	-1.51	.14	1.05	.5	1.26	1.2
Knows Goal	-1.68	.15	1.09	.8	.98	.0
Recognises	-2.70	.17	.85	-1.1	.65	-1.0
<b><i>Easier Items</i></b>						

Note: Fit parameters:  $MnSq = 1 \pm 0.4$ ;  $z \text{ std} = 0 \pm 2$

Consistent with the Rasch hierarchy generated in Section 6.3.1 from the study of assessment validity, *Recognises* achieved the lowest difficulty measure, while *Analyses* was calibrated at the top of the Rasch hierarchy. The Rasch calibrated difficulty measure for each item is a linear measure of how difficult each strategy is to apply. Individual item difficulty measures from Section 6.3.1 were correlated with the values from this study revealing a strong, positive, statistically significant correlation between the calibrated hierarchies from both studies ( $r = .87$ ;  $p < .001$ ).

Vertical rulers for each facet calibrated in the FACETS analysis are presented in Figure 9.9. On the right is the hierarchy of items from least difficult (bottom) to most difficult (top). On the left is the hierarchy of subjects, showing Subject 5 as the most impaired, and Subject 3 as the most able. The central facet shows the relative difference between phases of the study, showing that the highest scores were achieved during phases B<sub>2</sub> and B<sub>1</sub> (PRPP Intervention phases), with the lowest scores achieved during phases A<sub>1</sub> and A<sub>2</sub> (Baseline phases).

Referring to Figure 9.9, the items in the lower portion of the hierarchy were *Recognising* and *Categorising* task objects/people/environments, *Knowing the Goal* of task performance, *Noticing* and *Matching* sensory information in the surrounding environment, and recalling how to *Use Objects*. These items represent the fundamental strategies from the Recall, Plan and Perceive Quadrants.

The next portion of the hierarchy contains several Recall items representing strategies for recalling the name or *Labels* for task objects, *Recalls Steps*, and recalling how to *Use body* postures and movements during task performance. Near these items were Perceive, Plan and Perform strategies used for knowing when performance *Starts*, how to *Maintain* task attention, and to *Continue* performance until the task end-point.

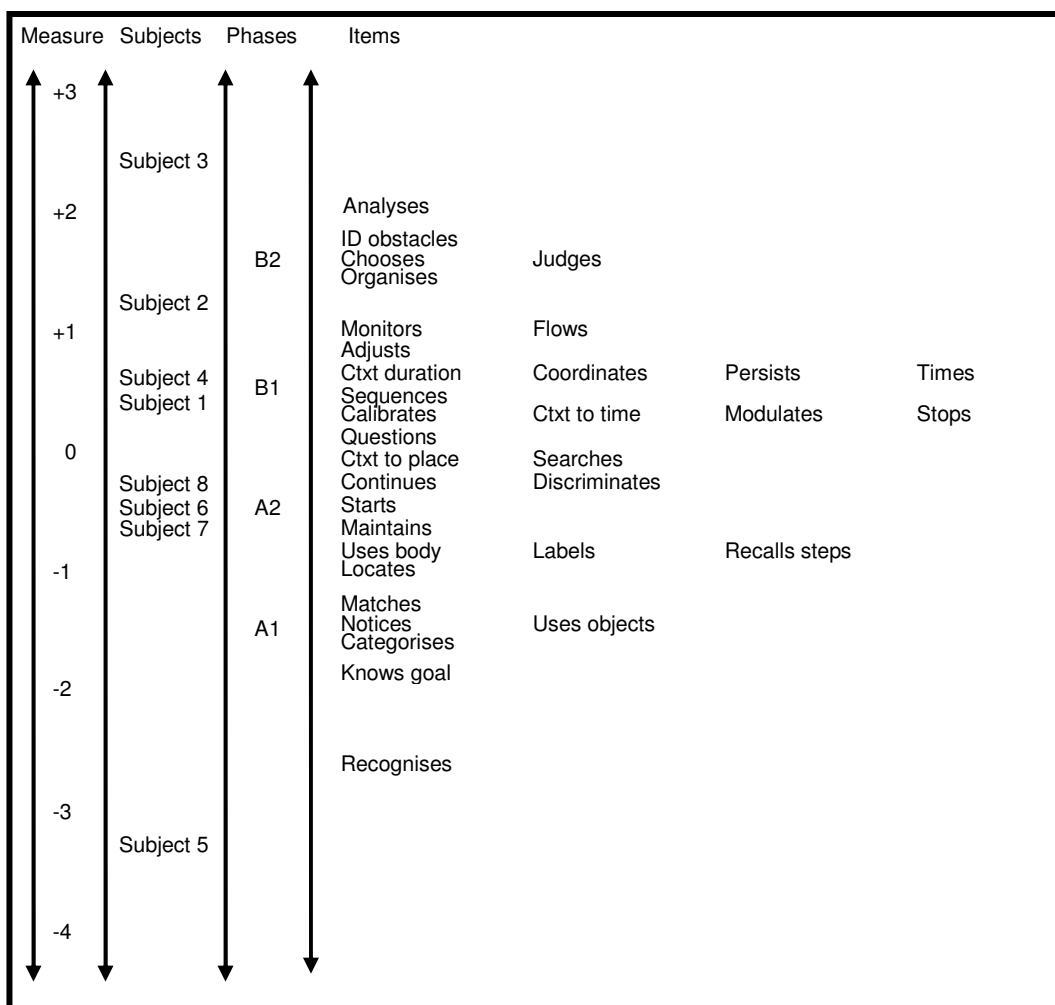


Figure 9.10 Rasch calibrated hierarchy for each facet

Strategies needed to *Search*, and *Discriminate* aspects of the environment, *Contextualise to Place*, and *Question* progress within the task were represented in the next hierarchical tier. This was followed by several strategies from all four quadrants essential for timing of performance, including *Contextualises to Time*, *Persists* in the face of obstacles, *Continues*, and *Stops* at the right time and place in the task, *Sequences*, *Contextualises to Duration*, and demonstrates overall *Flow* and *Timing* of the task. In this same region were strategies for *Modulating* attention, *Calibrating*, *Coordinating* and *Adjusting* performance.

These items give way to the highest level of the Rasch generated hierarchy, where the most complex information processing strategies are represented. These processing strategies are considered to be part of the ‘Supervisory or Executive System’ that controls and evaluates skilled performance, including *Organises* self and environment, *Monitors* actions and outcomes, *Chooses* effective tactics, *Identifies Obstacles* to performance, *Judges* and *Analyses* the safety and effectiveness of task performance.

## **9.6 SUMMARY OF RASCH ANALYSIS**

Data collected in this phase of the research enabled confirmatory analysis of the Rasch generated hierarchy from Research Phase Three. This hierarchy is similar, though not exactly the same as the hierarchy generated in Section 6.3.1 (Chapter 6). The effect of intervention on the difficulty measures of targeted strategies is not known, and is an area that requires further research. As the PRPP System is an emerging clinical assessment, ongoing validation of the instrument’s measurement properties is useful in creating a broader evidence base for the assessment tool.

The generated hierarchy reflects cognitive theory that organises human cognition into a hierarchy of basic and complex processes, in which basic processes include sensory perception, attention and memory mechanisms that are essential for execution of complex processes, such as planning, problem solving and abstract thought (Constantinidou et al, 2004). The Rasch calibrated hierarchy of PRPP strategies is also congruent with the sequential order of information processing stages (Lerner, 2002), whereby process of sensory registration occur first, leading to encoding of information and storage in memory structures, supervised and controlled by a system of executive processes.



## CHAPTER TEN

### THE PRPP SYSTEM OF INTERVENTION – EFFECT ON AGITATED BEHAVIOUR

#### RESEARCH PHASE FOUR

Chapter Ten reports on findings from Research Phase Four. This paper continues the examination from Chapters Eight and Nine into the effectiveness of occupational therapy intervention with adults demonstrating agitation following severe brain injury. It involves the same case series of eight adults during early brain injury rehabilitation. In contrast to Chapters Eight and Nine, this chapter focuses on the impact of PRPP Intervention on agitated behaviour.

This chapter is currently under review with *Brain Injury*. The manuscript was submitted in April 2008 as: Nott, M. T., Chapparo, C., & Heard, R. Instructing information processing strategies in clients with agitation following brain injury. *Brain Injury*, (Under review; submitted 30<sup>th</sup> April 2008).

All sources cited in the manuscript are referenced at the end of the chapter.

Authorship statements attesting to the contribution of the researcher are included in Appendix II.

## **ABSTRACT**

**Objective:** Systematically evaluate changes in information processing strategy use and agitated behaviour in adults with brain injury during acute rehabilitation.

**Design:** Single-system experimental design (ABAB) across eight subjects.

**Methods:** Subjects functioning at Rancho Level 4 or 5 participated in occupational therapy (OT) intervention that alternated weekly between the usual therapy approach and the experimental Perceive, Recall, Plan and Perform (PRPP) System approach over 4-weeks. Information processing capacity during occupational tasks and agitated behaviour were concurrently measured. PTA status was prospectively monitored.

**Experimental intervention:** The PRPP System is a dynamic assessment and intervention approach that directly links results of cognitive task analysis with strategies for intervention. Task training, strategy training and strategy application within occupational performance are simultaneously targeted.

**Results:** Both OT approaches were shown to effectively increase information processing capacity during occupational performance, with the PRPP Intervention being more effective than current intervention approaches. Agitation was concomitantly measured and shown to systematically reduce over time in most cases. Higher daily variability was seen in more agitated subjects. Implementation of the PRPP System of Intervention did not appear to exacerbate agitated behaviour.

**Conclusions:** Adults in acute rehabilitation effectively learned and applied information processing strategies to improve task performance, in the presence of agitation and posttraumatic amnesia.

## 10.1 BACKGROUND

Cognitive-behavioural sequelae of brain injury, such as agitation and post-traumatic amnesia (PTA) can disrupt the rehabilitation process. Clinicians agree that agitated behaviour interferes with progress in therapy and limits the achievement of functional goals (Sandel & Mysiw, 1996). Agitation can be conceptualised along a continuum with varying levels of behavioural disturbance characterised by aggression, impulsivity, akathisia, inattention, disinhibition or emotional lability (Corrigan & Bogner, 1994; Lequerica et al., 2007; Lombard & Zafonte, 2005; Sandel & Mysiw, 1996). Even low levels of agitation have been shown to substantially disrupt rehabilitation by limiting engagement in therapy (Lequerica et al., 2007).

Clinical surveys classify agitation management techniques into broad categories including structured daily activities/routines, environmental interventions, behavioural interventions, and pharmacological interventions (Gaber, 2006; Herbel, Schermerhorn, & Howard, 1990). Restoration of day and night activity patterns, with routine activity and rest periods (Lombard & Zafonte, 2005) facilitate orientation and maintain predictable structure and routine (Giles & Clark-Wilson, 1999; Radomski, 2008). Controlling environmental variables to reduce over-stimulation from noise, light, visitors, staff and other patients can prevent triggering agitated responses (Bermann & Bush, 1988; Giles & Clark-Wilson, 1999; Pryor, 2004; Wilson & Dailey, 1999), and minimise distractions (Radomski, 2008). Behavioural modification techniques may involve antecedent control and reinforcement programmes (Giles, 1999; Giles & Manchester, 2006; Slifer et al., 1996; Slifer et al., 1997; Ylvisaker et al., 2007), although evidence of effectiveness in this area primarily focuses on post-acute stages of rehabilitation with limited guidance for

application in acute rehabilitation contexts. Techniques to reduce unwanted behaviours may also include distraction (Giles & Clark-Wilson, 1999; Pryor, 2006), redirection (Giles & Clark-Wilson, 1999; Radomski, 2008; Yuen & Benzing, 1996) and engaging the client in gross motor activities (Giles & Clark-Wilson, 1999; Lombard & Zafonte, 2005; Radomski, 2008). Few studies have attempted to evaluate the effectiveness of these approaches either singly or in combination during the acute rehabilitation stage following TBI.

These global approaches are usually implemented in response to overarching rehabilitation team goals. Occupational therapists intervene with patients within this overall team approach to commence specific functional retraining of automatic and over-learned tasks (such as self-care) (Bermann, 1988), where the activity itself and the instructions given are concomitant with a predictable and consistent daily routine (Yuen & Benzing, 1996).

Within current literature there is little evidence to prepare occupational therapists for commencing effective skill based retraining with confused and agitated patients. Therapists understandably feel uncertain about implementing intervention methods that may increase agitated behaviour if the task is too demanding or stimulating. Occupational therapists working with brain-injured adults report being exposed to a spectrum of aggressive behaviour; from verbal aggression and threats at one end to physical aggression at the other end (Beaulieu, 2007). Physical aggression most frequently occurs during activities requiring close and physical contact with patients such as during washing and dressing activities.

Occupational therapy (OT) intervention with brain injured adults in the acute rehabilitation phase could be classified into (1) remedial training of specific cognitive/behavioural capacities, and (2) skill/task based retraining with an adaptive or compensatory approach.

Remediation of specific capacities such as attention or memory typically involves repetition and practice of individual cognitive skills outside the context of the task in which the skill is required. This deficit-specific approach does not direct therapy towards the interrelationship *between* specific cognitive skills, nor how these skills relate to each other for cognitive processing and task performance (Toglia, 1998). As such, remedial approaches demonstrate poor generalisation, and are generally thought to have limited effect within the acute rehabilitation period defined by post-traumatic amnesia.

Task based retraining, involving adaptation of the environment and modification of task demands, has been described as “especially useful for agitated and non-compliant clients” (Yuen & Benzing, 1996, p.231). Intervention strategies based on guidance and redirection, environmental set-up, hierarchical prompting (verbal, gestural and physical prompts), reinforcement, and chaining of task steps have been described as effective in promoting occupational task performance with brain injured adults in acute rehabilitation (Giles & Clark-Wilson, 1999; Nicholls & Chapparo, 1993; Yuen & Benzing, 1996). Non-experimental case studies have primarily been used to demonstrate these guiding, redirecting and instructional techniques, providing only low level evidence of treatment effectiveness.

The instructional methods implemented within the task-based approach aim towards end-points that represent a specific functional skill or behaviour, for example acquisition and performance of eating or dressing skills. In contrast, the end-points of remedial retraining are the specific cognitive capacities being targeted. The intervention approach under evaluation in this study, moves away from the traditional dichotomy of remedial versus adaptive, and focuses on acquisition and implementation of information processing strategies that are applied across various functional tasks and activities. The Perceive, Recall, Plan and Perform (PRPP) intervention approach (Chapparo & Ranka, 2007) simultaneously focuses on task training, strategy training and strategy application within the context of everyday performance. It is part of a dynamic system of intervention that directly links the results of behavioural and cognitive task analysis with strategies for intervention (Chapparo & Ranka, 1997). It is an extension of the 'Stop Think Do' program developed for use with children and adolescents with intellectual disability (Beck & Horne, 1992), self harm tendencies, impulsivity and anger management issues (Murphy & Cooke, 1999). Table 10.1 defines the core intervention strategies in the PRPP System of Intervention, integrating aspects of systematic instruction and information processing theory.

**Table 10.1 Core intervention strategies in the PRPP System of Intervention: Definition**

<b>Strategy</b>	<b>Definition</b>
Intervention goal is task mastery	<ul style="list-style-type: none"> <li>▪ Expected outcome is improved functional performance in everyday tasks required by the person’s occupational roles and context.</li> <li>▪ Intervention success is therefore measured by increased functional performance.</li> </ul>
Application of evidence based principles of systematic instruction	<ul style="list-style-type: none"> <li>▪ Goal of intervention is clear to client.</li> <li>▪ Least to most prompt hierarchy is used.</li> <li>▪ Multiple opportunities for practice of the task and target cognitive strategy are offered and performance errors are prevented.</li> <li>▪ Learning occurs across natural contexts and tasks to promote generalisation.</li> <li>▪ Feedback is specific to task mastery and the cognitive strategy that is the target of intervention.</li> </ul>
Cognitive strategies are behaviourally defined and measurable	<ul style="list-style-type: none"> <li>▪ Strategies required for task performance are identified using the PRPP System of Task Analysis (outer ring Figure 10.1) and their effectiveness measured before and throughout intervention.</li> </ul>
‘Chunking’ of strategies across all PRPP quadrants is planned	<ul style="list-style-type: none"> <li>▪ Starting with ‘Stops’, one or two descriptors are targeted from each processing quadrant for ‘Sense’ (Perceive Quadrant), ‘Think’ (Recall and Plan Quadrants), and ‘Do’ (Perform Quadrant).</li> <li>▪ Single descriptors are not used.</li> <li>▪ A line of processing required for the task mirrors the direction of arrows in the centre of the PRPP System of Task Analysis</li> </ul>
Focus of intervention is on application of cognitive strategies (descriptors) to real world performance.	<ul style="list-style-type: none"> <li>▪ The descriptor behaviours form the central verbal, physical or visual prompts given during performance and are modelled by the therapist if required.</li> <li>▪ The therapist acts as a cognitive mediator</li> <li>▪ The patient is taught to self-instruct in the strategies.</li> </ul>

Patients learn to apply a sequence of processing strategies to ‘*Stop, Sense, Think, Do*’ via verbal, visual, gestural and/or physical prompts given by the therapist. ‘*Stop*’ strategies enable the patient to cease engagement in distracting or non-functional behaviours, lower arousal (if heightened) to the task demands, and direct attention to the task. ‘*Sense*’ strategies facilitate

perception of sensory information relevant to the task, while *'Think'* strategies focus on recalling or planning information to develop a plan of action. Finally *'Do'* strategies enable accurate implementation of the intended plan. Prompting techniques shift from content-free to content-based behavioural prompts selected by the therapist, based on findings from the assessment component of the system (Chapparo & Ranka, 1997). The therapist's participation fades as the patient internalises the strategies and applies them across a range of tasks and settings.

This paper outlines observed changes in information processing strategy use and agitated behaviour over a four-week period, during which time the PRPP Intervention approach was implemented and compared to the current OT intervention approach.

## **10.2 METHOD**

### **10.2.1 Subjects**

All adults admitted to the brain injury rehabilitation unit (BIRU) during the twelve-month period from November 2006-November 2007 were screened according to the following selection criteria: first onset of brain injury; presence of post-traumatic amnesia; aged 17 years or older; demonstrating agitated behaviour as defined by the Levels of Cognitive Functioning Scale (Hagen, 2001). Seven adults with traumatic brain injuries and one with a hypoxic brain injury were recruited to the study. Table 10.2 summarises demographic and injury related information for each subject.



**Table 10.2 Subject characteristics**

Subject	Age	Sex	CT scan/MRI results	GCS /15	Mode of injury	Recruitment (days since injury)	PTA (in days)	Rancho level	Characteristic behaviours
1	35	F	DAI; hyperdense foci in right hemisphere	8	CHI: passenger in MVA	61	139	V	restless, excessive response to external stimuli, poor attention, memory impairment
2	22	F	SAH; SDH; multiple contusions; effacement of sulci	7	CHI: driver in MVA	31	57	V	heightened activity state, internal confusion, poor attention and memory, verbal outbursts
3	23	F	multiple SAH; frontal ICH; left occipital haemorrhage	6	CHI: driver in MVA	41	54	V	excessive response to external stimuli, memory impairment, inappropriate responses
4	41	F	SAH with ventricular extension; facial fractures	4	CHI: pedestrian hit by car	34	57	V	restless, heightened activity state, memory impairment, non-purposeful behaviour
5	56	M	SAH; right frontal contusions	3	CHI: pushbike rider hit by car	59	U/A	IV	aggressive, restless, responds primarily to internal stimuli, severe memory loss, confusion
6	25	M	right frontal contusion; EDH; fractured base of skull	3	CHI: pedestrian hit by car	20	> 60*	IV	aggressive, restless, excessive response to internal & external stimuli, bizarre behaviours
7	47	M	traumatic fronto-temporal lobectomy	12	Penetrating: GSW	34	57	IV	non-purposeful behaviour, restless/wanders, fragmented responses, severe memory loss
8	24	M	global ischaemic changes	N/A	Hypoxia	14	N/A	IV	heightened activity state, poor attention, restless/wandering, severe memory loss

**Notes:** DAI = diffuse axonal injury; SAH = sub-arachnoid haemorrhage; SDH = sub-dural haematoma; ICH = intra-cranial haemorrhage; EDH = extra-dural haemorrhage. CHI = closed head injury; GSW = gun shot wound; MVA = motor vehicle accident. N/A = assessment not performed/appropriate due to non-traumatic nature of injury; U/A = unable to assess to level of agitation and aggression; \* Subject 7 was transferred to an alternate rehabilitation facility 60 days post-injury and remained in PTA at this time.

### 10.2.2 Design

An ABAB single case experimental design was adopted to compare performance under experimental (PRPP Intervention) and control conditions (current OT intervention), using a sequential introduction and withdrawal design (Gianutsos & Gianutsos, 1987; Thompson, 2006). Several design features enhanced study validity. The repeated baseline and intervention design improved internal validity by controlling for history and maturation within subjects (Backman et al., 1997; Ottenbacher & Hinderer, 2001; Zhan & Ottenbacher, 2001). The effect of natural recovery can be more clearly differentiated from the effect of intervention (Barlow & Hersen, 1984); a design feature that is particularly relevant in brain injury rehabilitation (Alderman, 2002). The clinical context in which data was collected ensured the ecological validity of the results (Zhan & Ottenbacher, 2001).

Measures to improve generalisation of findings and enhance external validity focused on replication of the study protocol. First, the protocol was directly replicated with 'like' subjects. Second, the protocol was systematically applied to subjects who differed from the original subjects by nature of injury, level of recovery and rehabilitation setting (Ottenbacher, 1986; Thompson, 2006).

Inter-rater reliability was measured using an independent observer, who scored video-footage of therapy sessions conducted across the 12-month study period. The level of agreement between the independent observer and the researcher (MN) was high [ICC (3,1) = 0.86 (95% CI: .73→.93)] reinforcing the non-biased measurement procedures implemented in the study. Rescoring of the video-footage by the researcher (MN) at the end of the study period allowed for measures of intra-rater reliability and checking of observer bias (Thompson, 2006). Intra-

rater reliability was very high [ICC (3,1) = 0.97 (95% CI: .94→.99)] providing further evidence of internal validity.

#### ***10.2.2.1 Dependent variables and measures***

Two dependent variables were measured. The primary target behaviour or dependent variable was information processing capacity during occupational performance. This was measured using the PRPP System of Task Analysis; a criterion referenced assessment that employs task analysis methods to identify difficulties in information processing during task performance (Chapparo & Ranka, 1997). This tool forms part of the overall PRPP System of assessment and intervention, in which assessment findings provide the focus for intervention (Fry & O'Brien, 2002). Sensitivity over time has been demonstrated for measurement of task based information processing in a case study of severe agitation following TBI (Nott & Chapparo, 2007).

Subjects were observed during task performance and scored against defined criteria for 34 different information processing descriptors on a 3-point scale; (3) effective for task performance, (2) questionable, or (1) not effective. Ratings for each descriptor were summed and converted to a total percentage score, therefore a higher total score indicates more effective information processing during task performance.

The second dependent variable, agitated behaviour, was measured using the Agitated Behaviour Scale (ABS) (Corrigan, 1989), a tool specifically developed to serially assess agitation during the acute period after head injury (Bogner, Corrigan, Bode, & Heinemann,

2000). The ABS consists of 14 items representing various manifestations of behavioural excess, rated for severity on a scale from 1 (absent) to 4 (present to an extreme or severe degree). Scores were summed and converted to percentages. Higher ABS scores indicate higher levels of observed agitation. The ABS is a valid and reliable measure of agitation in adults with traumatic brain injuries (Corrigan, 1989; Corrigan & Bogner, 1994), therefore inter-rater reliability was not specifically tested with staff involved in scoring the ABS in this study. In-house training sessions were provided to staff collecting data with the ABS.

Status of post-traumatic amnesia (PTA) was concomitantly measured using the Westmead PTA Scale (Shores, Marosszeky, Sandanam, & Batchelor, 1986), though not considered a dependent variable. Individuals were deemed to have emerged from PTA on the first day of scoring three consecutive scores of 12/12.

All measures were collected daily. PRPP data was collected by the researcher (MN); nursing staff collected ABS data during the morning-day shift (0700-1500hrs); and the clinical occupational therapist collected PTA data. Multiple sources of data were collected to enhance the rigor of the study design.

#### ***10.2.2.2 Independent variable***

The independent variable in this study was occupational therapy intervention. Subjects received usual occupational therapy intervention during baseline phases, alternating with the PRPP Intervention during the experimental intervention phases.

### **10.2.3 Intervention procedures**

The study protocol involved four sequential phases, alternating between baseline and experimental intervention. The study period (4-weeks) was established from previous research by the authors, identifying the average duration of agitation in patients at this rehabilitation facility to be 30 days (Nott, Chapparo, & Baguley, 2006). Weekly alternation between phases enabled collection of at least six data points in each phase and served pragmatic purposes in treatment planning within the clinical context. Stability of response requires a minimum of 5 data points as the target behaviours have some tendency to fluctuate day-to-day (Ottenbacher, 1986). The study protocol was slightly modified for Subject 7 who did not transfer to the BIRU until Day 19 of the study. An extended Baseline 2 phase was implemented in order to collect six days of Baseline data in the BIRU prior to commencing Intervention 2. This ensured internal validity of comparing adjacent Baseline and Intervention phases within the same treatment context, i.e. acute and rehabilitation settings. Subject 8 completed the usual 4-week protocol, however he remained in an acute care setting rather than the BIRU context.

Under each intervention condition, occupational therapy was provided as part of a multi-disciplinary rehabilitation programme including medical and nursing care, physiotherapy, speech pathology, clinical psychology and social work. A structured, daily routine, with regular timetabled rest and activity periods was part of the standard rehabilitation programme for patients functioning at Rancho Level 4 or 5 at the BIRU. In contrast, Subjects 7 and 8 who were managed on non-neurosurgical acute wards (Subject 7 until Day 19 of the study, Subject 8 for the entire duration) did not have access to the BIRU structured daily routine described above.

### ***10.2.3.1 Baseline intervention - current occupational therapy approach***

During baseline phases, subjects received daily occupational therapy from their clinical OT. The current approach is described as functional skill based training with aspects of behavioural management. Therapy sessions targeted specific occupational tasks or activities selected by the clinical OT in accordance with rehabilitation goals (for example self care, leisure, community participation, home management). Methods of intervention included systematic instruction; task adaptation; environmental modification; physical guidance and facilitation. Intervention was conducted in each subject's hospital bedroom or bathroom, communal dining/leisure areas, ADL kitchen, and local community settings.

### ***10.2.3.2 Experimental intervention – PRPP System***

Occupational therapy was provided daily during the experimental intervention phases by the research OT (MN) using the PRPP intervention approach. The PRPP System, as outlined earlier, is a dynamic assessment and intervention approach, where intervention is based upon all stages of information processing. Intervention sessions specifically targeted learning of information processing strategies using graded prompts (verbal, visual, gestural, physical), progressing from content free meta-prompts to more specific content based behavioural prompts. Patients learnt to apply 'stopping', 'sensing/attending', 'thinking' (recalling and planning), and 'doing' strategies to their performance across various occupational tasks (including self-care, leisure, home management and community integration activities).

To minimise bias and maintain internal validity, the tasks/activities targeted during the experimental intervention phases were selected by the clinical OT. Subjects were informed they were to have different therapists on alternate weeks, with no further information

provided regarding similarities or differences in intervention procedures. Therapy sessions during the experimental phases were not observed by the clinical OT to minimise carry-over effects.

#### **10.2.4 Data Analysis**

This paper is one of two papers related to this intervention study, and reports primarily on the relationship between agitated behaviour data and information processing during occupational performance. More detailed findings specifically related to information processing changes are reported elsewhere.

Data were graphed daily as observations occurred. Visual data analysis examined change in performance level between adjacent phases, latency of change, and trend/slope of plotted data (Kazdin, 2003). Change in level refers to an abrupt change in performance between two phases, resulting in noticeably different data levels on the y-axis (Ottenbacher, 1986); the timing of this change is referred to as latency, (Kazdin, 2003) while trend changes occur when the direction in which data is moving changes (Backman et al., 1997).

Performance during PTA can be variable and fluctuate on a daily basis, therefore weekly mean values have been calculated and plotted on the graphs to assist data interpretation. Serial dependency of the data was checked using autocorrelation coefficients (refer to Ottenbacher, 1986, p.173 for specific procedures). PRPP scores demonstrated a level of autocorrelation that did not reach statistical significance, while autocorrelation of ABS scores was statistically significant.

## 10.3 RESULTS

Figures 10.1-10.8 present subjects' daily ABS score and PRPP Total% scores across sequential phases of the study, with a mean line calculated for each phase on each variable. Time in days is expressed on the x-axis. Where applicable, a vertical arrow from the x-axis indicates day of PTA emergence. First, subjects functioning at Rancho Level 5 when recruited to the study (Subjects 1-4) are described, followed by subjects functioning at Rancho Level 4 when recruited to the study (Subjects 5-8) (Hagen, 2001). Individuals functioning at Level 5 are described as confused and inappropriate; who may demonstrate agitation in response to *external* stimuli. In contrast, Level 4 functioning is characterised by agitation in response to *internal* stimuli/ confusion.

### 10.3.1 Individual results

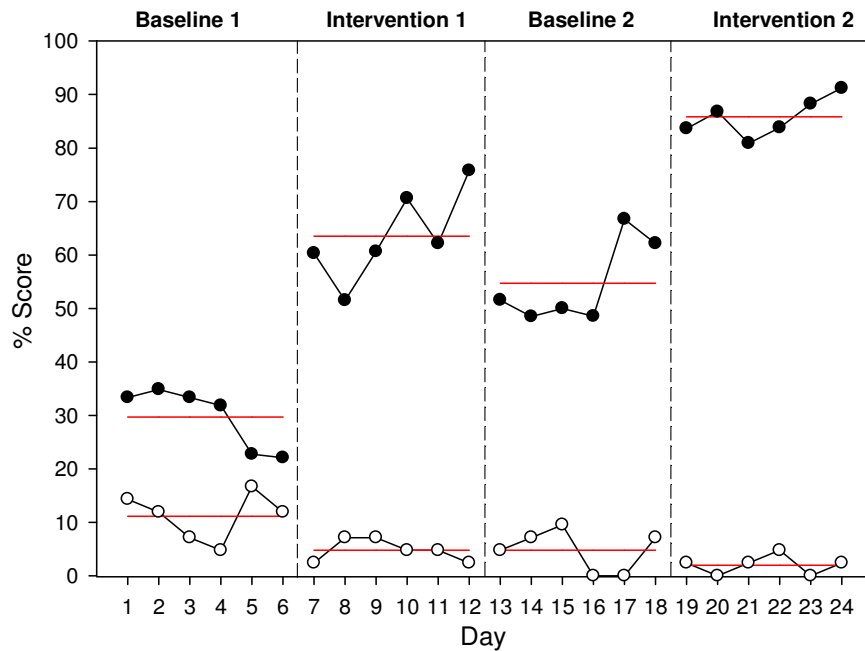
#### 10.3.1.1 Subject 1

At the time of recruitment, Subject 1 was demonstrating poor attention and memory, restlessness, impulsivity, and agitation in response to external stimuli. She progressed to Rancho Level 6 early in the study period but did not emerge from PTA.

Information processing ability improved substantially during the study as can be clearly seen in Figure 10.1, with greater increases in processing capacity evident during both PRPP Intervention phases. A large rise in level occurred between Baseline 1 and the first PRPP Intervention phase (PRPP Total% Baseline 1  $\bar{x}$  = 30%; Intervention 1  $\bar{x}$  = 64%; Baseline 2  $\bar{x}$  = 55%; Intervention 2  $\bar{x}$  = 86%). ABS scores were low from Baseline 1 ( $\bar{x}$  = 11%) and progressively decreased over the study period (Intervention 1  $\bar{x}$  & Baseline 2  $\bar{x}$  = 5%; Intervention 2  $\bar{x}$  = 2%). The introduction of PRPP Intervention did not appear to increase



agitated behaviour, as ABS scores continued to gradually decline over all four study phases. ABS recording for Subject 1 clustered on the Disinhibition factor with very few recordings on the factors of Aggression or Lability.

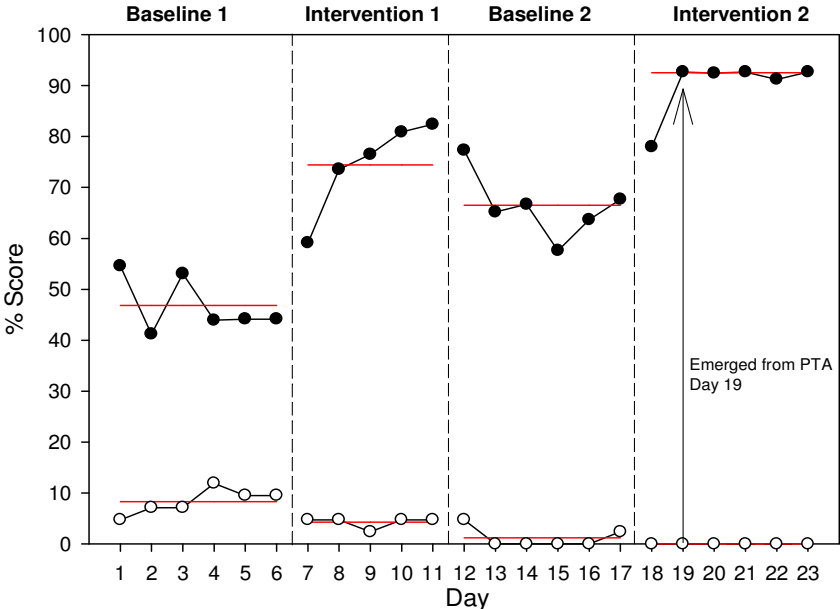


**Figure 10.1 Subject 1 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

### 10.3.1.2 Subject 2

When recruited to this study, Subject 2 exhibited a heightened activity state, internal confusion, poor attention and memory, and occasional verbal outbursts with confabulation. She was functioning at Rancho Level 5, then progressed to Level 6 and 7 during the study. She emerged from PTA on Day 19.

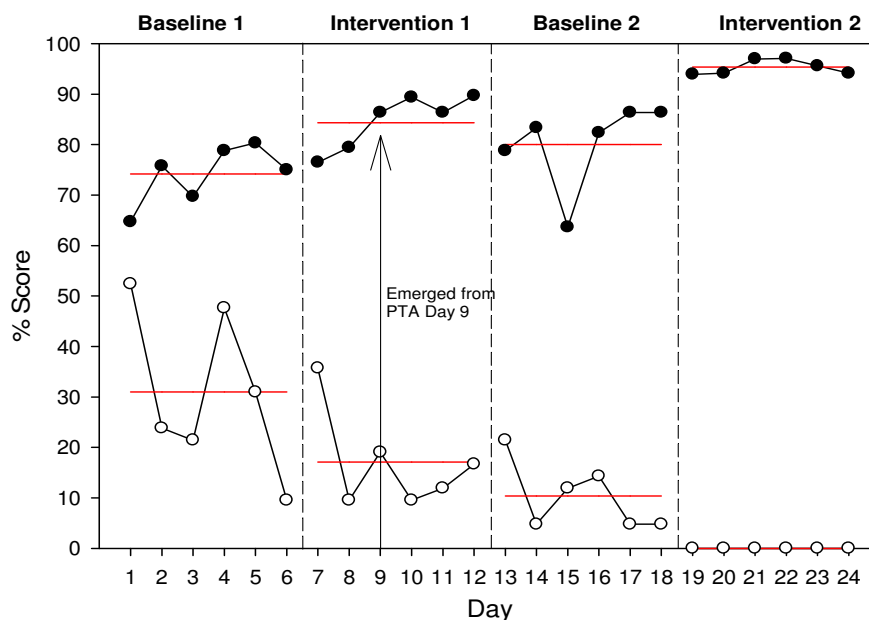
Subject 2 demonstrated a very clear pattern of daily information processing and agitated behaviour (see Figure 10.2) parallel to that seen in Subject 1, with clear improvements in information processing ability across the study phases and greater increases when receiving PRPP Intervention (PRPP Total% Baseline 1  $\bar{x}$  = 47%, Intervention 1  $\bar{x}$  = 75%, Baseline 2  $\bar{x}$  = 66%, Intervention 2  $\bar{x}$  = 90%). Low levels of agitated behaviour were measured using the ABS. A slight accelerating trend was evident during Baseline 1 ( $\bar{x}$  = 8%), which was reversed during the first PRPP Intervention phase ( $\bar{x}$  = 4%). ABS scores continued to decline towards zero (Baseline 2  $\bar{x}$  = 1%, Intervention 2  $\bar{x}$  = 0%). ABS recording for Subject 2 clustered on the Disinhibition factor with one recording under the Lability factor. No observations on the Aggression factor were recorded. Subject 2 emerged from PTA on Day 19 of the study. Agitated behaviour was near extinction prior to PTA emergence, with no episodes of agitation recorded post-emergence. Again, introduction of the PRPP intervention did not increase or exacerbate agitated behaviour.



**Figure 10.2 Subject 2 Daily PRPP Total% scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

### 10.3.1.3 Subject 3

Subject 3 was also reported to be functioning at Rancho Level 5 when recruited to the study, demonstrating internal confusion, poor memory, agitation in response to external stimuli, and verbal outbursts. She was able to participate in highly structured functional tasks but demonstrated fragmented responses. Levels of agitation measured using the ABS were higher than the previous two subjects, and loaded on all three factors; Disinhibition, Aggression and Lability. She progressed to Rancho Level 6 then 7 during the study, emerging from PTA on Day 9.



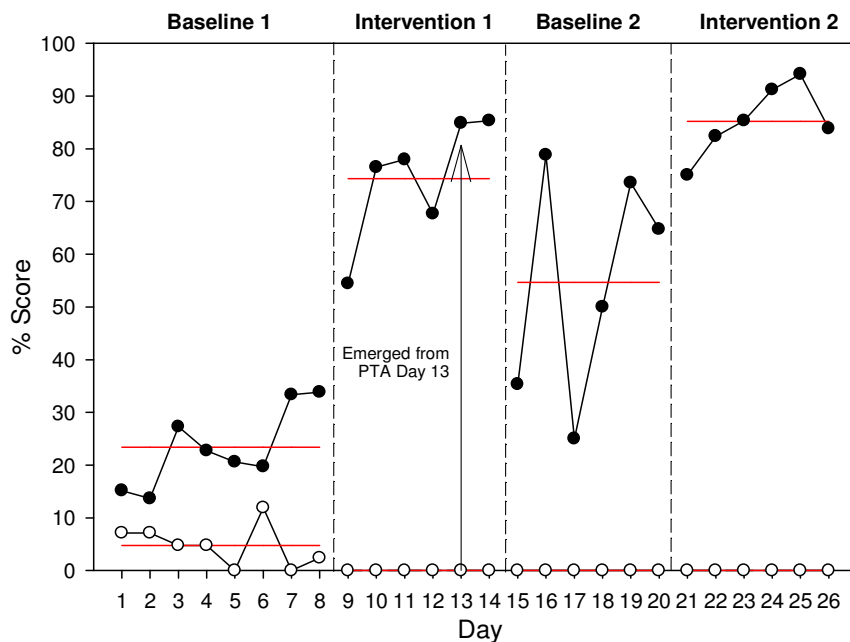
**Figure 10.3 Subject 3 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

Consistent improvement in processing abilities during functional tasks was clearly evident across the 4-weeks of the study (refer to Figure 10.3). Greater information processing capacity was observed under conditions of PRPP Intervention, though differences between phases were smaller (PRPP Total% Baseline 1  $\bar{x}$  = 74%, Intervention 1  $\bar{x}$  = 85%, Baseline 2  $\bar{x}$

= 80%, Intervention 2  $\bar{x}$  = 95%). Agitated behaviour was initially high and fluctuated during the first baseline period ( $\bar{x}$  = 31%), then decreased over time to be extinct during the final phase of the study (Intervention 1  $\bar{x}$  = 17%, Baseline 2  $\bar{x}$  = 10%; Intervention 2  $\bar{x}$  = 0%). Once more, introduction of the PRPP intervention did not increase or exacerbate agitated behaviour. Subject 4 emerged from PTA on Day 9 of the study, by which time agitation had started to decline; however agitated behaviour continued to be recorded for a further nine days after PTA had resolved.

#### 10.3.1.4 Subject 4

Subject 4 was functioning at Rancho Level 5 at the time of recruitment, demonstrating some restlessness, non-purposeful motor behaviour, and memory impairment. She rapidly progressed to Rancho Level 6 and 7 during the remaining phases of the study.



**Figure 10.4 Subject 4 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

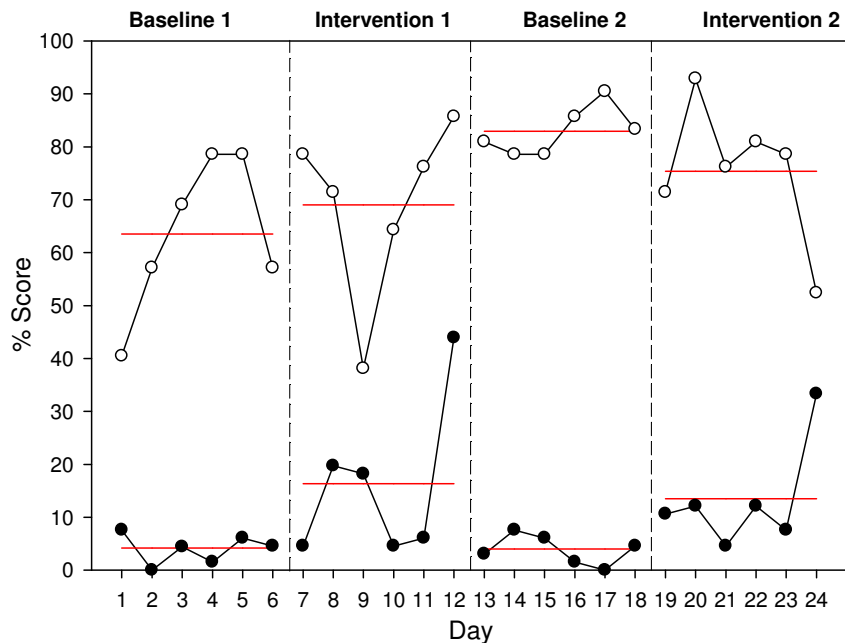
The general presentation of change over time observed in Subjects 1 - 3 was repeated again with Subject 4 (refer to Figure 10.4). Information processing ability improved substantially during the study, with greater increases in processing capacity evident during both PRPP Intervention phases. A large rise in level occurred between Baseline 1 and the first PRPP Intervention phase (PRPP Total% Baseline 1  $\bar{x}$  = 23%, Intervention 1  $\bar{x}$  = 74%), and then dropped in level when the PRP Intervention was withdrawn for Baseline 2 ( $\bar{x}$  = 55%), rising again when the PRPP Intervention was reintroduced at Intervention 2 ( $\bar{x}$  = 85%).

Very low levels of agitated behaviour were reported in Subject 4 during Baseline 1 ( $\bar{x}$  = 5%) followed by cessation of all agitation on Day 9 of the study. Again, introduction of the PRPP intervention did not increase or exacerbate agitated behaviour. ABS recordings for Subject 4 were reported on the Disinhibition and Lability factors, with no observations on the Aggression factor. In this case, agitation appeared to have resolved just prior to PTA emergence (Day 13).

#### ***10.3.1.5 Subject 5***

Subject 5 demonstrated the lowest levels of information processing throughout the study, and the highest recordings of agitated behaviour (see Figure 10.5). He remained confused and in PTA throughout the study. Subject 5 demonstrated typical features of Rancho Level 4. He was verbally and physically aggressive, physically restless with attempts to remove his restraints and get out of his bed/wheelchair, he was responding primarily to his own internal stimuli, had severe memory loss, and confusion. His gross attention was very limited, with nil ability to selectively attend to tasks or other people. Behaviours demonstrated by Subject 5

loaded on all three factors of the ABS; Disinhibition, Aggression and Liability. Subject 5 remained at Rancho Level 4 for the entire period of the study.



**Figure 10.5 Subject 5 Daily PRPP Total% scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

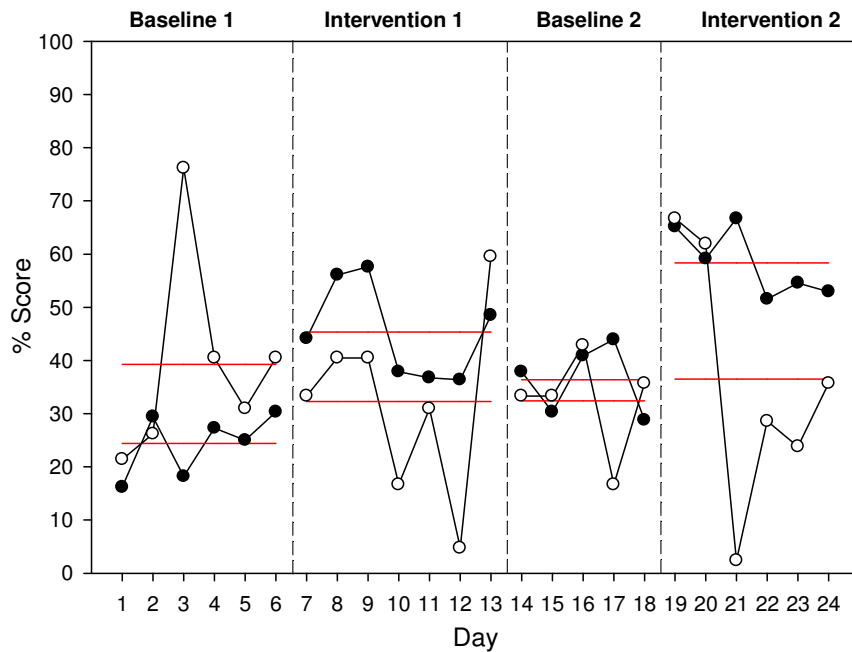
Subject 5's information processing capacity was very limited, though increases in processing ability did occur in response to the PRPP Intervention (PRPP Total% Baseline 1  $\bar{x}$  = 4%, Intervention 2  $\bar{x}$  = 16%, Baseline 2  $\bar{x}$  = 4%, Intervention 2  $\bar{x}$  = 13%). An accelerating trend in agitated behaviour was evident during the first three study phases (ABS Baseline 1  $\bar{x}$  = 64%, Intervention 1  $\bar{x}$  = 69%, Baseline 2  $\bar{x}$  = 83%). ABS scores appeared to slowly decline in the final days of the second PRPP Intervention phase ( $\bar{x}$  = 75%).

### **10.3.1.6 Subject 6**

Subject 6 was functioning at Rancho Level 4 on recruitment to the study, demonstrating verbal and physical aggression, usually targeted at staff. He was physically restless, demonstrated out-of-proportion responses to both internal and external stimuli, and also manifested bizarre behaviours. He progressed to Rancho Level 5, with behaviours being primarily externally driven. Many behaviours appeared to be learned responses in order to achieve attention or a specific desired outcome rather than being driven by a state of confusion. Subject 6 demonstrated a wide range of behaviours on the ABS that loaded on all three factors; Disinhibition, Aggression and Lability.

Information processing ability improved during the study, with greater increases in processing capacity evident during both PRPP Intervention phases (PRPP Total% Baseline 1  $\bar{x}$  = 24%, Intervention 1  $\bar{x}$  = 45%, Baseline 2  $\bar{x}$  = 36%, Intervention 2  $\bar{x}$  = 58%). Subject 6 did not emerge from PTA during the study; therefore all observed improvements in performance occurred whilst he remained in PTA.

Subject 6's agitated behaviour remained a mean phase level of 30-40% during the study, however daily recordings of behaviour fluctuated widely around these values, from as high as 76% on Day 3, to as low as 2% on Day 12. An increasing trend was evident during Baseline 1 (ABS  $\bar{x}$  = 39%) with a change in direction to reduced agitation during PRPP Intervention 1 ( $\bar{x}$  = 32%), and Baseline 2 ( $\bar{x}$  = 32%). Agitation was initially high then rapidly dropped during the second PRPP Intervention phase ( $\bar{x}$  = 37%). The overall trend across the duration of the study appears to be a decrease in agitation; however the degree of day-to-day variation distorts the overall clinical picture.



**Figure 10.6 Subject 6 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

### 10.3.1.7 Subject 7

Subject 7 had sustained an open rather than closed head injury and was initially managed on an acute surgical ward due to complications with the wound (day 1-19). He was then transferred to the BIRU on Day 19 and the protocol was modified to have an extended Baseline 2 period. He demonstrated classic characteristics of Rancho Level 4, with repetitive non-purposeful behaviours and motor restlessness, attempting to remove restraints and his IV tube. He repeatedly absconded from the ward area and required 1:1 supervision. His responses were often fragmented, with evidence of severe memory loss. Subject 7 demonstrated behaviours that loaded primarily loaded on the ABS factor of Disinhibition. Reports of behaviour loading on the Aggression factor were limited to the first 7 days of the study. He gradually progressed to Rancho Level 5 and 6 during the study.



Information processing ability improved during the study, with significantly greater increases in processing capacity evident during both PRPP Intervention phases, evidenced by very large increases in performance level between adjacent Baseline and Intervention phases (see Figure 10.7). A large change in direction occurred during the second Baseline phase (Total PRPP % Baseline 1  $\bar{x} = 7\%$ , Intervention 1  $\bar{x} = 51\%$ , Baseline 2<sub>acute</sub>  $\bar{x} = 29\%$ , Baseline 2<sub>BIRU</sub>  $\bar{x} = 22\%$ , Intervention 2  $\bar{x} = 80\%$ ).

Subject 7's agitated behaviour progressively declined over the study period (ABS Baseline 1  $\bar{x} = 25\%$ , Intervention 1  $\bar{x} = 14\%$ , Baseline 2<sub>acute</sub> & BIRU  $\bar{x} = 10\%$ , Intervention 2  $\bar{x} = 13\%$ ), with some localised fluctuations. He remained in PTA during the study.

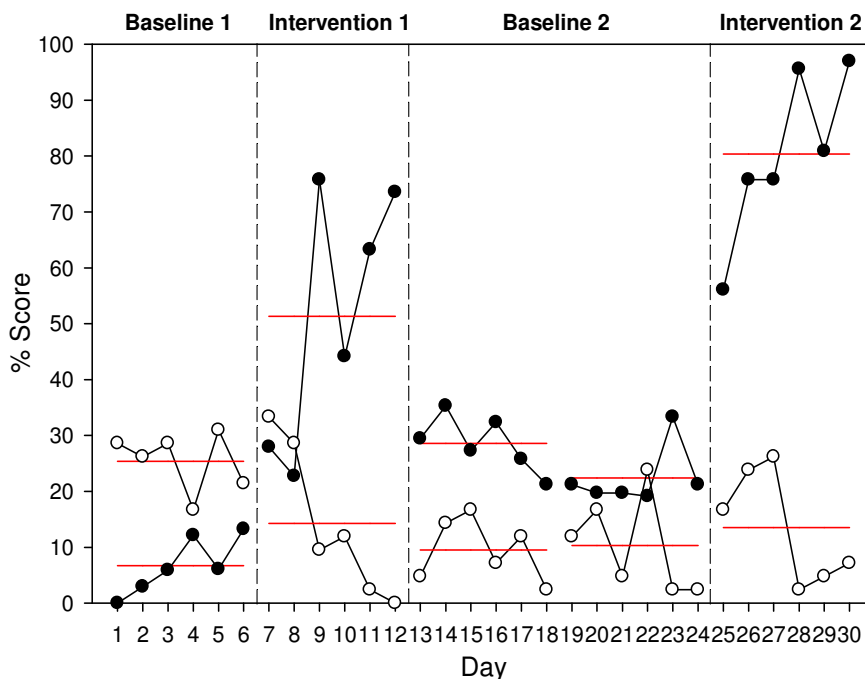


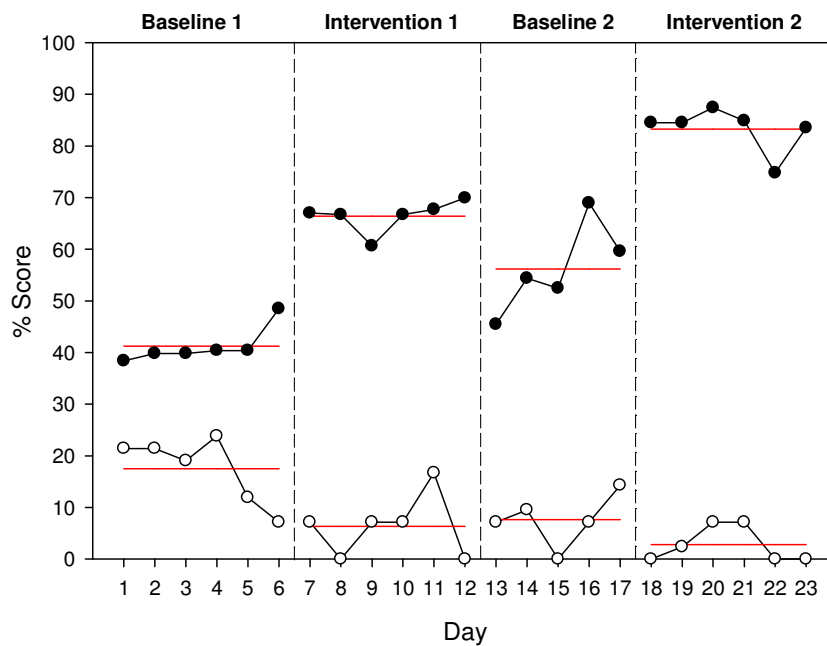
Figure 10.7 Subject 7 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)

### **10.3.1.8 Subject 8**

Subject 8 sustained a hypoxic injury secondary to cardiac failure, and remained on an acute cardiac ward for the duration of the study. In this case, Baseline intervention represents current occupational therapy intervention within the context of a general ward environment.

Information processing capacity and agitated behaviour patterns were similar to the first group of subjects (1-4), even though Subject 8 was initially functioning at a lower Rancho level. He progressed from Level 4 to 5 during the study. Information processing ability improved during the study (refer to Figure 10.8), with significantly greater increases in processing capacity evident during both PRPP Intervention phases (Total PRPP % Baseline 1  $\bar{x}$  = 12%, Intervention 1  $\bar{x}$  = 50%, Baseline 2  $\bar{x}$  = 35%, Intervention 2  $\bar{x}$  = 76%).

Subject 8 demonstrated behaviours that loaded primarily on the ABS factors of Disinhibition and Lability. Instances of behaviour loading on the Aggression factor were limited to the first 5 days of the study. ABS scores gradually decreased over the study period (Baseline 1  $\bar{x}$  = 17%, Intervention 1  $\bar{x}$  = 6%, Baseline 2  $\bar{x}$  = 8%, Intervention 2  $\bar{x}$  = 3%). Again, introduction of the PRPP intervention did not increase or exacerbate agitated behaviour.



**Figure 10.8 Subject 8 Daily PRPP Total % scores with mean lines (filled circles); Daily ABS score with mean lines (open circles)**

## 10.4 DISCUSSION

This study concurrently measured information processing strategy use and agitated behaviour in adults with brain injury participating alternatively in usual OT intervention and the PRPP System of Intervention. The single system design enabled detailed study of individual cases whilst the presentation of a case series allows a broader observation of the relative contribution of each intervention method. In all cases, use of information processing strategies to support occupational performance improved more in response to PRPP Intervention than current therapy approaches (for detailed analysis of individual differences on measures of information processing capacity please refer to Nott, Chapparo and Heard, *under review*). Concomitant measurements of daily agitated behaviour suggested that PRPP Intervention *did not* increase or exacerbate subjects' agitated behaviour. In some cases, agitated behaviour

reduced more rapidly during PRPP Intervention phases than during baselines phases of the study.

This case series supports research identifying the ability of patients in PTA to learn and acquire functional skills following brain injury (Gasquoine, 1991; Giles & Clark-Wilson, 1999; Weir, Doig, Fleming, Wiemers, & Zemljic, 2006). The PRPP Intervention approach focused on information processing strategies to structure and organise information required for effective task performance, focusing attention, highlighting integral task components, facilitating recall of task procedures, identifying and avoiding obstacles to performance, use of internally driven tactics, and goal direction. The focus on strategy acquisition and application increases the level and depth of cognitive processing necessary for task performance. This approach is in contrast with usual therapy approaches used during the agitated stage of recovery such as modifying task demands and environmental stimuli to reduce task demands and thereby minimise triggers for agitation (Radomski, 2008).

Therapists understandably may feel uncertain about implementing intervention methods that may increase agitated responses if the task is too demanding or stimulating, therefore agitated behaviour was systematically monitored and found *not* to increase in response to the PRPP Intervention approach. Direct causal research designs are required to examine the relationship between effective use of information processing strategies during task performance and agitation, however these initial results do not suggest any exacerbation of behaviour upon introduction of the PRPP Intervention, and may suggest a more rapid decline in agitation in some cases.

As seen in previous studies of agitation during acute rehabilitation (Lequerica et al., 2007), use of the ABS effectively captured a range of behaviours, across a wide spectrum of severity levels. Behaviours that represented disinhibition, such as impulsivity, short attention span, pulling at tubes/restraints, restlessness, and repetitive behaviours either physical or verbal were the most commonly recorded behaviours using the ABS. Behaviours representing emotional lability and aggression were recorded at a lower frequency than disinhibited behaviours.

The Rancho Los Amigos Levels of Cognitive Functioning Scale (Hagen, 2001) differentiates between agitated behaviour at Rancho Level 4 and 5, as being either driven by internal confusion or by external stimuli. Subjects 1-4 were recruited into the study at Level 5, while Subjects 5-8 were functioning at rancho Level 4. A consistent trend towards decreased agitation and cessation of agitation prior to completion of the study was seen in Subjects 1-4. Even at levels that may fall below the standardised criteria for agitated behaviour using the ABS, these behaviours can be disruptive to therapy and rehabilitation progress (Lequerica et al., 2007).

In contrast to the first four subjects, Subjects 5-8 were functioning at Rancho Level 4 when recruited to the study. A pattern of decreasing agitation (though not to complete cessation) was seen in Subjects 7 and 8 who did not have as severe underlying information processing difficulties as Subjects 5 and 6, who demonstrated varied agitated behaviour responses over time. Many factors specific to the person and environment may contribute to agitated behaviours.

In Subjects 1-6 the rehabilitation environment (BIRU) included consistent daily routines, with a structured therapy and rest timetable monitored by the clinical team. Subject 7 was managed on an acute surgical ward for part of the study then transferred to the BIRU context, while Subject 8 remained on an acute cardiac ward throughout the study period. In both these cases, information processing capacity during PRPP intervention phases was significantly higher than Baseline phases, where the same level of structured multi-disciplinary intervention was not in place.

Agitation is typically characterised as a feature or characteristic of the PTA stage of recovery. Previous research suggests that agitation is a phenomenon that occurs during the period of PTA (Corrigan & Bogner, 1994; Lombard & Zafonte, 2005; Sandel & Mysiw, 1996) and usually resolves prior to emergence from PTA (van der Naalt, van Zomeren, Sluiter, & Minderhoud, 2000). Three subjects (Subjects 2, 3, & 4) emerged from PTA during the study period. In these cases, agitation was present during the PTA period and started to decline as information processing ability improved. Agitation ceased prior to PTA resolution for Subjects 2 and 4, while Subject 3 continued to demonstrate agitation for nine days following PTA emergence. Subjects 5, 6, and 7 did not emerge from PTA during the study period and continued to demonstrate agitated behaviour, lending further support for the temporal association of these two characteristics of TBI sequelae.

Poor generalisation is a frequently cited limitation of single-system designs. To improve generalisation in this study, the protocol was systematically replicated across subjects and settings to accumulate evidence for external validity and generalisation of findings (Backman et al., 1997; Ottenbacher, 1986). Concerns with observer bias are also commonly cited in

single-system research. Through video analysis of therapy sessions, a high degree of intra-rater and inter-rater reliability were established, indicating that observer bias was minimal during this study.

Clinical studies within the context of acute TBI rehabilitation are vulnerable to the confounding effect of natural recovery. The reversal design adopted in this study enabled repeated baseline measurements to determine the relative effect of the experimental treatment, current occupational therapy intervention, and the contribution of natural recovery. In all cases processing strategy use during occupational tasks declined at the start of Baseline 2 (when the usual intervention approach was reintroduced), though it did not usually return to the level of Baseline 1. Positive differences between Baseline 1 and Intervention 1 were repeated between Baseline 2 and Intervention 2, supporting the effectiveness of the PRPP Intervention above and beyond the effect of current intervention and natural recovery.

This study concomitantly measured agitation during sequential introduction and withdrawal of two different occupational therapy intervention approaches. Primarily this study was concerned with ensuring that PRPP Intervention did not exacerbate agitation. This study did not control for confounding variables such as therapy provided by other team members, pharmacotherapy, and the rehabilitation context and setting. Factors not measured in this study may have contributed to changes in agitated behaviour during the study period, however it is improbable that any phasing of other therapies coincided with the phasing of PRPP Intervention.

## **10.5 CONCLUSION**

This study evaluated the effectiveness of the PRPP System of Intervention in comparison to current occupational therapy approaches with brain injured adults during Rancho Level 4 and 5. Both approaches were shown to effectively increase information processing capacity during occupational performance, with the PRPP Intervention being more effective than current intervention approaches. Adults in early stages of brain injury rehabilitation effectively learned and applied information processing strategies to improve task performance, in the presence of agitation and posttraumatic amnesia. Agitation was concomitantly measured and shown to systematically reduce over time.

This case series suggests a strong treatment effect that requires replication across a greater number of subjects, therapists and settings to consolidate the evidence base upon which occupational therapists can make decisions regarding rehabilitation of adults with brain injuries.



## 10.6 REFERENCES

- Alderman, N. (2002). Individual case studies. In S. Priebe & M. Slade (Eds.), *Evidence in Mental Health Care* (pp. 142-157). Hove: Brunner-Routledge.
- Backman, C. L., Harris, S. R., Chisholm, J.-A. M., & Monette, A. D. (1997). Single-subject research in rehabilitation: A review of studies using AB, withdrawal, multiple baseline, and alternating treatments designs. *Archives of Physical Medicine and Rehabilitation*, 78(10), 1145-1153.
- Barlow, D. H. & Hersen, M. (1984). *Single case experimental designs. Strategies for studying behavior change. 2nd ed.* Elmsford, New York: Pergamon Press Inc.
- Beaulieu, K. (2007). Occupational therapists' perceptions and management of aggression related to adults with a brain injury. *British Journal of Occupational Therapy*, 70(4), 161-170.
- Beck, J. & Horne, D. (1992). A whole school implementation of the Stop, Think, Do! Social skills training program. In B. Willis & J. Izard (Eds.), *Student behavior problems: directions, perspectives and expectations*. Hawthorn, Victoria: Australian Council for Educational Research.
- Bermann, D. E. (1988). Psychosocial elements of head injury. In K. M. Kovich & D. E. Bermann (Eds.), *Head Injury. A guide to functional outcomes in occupational therapy*. (pp. 35-44). Rockville, Maryland: Aspen Publishers.
- Bermann, D. E. & Bush, T. (1988). Treatment of sensory-perceptual and cognitive deficits. In K. M. Kovich & D. E. Bermann (Eds.), *Head injury. A guide to functional outcomes in occupational therapy*. (pp. 45-65). Rockville, Maryland: Aspen Publishers.
- Bogner, J. A., Corrigan, J. D., Bode, R. K., & Heinemann, A. W. (2000). Rating scale analysis of the Agitated Behavior Scale. *Journal of Head Trauma Rehabilitation*, 15(1), 656-669.
- Chapparo, C. & Ranka, J. (1997). The Perceive, Recall, Plan and Perform System of Task Analysis. In C. Chapparo & J. Ranka (Eds.), *Occupational Performance Model (Australia), Monograph 1* (pp. 189-198). Sydney: Total Print Control.
- Chapparo, C. & Ranka, J. (2005). *The PRPP System of Task Analysis: user's training manual*. Lidcombe: Available from The School of Occupation and Leisure Sciences, The University of Sydney.
- Chapparo, C. & Ranka, J. (2007). The PRPP System: intervention. Available from the Discipline of Occupational Therapy, Faculty of Health Sciences, The University of Sydney.
- Constantinidou, F., Thomas, R. D., & Best, P. J. (2004). Principles of cognitive rehabilitation: an integrated approach. In M. J. Ashley (Ed.), *Traumatic brain injury: rehabilitative treatment and case management* (2nd ed., pp. 337-363). Boca Raton: CRC Press.

- Corrigan, J. D. (1989). Development of a scale for assessment of agitation following traumatic brain injury. *Journal of Clinical & Experimental Neuropsychology*, *11*(2), 261-277.
- Corrigan, J. D. & Bogner, J. A. (1994). Factor structure of the Agitated Behavior Scale. *Journal of Clinical & Experimental Neuropsychology*, *16*(3), 386-392.
- Fry, K. & O'Brien, L. (2002). Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: A case study. *Australian Occupational Therapy Journal*, *49*(4), 182-187.
- Gaber, T. A. K. (2006). Medico-legal and ethical aspects in the management of wandering patients following brain injury: Questionnaire survey. *Disability and Rehabilitation*, *28*(22), 1413-1416.
- Gasquoine, P. G. (1991). Learning in post-traumatic amnesia following extremely severe closed head injury. *Brain Injury*, *5*(2), 169-175.
- Gianutsos, R. & Gianutsos, J. (1987). Single-case experimental approaches to the assessment of interventions in rehabilitation. In B. Caplan (Ed.), *Rehabilitation psychology desk reference* (pp. 453-470). Rockville: Aspen Publishers.
- Giles, G. M. (1999). Management of behavioural disregulation and non-compliance in the post-acute severely brain -injured adult. In G. M. Giles & J. Clark-Wilson (Eds.), *Rehabilitation of the severely brain-injured adult: a practical approach* (2nd ed., pp. 81-96). Cheltenham: Stanley Thornes (Publishers) Ltd.
- Giles, G. M. & Clark-Wilson, J. (1999). Functional skills training following severe brain injury. In G. M. Giles & J. Clark-Wilson (Eds.), *Rehabilitation of the severely brain-injured adult* (2nd ed., pp. 97-134). Cheltenham: Stanley Thornes (Publishers) Ltd.
- Giles, G. M. & Manchester, D. (2006). Two approaches to behavior disorder after traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *21*(2), 168-178.
- Hagen, C. (2001). The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *re-Learning Times*, *8*(1), 1.
- Herbel, K., Schermerhorn, L., & Howard, J. (1990). Management of agitated head-injured patients: A survey of current techniques. *Rehabilitation Nursing*, *15*(2), 66-69.
- Kazdin, A. E. (2003). *Research design in clinical psychology* (4 ed.). Boston: Allyn & Bacon.
- Lequerica, A. H., Rapport, L. J., Loehner, K., Axelrod, B. N., Vangel, S. J., Jr., & Hanks, R. A. (2007). Agitation in acquired brain injury: Impact on acute rehabilitation therapies. *Journal of Head Trauma Rehabilitation*, *22*(3), 177-183.
- Lerner, J. W. (1997). *Learning disabilities. Theories, diagnosis, and teaching strategies* (7th ed.). Boston: Houghton Mifflin Company.

- Linacre, J. M. (2007). FACETS Rasch measurement computer program. Chicago: Winsetps.com.
- Lombard, L. A. & Zafonte, R. D. (2005). Agitation after traumatic brain injury: considerations and treatment options. *American Journal of Physical Medicine & Rehabilitation*, 84(10), 797-812.
- Militello, L. G. & Hutton, R. J. B. (1998). Applied Cognitive Task Analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41(11), 1618-1641.
- Murphy, D. P. & Cooke, J. (1999). Traffic light lessons: Problem solving skills with adolescents. *Community Practitioner*, 72(10), 322-324.
- Nicholls, J. & Chapparo, C. (1993). OPM(A): Improving performance of occupational tasks and routines in clients with extreme agitation after traumatic brain impairment. Retrieved 31st July, 2004, from <http://www.occupationalperformance.com/oldsite/appimprove01.html>
- Nott, M. T. & Chapparo, C. (2007). Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. *Australian Occupational Therapy Journal*, 54.
- Nott, M. T., Chapparo, C., & Baguley, I. J. (2006). Agitation following traumatic brain injury: An Australian sample. *Brain Injury*, 20(11), 1175-1182.
- Ottenbacher, K. J. (1986). *Evaluating clinical change: strategies for occupational and physical therapists*. Baltimore: Williams & Wilkins.
- Ottenbacher, K. J. & Hinderer, S. R. (2001). Evidence-based practice: methods to evaluate individual patient improvement. *American Journal of Physical Medicine & Rehabilitation*, 80(10), 786-796.
- Pryor, J. (2004). What environmental factors irritate people with acquired brain injury? *Disability and Rehabilitation*, 26(16), 974-980.
- Pryor, J. (2006). What do nurses do in response to their predictions of aggression? *Journal of Neuroscience Nursing*, 38(3), 177-182.
- Radomski, M. V. (2008). Traumatic brain injury. In C. A. Trombly Latham & M. V. Radomski (Eds.), *Occupational therapy for physical dysfunction* (6 ed.). Baltimore: Lippincott, Williams & Wilkins.
- Sandel, M. E. & Mysiw, W. J. (1996). The agitated brain injured patient. Part 1: Definitions, differential diagnosis, and assessment. *Archives of Physical Medicine & Rehabilitation*, 77(6), 617-623.
- Schraagen, J. M., Chipman, S. F., & Shalin, V. (2000). *Cognitive task analysis*. Mahwah: Lawrence Erlbaum Associates.

- Shores, E. A., Marosszeky, J. E., Sandanam, J., & Batchelor, J. (1986). Preliminary validation of a clinical scale for measuring the duration of post traumatic amnesia. *Medical Journal of Australia*, 144, 569-572.
- Slifer, K. J., Tucker, C. L., Gerson, A. C., Cataldo, M. D., Sevier, R. C., Suter, A. H., et al. (1996). Operant conditioning for behaviour management during posttraumatic amnesia in children and adolescents with brain injury. *Journal of Head Trauma Rehabilitation*, 11(1), 39-50.
- Slifer, K. J., Tucker, C. L., Gerson, A. C., Sevier, R. C., Kane, A. C., Amari, A., et al. (1997). Antecedent management and compliance training improve adolescents' participation in early brain injury rehabilitation. *Brain Injury*, 11(12), 877-889.
- Thompson, C. K. (2006). Single subject controlled experiments in aphasia: the science and the state of the science. *Journal of Communication Disorders*, 39(4), 266-291.
- Toglia, J. P. (1998). A dynamic interactional model to cognitive rehabilitation. In N. Katz (Ed.), *Cognition and occupation in rehabilitation: cognitive models for intervention in occupational therapy* (pp. 5-50). Bethesda: American Occupational Therapy Association.
- van der Naalt, J., van Zomeren, A. H., Sluiter, W. J., & Minderhoud, J. M. (2000). Acute behavioural disturbances related to imaging studies and outcome in mild-to-moderate head injury. *Brain Injury*, 14(9), 781-788.
- Weir, N., Doig, E. J., Fleming, J. M., Wiemers, A., & Zemljic, C. (2006). Objective and behavioural assessment of the emergence from post-traumatic amnesia (PTA). *Brain Injury*, 20(9), 927-935.
- Wilson, J. C. & Dailey, W. (1999). The practice of behavioural treatment in the acute rehabilitation setting. In G. M. Giles & J. Clark-Wilson (Eds.), *Rehabilitation of the severely brain-injured adult: a practical approach* (2nd ed., p. 54). Cheltenham: Stanley Thornes (Publishers) Ltd.
- Ylvisaker, M., Turkstra, L., Coehlo, C., Yorkston, K., Kennedy, M., Sohlberg, M. M., et al. (2007). Behavioural interventions for children and adults with behaviour disorders after TBI: A systematic review of the evidence. *Brain Injury*, 21(8), 769 - 805.
- Yuen, H. K. & Benzing, P. (1996). Guiding of behaviour through redirection in brain injury rehabilitation. *Brain Injury*, 10(3), 229-238.
- Zhan, S. & Ottenbacher, K. J. (2001). Single subject research designs for disability research. *Disability and Rehabilitation*, 23(1), 1-8.

## **CHAPTER 11: DISCUSSION AND CONCLUSION**

The purpose of this final chapter is to view the research study in its entirety in order to determine what has been learned from the study and the significance for the occupational therapy profession. An overview is first presented, reiterating the aims, methods and outcome of each research phase. The second section of this chapter will draw together the individual findings from Chapters Four to Ten, and discuss the major findings in the context of the overall research project. Next, the study limitations are reviewed followed by the theoretical, clinical, methodological, and empirical significance of the study. Implications for future research and practice are finally discussed.

### **11.1 OVERVIEW**

This research was guided by a series of clinical questions for which current brain injury and occupational therapy literature provided few answers. First, adults with TBI who are agitated during acute rehabilitation are reported to experience poor functional outcomes. The reasons for this have not been examined in detail. Second, a relationship between impaired cognition and agitation is evident, yet few assessment tools suitable for use in acute TBI rehabilitation are applicable for assessing the effects of cognitive and behavioural dysfunction during occupational performance. Third, occupational therapists are required to provide intervention for this group of patients in the absence of a clear professional evidence base. In response to these problems, the primary purpose of the current research was to

investigate how information processing deficits impact on the occupational performance of adults with agitated behaviour following TBI.

Five research questions arose from this overall purpose:

1. To what extent does agitated behaviour impact on functional outcomes following inpatient rehabilitation of adults with TBI?
2. How can the capacity to apply information processing strategies during occupational performance be effectively measured in adults with agitated behaviour during acute TBI rehabilitation?
3. What types of strategy application deficits are identified by Stage 2 of the PRPP System of Task Analysis when observing the occupational performance of adults with agitated behaviour following TBI?
4. How valid and reliable is Stage 2 of the PRPP System of Task Analysis when measuring application of information processing strategies during occupational performance of adults with agitated behaviour following TBI?
5. How effective is the PRPP System of Intervention for improving application of information processing strategies during occupational performance of adults demonstrating agitated behaviour during acute TBI rehabilitation?

A mixed-methods approach was used to explore these research questions. A correlational outcome study first compared functional outcomes of adults with agitation during TBI rehabilitation to the outcomes achieved by adults without agitation following TBI. A retrospective medical record review confirmed the high incidence of agitated behaviour in adults undergoing specialist rehabilitation

following severe TBI. These patients achieved poorer outcomes at the time of discharge, particularly in the area of functional cognition. The association between agitation and poor cognition persisted for up to two years following discharge. These findings confirmed results from previous studies, and directed the subsequent lines of research inquiry.

Research Phase One highlighted the need for more detailed and specific assessment tools to measure the impact of agitated behaviour and cognitive changes on occupational performance. An extensive literature review and critique was conducted, in which assessment tools were evaluated against standard criteria, within the clinical framework of the Occupational Performance Model (Australia). The PRPP System of Task Analysis was identified as a promising assessment tool for use in this population, examining a sufficiently broad range of information processing capacities, using observational methods within the context of functional task performance, and having preliminary information on validity and reliability for measuring performance of adults with TBI. A detailed case study followed, in which one patient deemed a critical case embodying all the clinical features of concern to the study, was repeatedly measured over a one-month period. Stage 2 of The PRPP System of Task Analysis was found to be clinically useful in measuring application of processing strategies across a range of functional tasks, and identified a consistent pattern of strategy application deficits from the Perceive and Plan Quadrants.

The next aspect of the research focused on the measurement properties of Stage 2 of the PRPP System of Task Analysis using two quantitative approaches: Rasch analysis and traditional test methods. Ten occupational therapists with experience in

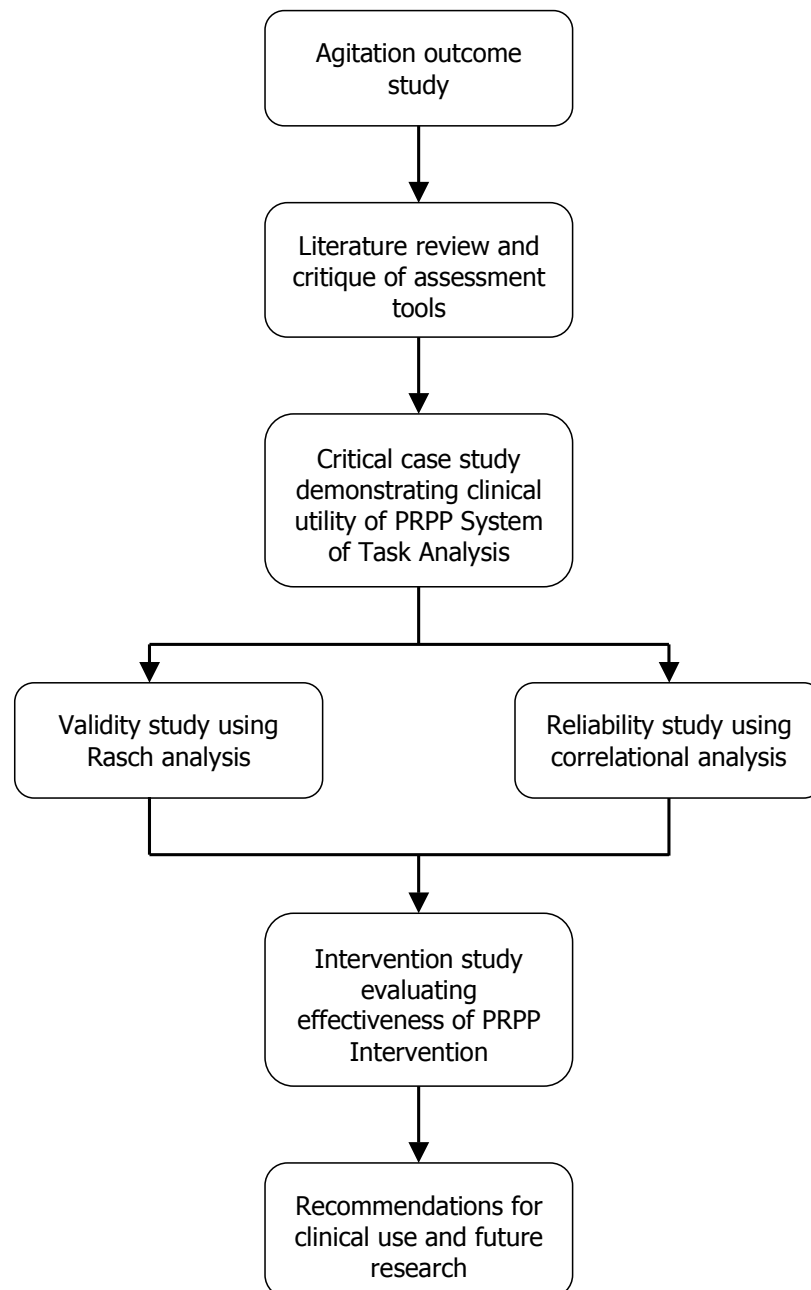
neurological rehabilitation analysed the task performance of five adults with agitated behaviour following brain injury, performing several different self-care tasks. These assessment scores first underwent Rasch calibration to create a linear hierarchy of information processing strategies. This hierarchy reiterated the findings of the earlier case study, and was consistent with the models of information processing, human cognition, and learning theory that underpin the PRPP System and cognitive rehabilitation more generally. Rasch analysis also confirmed the unidimensionality of the items that comprise the PRPP System of Task Analysis, demonstrating acceptable ‘goodness-of-fit’ with the Rasch model. Internal consistency of the measure was confirmed using traditional test statistics, achieving a very high Cronbach’s alpha.

This phase of the research was also concerned with the reliability of assessment procedures. Test reliability, inter-rater reliability and intra-rater agreement of the PRPP System of Task Analysis were examined. Correlation between ratings for the purpose of measuring test reliability was high, and moderate to high for rater reliability. Differences in ratings between two testing occasions were not significant, suggesting adequate intra-rater agreement was achieved.

Finally, an experimental single case design with replication across a series of adults was carried out to examine the effectiveness of PRPP Intervention in comparison to conventional occupational therapy in an ABAB design. Application of information processing strategies during occupational performance consistently improved during the four-week period of the study, while agitated behaviour tended to progressively decrease. Both intervention approaches were associated with improved strategy



application during task performance, however the greatest improvement was associated with the PRPP Intervention phases, achieving a very large treatment effect in comparison to conventional intervention. The sequence of research phases in the study is illustrated below (Figure 11.1).



**Figure 11.1** Flowchart of research phases

## 11.2 DISCUSSION OF FINDINGS

This section draws together individual findings from all the research phases to present the primary findings in the context of the overall research project. These findings are listed below and form the basis for five main discussion points.

1. A significant proportion of adults with severe TBI demonstrate agitated behaviour during inpatient rehabilitation, limiting their achievement of functional goals, and in particular, being associated with poor cognitive outcome.
2. Information processing difficulties are extensive in adults with agitated behaviour following severe TBI, with greatest difficulty observed in applying planning and attention strategies during occupational performance.
3. Difficulty applying information processing strategies during occupational performance can be observed and measured using Stage 2 of the PRPP System of Task Analysis, an emerging valid and reliable assessment method that is suitable for use with adults with severe TBI demonstrating agitated behaviour during acute rehabilitation.
4. The strategy training approach utilised in the PRPP System of Intervention effectively targets information processing strategy use during occupational performance in adults with severe TBI demonstrating agitated behaviour, and is more effective than conventional instructional approaches.
5. The integrated components of the PRPP System enable occupational therapy assessment and intervention with adults who are demonstrating agitated behaviour during PTA, and who would otherwise not be considered able to participate in traditional assessment and intervention procedures.

### **11.2.1 Agitation in TBI rehabilitation**

Limited research has been conducted in Australia to specifically examine the nature and extent of agitated behaviour in adults following TBI. In order to understand the local context, this study quantified the nature and extent of agitated behaviour during inpatient rehabilitation at a specialist brain injury service in Sydney, and then examined the impact of agitated behaviour on functional outcomes, generating the following finding:

*A significant proportion of adults with severe TBI demonstrate agitated behaviour during inpatient rehabilitation, limiting their achievement of functional goals, and in particular, being associated with poor cognitive outcome.*

Agitated behaviour is a significant problem during TBI rehabilitation. Nearly three-quarters (70%) of adults with severe TBI recruited to the retrospective study in Research Phase One demonstrated agitated behaviour at some stage during inpatient rehabilitation. This figure is higher than the reported 36-57% in most previously published studies (Bogner et al., 2001; Kadyan et al., 2004; Maryniak et al., 2001; Reyes et al., 1981); but lower than Lequerica et al.'s (2007) reported level of agitated behaviour when considering all forms of agitated behaviour (91%). Reported incidence varies due to different definitions, data collection methods, and clinical settings.

Research Phase One was conducted in a specialist brain injury rehabilitation facility that provides both short and long-term rehabilitation programmes. The high incidence and longer duration of agitation in this sample may be an indicator of the

injury severity in patients who are targeted for referral to the longer-term rehabilitation programme at the facility. Second, discrepancies in reported incidence may arise with differing data collection methods. Prospective measures of agitation using the ABS have consistently identified lower levels of agitation (Bogner et al., 2001; Kadyan et al., 2004; Lequerica et al., 2007) in comparison to methods based on review of medical records (Maryniak et al., 2001). This may suggest a tendency to include comments regarding agitated behaviour in medical records that may not be assessed as meeting the criterion for agitated behaviour on an objective scale. The impact of differing data collection and definitional methods has been clearly highlighted when determining incidence. Lequerica et al. (2007) identified the presence of one or more agitated behaviours in 91% of TBI patients during acute rehabilitation. In contrast, when the ABS cut-off score was applied, only 6% of the same sample were categorised as agitated. Use of objective criterion levels interpreted at 'cut-off' scores, may inadvertently mask levels of agitated behaviour that are considered to be sub-threshold, but may still impact on performance and achievement of functional goals (Lequerica et al., 2007).

Agitation is considered by the rehabilitation team to limit participation in rehabilitation and achievement of functional outcomes (Bogner et al., 2000; Burnett et al., 1999; Sandel & Mysiw, 1996). The findings of Research Phase One support these clinical impressions.

In this study, agitated behaviour was associated with prolonged length of rehabilitation stay, increased duration of PTA and poor functional cognition. These findings resonate with previous studies demonstrating a relationship between presence of agitation and increased PTA duration (Maryniak et al., 2001), lengthier rehabilitation stay (Bogner et al., 2001; Kadyan et al., 2004) and poor cognitive outcome at the time of rehabilitation discharge (Bogner et al., 2001).

The observed changes in functional outcome in agitated patients are hypothesised to result from reduced engagement in therapy. Both injury severity and agitation are known predictors of engagement in therapy (Lenze et al., 2004; Lequerica et al., 2007; Lequerica et al., 2006), and previous research has identified an inverse relationship between level of agitation and engagement in both occupational therapy and physiotherapy (Lequerica et al., 2007).

The underlying reason or cause for reduced engagement in therapy is not well understood. Impairments in cognition have been identified as largely responsible for the relationship between agitation and poor rehabilitation outcomes (Bogner et al., 2001). It is suggested that cognitive features and the disruptive nature of agitated behaviour may interfere with the patient's ability to focus on tasks or goals, and become fully engaged in therapy (Lequerica et al., 2007). Subsequent phases of this research attempted to identify specific areas of cognitive capacity most affected in adults with agitated behaviour, in order to better understand these limitations to therapy engagement, and to identify intervention approaches that may be most beneficial in this acute stage of recovery.

### **11.2.2 A consistent pattern of information processing difficulty**

Effective occupational performance is thought to require application and integration of many information processing strategies including attending to and perceiving information from the surrounding sensory environment, recalling and retrieving information from memory stores, planning and executive processes, monitoring and adjusting performance, and use of feedback.

Several observation based assessment tools were reviewed to identify a task based assessment suitable for measuring information processing in the broad sense described above, that was also clinically appropriate to use with adults demonstrating agitated behaviour during the early stages of TBI rehabilitation. The PRPP System of Task Analysis was selected as demonstrating the highest clinical utility in this population (Chapparo & Ranka, 1997a, 2005).

The PRPP System of Task Analysis was used during Research Phases Two, Three and Four to systematically evaluate the information processing difficulties experienced by adults with agitated behaviour following TBI. The following overall finding emerged from the data analysis:

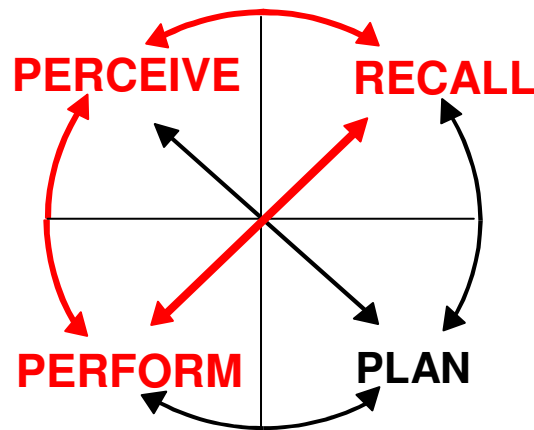
*Information processing difficulties are extensive in adults with agitated behaviour following severe TBI, with greatest difficulty observed in applying planning and attention strategies during occupational performance.*

Repeated observational assessment of patients performing various functional tasks, rated by the researcher and several occupational therapists, provided data upon which a Rasch calibrated hierarchy of information processing strategies was generated. This

hierarchy outlines a linear continuum of cognitive strategies from those that appear least difficult for patients to apply, through to strategies that appear most difficult for patients to apply during occupational performance. The hierarchy delineated in Phase Three of the project was highly correlated with the hierarchy generated in Phase Four; supporting the consistency of this information processing pattern in acutely brain injured adults.

#### ***11.2.2.1 A Rasch calibrated hierarchy of information processing strategies***

Information processing strategies in the lower order of the Rasch hierarchy (i.e. relatively easier to apply) included strategies that form the grounding or basis upon which occupational performance can occur, sometimes referred to as basic cognitive processes or strategies. These included the PRPP strategies of *recognising* and *categorising* objects, *noticing*, *discriminating* and *matching* aspects of objects and the environment, recalling how to *use objects*, *knowing the goal* of a task and *initiating* task performance. These cognitive strategies are automatically initiated for familiar, habitual tasks (Missiuna et al., 2001), and represent the processing cycle depicted in Figure 11.1, that commences with Perceive, moves to Recall of automatic or habitual information (procedural memory), and bypasses the Plan Quadrant via the diagonal arrow directly to Perform.



**Figure 11.2 Central PRPP Quadrants with multi-directional arrows indicating sequence for initial perception, recall and performance**

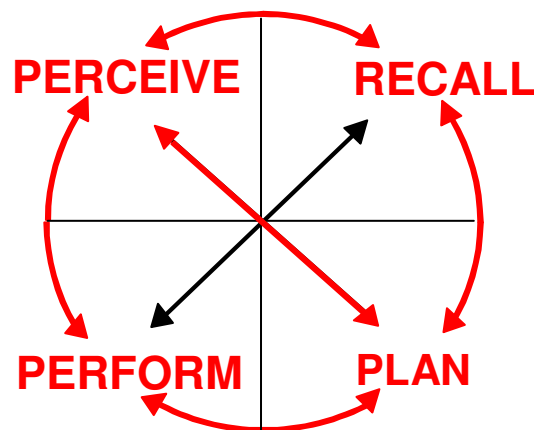
Higher functioning patients appeared to have retained this processing sequence for the purpose of routine, procedural tasks; however more severely impaired patients demonstrated difficulty using this strategy sequence, getting ‘stuck’ processing between the Perceive and Recall Quadrants, requiring prompting to initiate Perform strategies. Alternatively, more impulsive patients were observed to bypass both the Recall and Plan Quadrants, processing information in the Perceive Quadrant and immediately enacting a Perform Quadrant strategy.

Supervising these lower order cognitive strategies on the Rasch hierarchy were complex, higher order strategies such as *analysing* and *judging* behaviour, *organising* oneself and the environment, *identifying obstacles* to performance, *sequencing* and *choosing* task actions. These strategies, primarily representing information processing capacities from the Plan Quadrant, were accompanied in the higher portion of the hierarchy by two Perceive Quadrant strategies: *modulating* attention and *monitoring* sensory aspects of task performance. Even the highest



functioning patients were not initially able to use these strategies during functional task performance.

In most cases, these strategies required targeted intervention for effective application to occupational performance. The inclusion of Plan Quadrant strategies in the processing sequence is depicted in Figure 11.2. Patients who were able to apply planning strategies typically engaged in processes of perceiving and recalling first, then generated a plan before proceeding to perform the intended action. Feedback from the Perform Quadrant is thought to activate the left side arrow to return sensory information about the action to the Perceive Quadrant, which in turn may activate the arrow through the centre to put in place another Plan of action. This cyclic activation pattern engages strategies for *analysing*, *monitoring* and *judging* performance, only observed in the highest functioning patients.



**Figure 11.3 Central PRPP Quadrants with multi-directional arrows indicating sequence for planning and evaluating performance**

These findings are consistent with previous studies using the PRPP System of Task Analysis, in which planning skills have been identified as one of the most complex areas of information processing in adults with neurological and psychological impairment (Aubin, et al., 2008; Fry & O'Brien, 2002; Still et al., 2002). Findings also parallel several theoretical models of learning, human cognition and information processing (Constantinidou et al., 2004; Lerner, 2002; Norman & Shallice, 1986; Schmidt & Wrisberg, 2004; Snell & Zirpoli, 1987; Sohlberg et al., 1993; Stuss, 1991), in which lower order skills are thought to be supervised by higher order skills.

The PRPP strategies in the lower section of the Rasch hierarchy are functionally and structurally aligned to the sensory register and short term memory components of the information processing system (Baddeley & Logie, 1999; Lerner, 2002).

Commensurate with Stuss's (1991) first order sensory, perceptual or knowledge based control functions, these strategies are essential components for the first stage of acquisitional learning (Snell & Zirpoli, 1987). It appears that sensory and procedural based strategies in the Perceive and Recall Quadrants may represent cognitive processes of relative strength for patients in this acute stage of TBI rehabilitation, providing a platform, or scaffold on which more complex processing strategies can be developed and built (Greber et al., 2007a).

In contrast, the PRPP strategies in the upper section of the Rasch hierarchy appear to be functionally and structurally aligned to the executive control system or supervisory attention system (Baddeley & Logie, 1999; Norman & Shallice, 1986; Stuss, 1991), integral to planning and problem solving, modulating and switching attention between task components, information monitoring and changing response

selection strategies (Constantinidou et al., 2004; Miyake et al., 2000). These metacognitive strategies are essential for maintenance and generalisation stages of the learning process, and for application of learned skills to novel situations (Missiuna et al., 2001; Snell & Zirpoli, 1987).

A consistent pattern of cognitive strategy deficit was observed during occupational performance of patients with agitated behaviour. This consistent pattern may, in part, be explained by similarities in level of functional recovery across subjects, location of initial injury within the brain and related neurofunctional deficits. All patients were recruited to the study during Rancho Level IV or V (Hagen et al., 2001), consistent with the acute rehabilitation stage of recovery associated with PTA. Similarities between patients' CT scans were evident: primarily reporting frontal lobe injuries; characteristics consistent with cerebral oedema; evidence of global ischaemic changes; and diffuse axonal injury. These injuries, interfering with the function of the frontal lobe or the association pathways that carry information to and from the frontal cortex (Petrides & Pandya, 2002), are likely to have contributed to strategy deficits of attention, working memory, information processing and executive function (Azouvi, 2000; Felmingham, Baguley, & Green, 2004; Soeda et al., 2005; Strangman et al., 2005).

Further research is required to test this pattern of information processing difficulty across a more heterogeneous group of adults with brain injuries, at different stages in the recovery process, with different injury profiles. At present, it is unclear if people apply cognitive strategies in the same way, to the same extent, for the same tasks.

Future research may consider if people who are performing the same task steps apply

different processing strategies, or apply strategies to different levels to achieve similar functional outcomes.

### **11.2.3 An emerging valid and reliable method for measuring strategy application deficits during occupational performance**

Measuring the effect of TBI on cognitive processes and behaviour during the early stages of recovery has traditionally challenged rehabilitation clinicians. Use of norm-referenced, standardised assessments provides information with minimal clinical utility. Criterion referenced assessment methods have progressively gained favour in rehabilitation contexts, demonstrating greater clinical utility by focusing on individual performance, not on group membership (Glaser, 1981). Criterion referenced assessment is particularly suited to acute TBI rehabilitation by assessing not simply the capacity of the person to perform the task, but the person's performance capacity relative to the demands of the task, and the demands made by the context of performance (Griffin, 1995). While the clinical utility of such assessment methods appears high, concerns with validity and reliability, particularly rater reliability have been raised (Dunn, Morgan, Reilly, & Parry, 2004). Therefore Research Phase Three involved a preliminary investigation into the measurement properties of the PRPP System of Task Analysis, and yielded the following finding for this sample:

*Difficulty applying information processing strategies during occupational performance can be observed and measured using Stage 2 of the PRPP System of Task Analysis, an emerging valid and reliable assessment method that is suitable for use with adults with severe TBI demonstrating agitated behaviour during acute rehabilitation.*

#### **11.2.3.1 Establishing validity of the PRPP System of Task Analysis**

Construct validity was evaluated using Rasch modelling of the individual strategy items that comprise Stage 2 of the PRPP System of Task Analysis. The strategies or descriptor items included in the PRPP System are intended to measure whether people are aware of what they need to do for effective occupational performance, and how they ‘think about’ or ‘think through’ what they are going to do. In essence, this requires application of processing strategies across a spectrum of cognitive areas, reflected by the hierarchy discussed previously.

Initial construct validity was established by comparing the degree of ‘fit’ between the PRPP performance scores collected in practice with scores predicted by the Rasch model. Thirty-three from thirty-four items achieved acceptable fit with the Rasch model, indicating unidimensionality of the assessment tool (Bond & Fox, 2001). This level of item fit compares favourably with occupational therapy assessment measures recently evaluated using Rasch modelling techniques, for example the A-ONE (Árnadóttir & Fisher, 2008), the Falls Behaviour Scale (Clemson, Bundy, Cumming, Kay, & Lockett, 2008), the Play Assessment for Group Settings (Lautamo et al., 2005), and the Assisting Hand Assessment (Krumlinde-Sundholm, Holmefur, Kottorp, & Eliasson, 2007).

Rasch analysis techniques were found to be particularly useful for this initial evaluation of instrument validity. While further research with a larger patient sample is necessary to add to these findings, this preliminary analysis offers initial support for unidimensionality and individual item fit.

#### ***11.2.3.2 Evaluating reliability of the PRPP System of Task Analysis***

Measurement of reliability was an important feature of this research, as criterion referenced assessments that rely on professional judgement, require sound reliability to allay concerns about the consistency and repeatability of what are sometimes perceived as ‘subjective’ scoring procedures (Dunn et al., 2004).

First, the reliability of test procedures was measured across several therapists, patients and tasks. Correlational analysis revealed high levels of test reliability indicating the procedures used to measure this sample were consistently applied by therapists and are highly repeatable across tasks and patients. High test reliability of the PRPP System of Task Analysis may be attributed to the clearly defined criterion measures developed for individual descriptor items. The establishment of standardised scoring rubrics is paramount for criterion referenced assessments (Eisner, 1993), as these form the basis upon which ratings are prescribed by therapists when observing patient performance.

Second, inter-rater reliability was measured between nine occupational therapists, using video analysis. Criterion referenced assessments rely on professional judgement. In turn judgement involves recognition that task performance does not have one universal outcome, approach or solution (Glaser, 1981; Griffin, 1995).

Moreover, most everyday tasks have not one single competency, but many. Different patients may apply the strategies included in the PRPP System in different ways to achieve the same task outcome. The complexity of this measurement approach challenges rater reliability even further. Therapists achieved a moderate level of rater reliability when using the PRPP System to assess processing strategy application across several tasks by several patients with severe brain injury. This level of inter-rater reliability is considered acceptable in this measurement context, and compares favourably with recently published clinical research in brain injury rehabilitation using a similar research design (Barreca et al., 2003).

The degree of inter-rater reliability found between occupational therapists in Research Phase Three suggests a common understanding of the scoring rubric taught in PRPP training workshops, and an ability to reliably interpret observed behaviour in adults with agitation following severe brain injury. This research assessed patients performing several tasks at one 'snap-shot' in time, therefore future research may consider how reliably the PRPP System can measure change in strategy application over time. The PRPP System of Task Analysis focuses on measuring how a person applies cognitive strategies at the present time, for the specific task at hand, it is not a generalised test of cognition nor does it attempt to predict cognitive functioning across different contexts and points in time. This feature enables future research to investigate how the application of strategies is modified by time, recovery and intervention processes, and may lead to the identification of particular strategies that are more responsive to intervention, or identification of 'task critical' strategies essential for occupational performance of adults with TBI.

#### **11.2.4 Instructing information processing strategies in adults with agitation following TBI**

Occupational therapy intervention was evaluated in a series of eight adults who were demonstrating agitated behaviour following severe brain injury. An ABAB single case experimental design was used to compare current/conventional occupational therapy intervention (A phases) with the PRPP System of Intervention (B phases) and yielded the following finding:

*The strategy training approach utilised in the PRPP System of Intervention effectively targets information processing strategy use during occupational performance in adults with severe TBI demonstrating agitated behaviour, and is more effective than conventional instructional approaches.*

In seven of the eight cases involved in Research Phase Four, occupational therapy directed by the PRPP System of Intervention was associated with statistically significant improvement in cognitive strategy use during occupational performance, and was associated with a large effect size. The effect of PRPP intervention was clinically evident in all eight cases, and was more effective than current instructional methods used by occupational therapists.

The effectiveness of cognitive rehabilitation based on strategy instruction is an area receiving a great deal of interest in contemporary brain injury literature (Ehlhardt, Sohlberg, Glang, & Albin, 2005; Kennedy et al., 2008; Kennedy & Coelho, 2005; Rath et al., 2003; Sohlberg et al., 2005). The findings from Research Phase Four are consistent with findings of two recent meta-analyses that evaluated strategy



instruction in comparison to conventional ‘control’ intervention (typically direct instruction) in adults with TBI (Kennedy et al., 2008), and in children and adolescents with learning disorders (Swanson & Sachse-Lee, 2000).

Findings from both meta-analyses support the findings from this study. Direct instruction and strategy instruction are effective for improving problem solving, planning, and organising abilities, however treatment effect size associated with strategy instruction is significantly larger than the effect size associated with conventional, direct instruction approaches. Kennedy et al. (2008) synthesised findings from randomised control trials, non-randomised group designs and single-subject designs, to provide a Level A recommendation that metacognitive strategy instruction should be the intervention of choice with young to middle-aged adults following TBI, when improvement in everyday, functional problems is the goal of intervention.

The PRPP Intervention approach focused on information processing strategies to structure and organise information required for effective task performance, focusing attention, highlighting integral task components, facilitating recall of task procedures, identifying and avoiding obstacles to performance, use of internally driven tactics, and goal direction (Chapparo & Ranka, 2007). Several features of the PRPP Intervention approach are hypothesised to underpin the level of success achieved with this approach in comparison to conventional intervention.

First, strategies requiring intervention were identified using the PRPP System of Task Analysis by observing performance across several functional tasks. Once identified,

strategies were ‘chunked’ together to enable instruction of multiple, strategies that followed a processing pattern described as: ‘*Stop, Sense, Think, Do*’ (Chapparo & Ranka, 2007). The sequential facilitation of multiple cognitive processes, rather than targeting specific, individual cognitive deficits, appears to be one of the integral components to the success of this approach (Singer & Cauraugh, 1985; Swanson & Sachse-Lee, 2000). The prompting of sequential strategies effectively facilitates the *flow* of information processing from initial input to response output, rather than retraining discrete processing skills at various stages in the information processing system.

This finding parallels previous studies using multi-processing strategy approaches in adults and children. Adults with brain injuries effectively learnt memory skills based on the sequence of stopping and thinking about what strategy to use; using the strategy; then checking and comparing the outcome (Freeman et al., 1992). Complex problem solving skills have also been taught to adults with brain injuries using this approach. Cognitive strategies during real-life tasks were applied to ‘stop and think’; ask ‘clear-thinking questions’; and to ‘think your way through’ the task (Rath et al., 2003).

Similar multi-processing strategy approaches have been effectively used to teach children, for example the ‘Goal-Plan-Do-Check’ and the ‘Goal-Plan-Do-Review’ approaches, that also focus on the flow of information processing during task performance (Feeney & Ylvisaker, 2003, 2006; Michenbaum & Goodman, 1971; Missiuna et al., 1998).

The structural and functional models of cognition proposed by Luria (1970) and Stuss (1991) support the application of this approach for use in TBI rehabilitation. Luria's functional systems model divides the brain into three functional interrelated systems, concerned respectively with arousal and attention; analysing, processing, coding and storing information; and programming, regulation, and verification of activity (Kirby, 1980; Languis & Miller, 1992; Luria, 1970). The three functions outlined by Stuss (1991) overlap those of Luria. Each level contains an input, comparator and an output system, targeting different types or levels of information processing. Sensory-perception and basic knowledge form the lowest part of the hierarchy, executive functions the middle component, and self-reflection the highest component (Sohlberg et al., 1993).

Both models highlight the integrative function of cognitive processes, with an inherent hierarchical sequence by which higher order, complex skills are built upon a platform of lower order skills (Ben-Yishay & Diller, 1993; Berkeland & Flinn, 2005). The multi-process sequence of strategies that forms the basis of the PRPP Intervention approach parallels the cognitive, functional sequences suggested by these theorists. '*Stop*' modulates arousal and re-allocates attention as per Luria's Unit One. '*Sense*' focuses on further modulation of attention and discrimination of sensory information as per Luria's Units One and Two, and Stuss's first level. '*Think*' targets recall and planning strategies that parallel Stuss's middle level of executive function and Luria's Units Two and Three. '*Do*' is represented in part by Luria's Unit Three and the output components of all Stuss's functional levels.

Languis and Miller (1992) describe the dynamic, interactive component of Luria's system as the most essential component to effective cognitive processing. The success of cognitive strategy training is thought to partly lie in the facilitation of multiple cognitive processes, rather than directing therapy towards discrete, individual cognitive skills in isolation, without considering the interrelationship between specific cognitive skills, or how these skills relate to each other for task performance (Toglia, 1998, 2005).

The second feature of the PRPP System of Intervention that may contribute to greater success in comparison to conventional therapy is the focus on cognitive strategy instruction rather than directly instructing skill acquisition. The conventional, direct instructional approach, derived from an acquisitional frame of reference, focuses on the development of specific skills required for occupational performance (Brasic Royeen, & Duncan, 1999; Sohlberg et al., 2005). Mastery of specific functional skills is the intended goal under this frame of reference (Greber et al., 2007a), whereby instruction targets objects or events within the environment, steps of the task, or task components (Gagné et al., 2005; Snell & Zirpoli, 1987; Swanson & Sachse-Lee, 2000). Direct instruction targets what are referred to as '*doing*' skills (Singer & Cauraugh, 1985).

In contrast, instruction that focuses on cognitive strategies emphasises '*thinking*' skills, prior to and during occupational performance (Singer & Cauraugh, 1985). PRPP Intervention is based upon instructional techniques that are not targeted at performance outcome per se, but at the patient's own cognitive strategies to achieve desired performance outcomes (Chapparo & Ranka, 2007; Gagné et al., 2005), for

example “*Start thinking about the next part, ask yourself ‘What do I need to do next?’ Start to get yourself ready.*”

Missiuna et al. (1998) highlight this as a central characteristic of the strategy training approach within their CO-OP model. Therapists must intend to create cognitive skill and understanding, rather than focus on acquisition of a physical skill or performing a task. The cognitive strategies that are taught are applied not only to that task, but transcend the specific task content to be a processing rule that is applicable and practiced in other real-world contexts.

The next aspect of PRPP Intervention hypothesised to contribute to the observed level of effectiveness in Research Phase Four, was the shift from therapist directed to patient directed cognitive processing. This movement away from therapist directed instruction to patient directed strategy use occurred via several mechanisms.

First, a least-to-most prompting hierarchy was used rather than the more intrusive most-to-least approach, to minimise dependence on the therapist and promote a more timely transition to autonomous performance (Greber et al., 2007b; Snell & Zirpoli, 1987). Second, self-instructional strategies were effectively learned following modelling of thinking by the researcher. While modelling of physical skills can occur through demonstration, guidance in the use of cognitive strategies can be achieved using think-aloud modelling, where the therapist audibly describes the decision-making processes that are occurring during the task (Greber et al., 2007b). Self-instructional techniques in this study focused on strategy-based prompts, used by patients to guide their own performance; for example “*Is this mouthful too big or too*

*small? Should I stop here or here? Will I move on now or wait?"* This approach is thought to inherently attribute a level of competence to the patient that direct instructional approaches do not (Missiuna et al., 2001).

Finally, 'bridging' techniques were used by the researcher, to deliberately prompt thinking about another time when this strategy may be useful in the future, or may have been used in the recent past; for example "*Focus in on this part now, this will be important to remember for tomorrow*", or "*Go inside your head, remember back to how we did this yesterday – remember how you started this movement*".

In summary, occupational performance of adults during acute brain injury rehabilitation improved significantly more in response to PRPP Intervention than conventional instructional intervention. Targeting cognitive strategies rather than skill acquisition, teaching multi-process sequences of strategies rather than discrete, individual skills, and moving away from a therapist directed approach towards a patient directed approach, were hypothesised to underpin the success observed in these adults over a short period of intervention.

The effectiveness of cognitive strategy training has been established in adults who are typically long past the acute stage of recovery (Kennedy et al., 2008). In contrast, this study represents systematic application of a cognitive strategy training approach to adults in acute brain injury rehabilitation, during the period of PTA. While several hypotheses have been outlined as possible explanations of the positive outcomes in this study, future research is essential to replicate these findings in a larger group

study, involving patients and therapists in various clinical settings such as acute care, inpatient rehabilitation, transitional living environments, and the wider community.

### **11.2.5 Occupational therapy assessment and intervention with agitated patients during PTA**

Agitation is typically characterised as a feature or characteristic of the PTA stage of recovery, (Corrigan & Bogner, 1994; Lombard & Zafonte, 2005; Sandel & Mysiw, 1996) and is thought to resolve prior to emergence from PTA (van der Naalt et al., 2000). For this reason, all participants were specifically targeted as being in PTA at the time of study recruitment.

*The integrated components of the PRPP System enable occupational therapy assessment and intervention with adults who are demonstrating agitated behaviour during PTA, and who would otherwise not be considered able to participate in traditional assessment and intervention procedures.*

The observational, task analytic basis of the PRPP assessment procedures enabled evaluation of information processing during the early stages of TBI rehabilitation, a practice that has traditionally challenged clinicians. Assessments based on direct clinical observation, such as the PRPP System of Task Analysis, may provide greater utility in the early stage of TBI rehabilitation (Donkervoort, Dekker, Stehmann-Saris, & Deelman, 2001; Elder, 1999), and enable timely assessment of changing cognition and behaviour during the PTA period (Weir et al., 2006). The flexibility permitted in selecting occupational tasks suitable for the patient, enabled assessment of patients across a variety of functional levels in Research Phases Two, Three and Four. The

PRPP System was suitable for assessing performance during very short, simple, functional tasks that are within the attention constraints of very agitated patients; and more complex community based tasks during later stages of the intervention period of Research Phase Four.

Occupational performance improvements were associated with concomitant reduction in agitated behaviour and progression to higher levels on the Rancho Los Amigos Levels of Cognitive Functioning Scale (Hagen, 2001). Patients initially functioning at Rancho Level V all progressed to higher Rancho Levels during the study, with an associated reduction in agitated behaviour. Three of these patients emerged from PTA during the four-week study period.

This progression was not universally observed in patients who were initially functioning at Rancho Level IV. One patient (Subject 5), who remained at Rancho Level IV throughout the study, demonstrated the highest levels of agitation. None of the patients who were recruited at Rancho Level IV emerged from PTA, and all continued to demonstrate some level of agitation throughout the study. A gradual decrease in agitation level was observed. At the same time, all subjects demonstrated some improvement in their ability to use information processing strategies during occupational performance, particularly during the PRPP Intervention phases of the study. It is hypothesised that improved cognitive strategy use may modify agitated behaviour during occupational tasks. Mediated learning of specific strategies to attend, interpret and use information from the environment may reduce a patient's heightened activity state sufficiently to enable engagement in therapeutic activity. Future research may explicate this hypothesised relationship and identify critical



cognitive strategies to assist this process, leading to greater reductions in agitated behaviour, and less interference with therapy engagement and functional performance.

### **11.3 RESEARCH LIMITATIONS**

Limitations of the research relate to the characteristics and sample size in each phase, and to the data collection and analysis techniques. In designing each phase of the research, attempts were made to minimise the effects of these limitations.

#### **11.3.1 Research Phase One - Agitation outcome study**

The retrospective cohort included in Research Phase One was recruited from a specialist brain injury rehabilitation facility that provides both short- and long-term rehabilitation programmes. The incidence and duration of agitation shown by these participants, which was markedly higher than incidence levels reported in previously published studies, may be an indicator of greater injury severity, typically demonstrated by individuals who are targeted for referral to the long-term rehabilitation programme offered by the facility. This may limit generalisation of these findings beyond the research sample of adults with severe TBI referred to a specialist brain injury rehabilitation service.

Data collection methods may also have contributed to the higher reported incidence rate. In this study, the presence of agitation was identified as concurrent reporting of at least two behaviours consistent with agitation (pre-defined) in the participant's medical record. This broad definition used to identify agitated behaviour from medical records may have contributed to a higher representation of agitation in this

sample, however as this study represented the first exploration of agitation in an Australian sample of adults with TBI, this broader stance was felt to be justified and appropriate to the aims of the research.

### **11.3.2 Research Phase Two – Critical case study**

Research Phase Two involved a descriptive case study in which one client only was examined; therefore limiting generalisation of findings. While this client illustrated many of the characteristics that are associated with severe agitation post-TBI, assessment of other clients may have generated different information processing profiles. As this case study was descriptive in nature, the aim of this research phase was not to measure the significance of the observed changes in statistical or clinical terms. Future research involving more participants is required to statistically examine the extent and direction of changes in performance over time.

In this case study, there was no attempt to control variables related to medical, therapeutic and nursing input, or the hospital context that may have influenced this client's information processing capacity, however the processing profile described in this study finds resonance with descriptions of severely agitated behaviour in TBI literature, and those observed in later research phases.

### **11.3.3 Research Phase Three – Validity and Reliability studies**

The first aspect of Research Phase Three examined the validity of the PRPP System of Task Analysis. In this study, five patients were recruited and videotaped performing several functional tasks. This footage was viewed and scored by ten occupational therapists. The primary limitation of this study inevitably lies in the

small patient sample from which data were collected. Agitation by its nature is present for varying periods of time and to differing extents in patients following TBI, therefore collecting occupational performance data on more than five patients in the one-year period in which this study component was conducted was not feasible.

Rasch analysis was selected as the statistical model of choice to initially examine the validity of the test structure for measuring information processing capacity in adults with agitated behaviour following TBI. This approach was intentionally selected as small sample sizes are permitted, and analysis can occur during preliminary stages of research to provide validation of test construction. To further examine the stability of the PRPP System of Task Analysis using Rasch analytic techniques, a sample of at least 30 patients will be needed, from a wider range of functional recovery levels (other than Rancho Level IV & V). This may also improve targeting of the PRPP test items in the higher portion of the Rasch hierarchy as few of these more difficult items targeted patients in this sample (i.e. items required greater information processing capacity than shown by patients at this stage of recovery).

The second study component in Research Phase Three examined the reliability of the PRPP System of Task Analysis' test procedures and rater reliability. Ratings from nine of the therapists in the validity study above were available for evaluation in the reliability component. Sample size issues were again evident in the reliability analysis, however the standardised procedures and initial examination of reliability across nine therapists is a large step forward in comparison to the self-developed outcome measures typically used to demonstrate change in adults with cognitive and behavioural difficulties following TBI (Ylvisaker et al., 2007).

A three-way correlational model was utilised to provide the most accurate measure of rater and test reliability, accounting for different patients performing different functional tasks (thus reflecting clinical practice). In order to achieve this three-way correlational model, *all* therapists are required to observe and rate *all* clients. In clinical settings, this is only feasible via scoring of video footage. Participants reported that scoring via video reduced the opportunities for therapists to engage directly with the client and created an artificial ‘distance’ between the therapist and patient that would not usually be present during clinical contexts.

#### **11.3.4 Research Phase Four - PRPP Intervention study**

The research limitations present during Research Phase Four were inevitably those inherent to the single-system experimental design. Procedures to minimise threats to internal and external validity were included in the study design. Intra-rater and inter-rater reliability were established using retrospective video-analytical methods.

Agreement achieved between the independent observer and the researcher suggested that observer bias was minimal during this study. Very high intra-rater reliability was achieved over the 12-month period of the study highlighting stability in scoring procedures. Additionally, multiple data collection sources were utilised (ABS collected by nursing staff, PTA collected by clinical OT, PRPP collected by researcher). Finally, treatment fidelity was evaluated by independent therapists, trained in PRPP Intervention.

Poor generalisation is a frequently cited limitation of single-system designs. To improve generalisation in this study, the protocol was systematically replicated across

subjects with varying levels of injury severity and differing modes of injury, then from a specialist brain injury rehabilitation setting to a general, acute hospital ward.

Finally, clinical studies within the context of acute TBI rehabilitation are vulnerable to the confounding effect of natural recovery. The reversal design adopted in this study enabled repeated baseline measurements to determine the relative effect of the experimental treatment, current occupational therapy intervention, and the contribution of natural recovery. In all cases processing strategy use during occupational tasks declined at the start of Baseline 2 (when PRPP Intervention was withdrawn and usual intervention was reintroduced), though it did not usually return to the level of Baseline 1. This effect may be accounted for in at least three ways.

First, the process of natural recovery would predispose an individual towards improved performance over time even in the absence of therapy; therefore a complete return to Baseline 1 level of performance was not expected. Second, the Baseline phases represented current therapy, that is, they *did not* represent an *absence* of therapy. Performance during both Baseline phases was expected to improve in response to current occupational therapy intervention. This research design required an *additional* improvement in performance to demonstrate the effect of the PRPP Intervention approach. The third factor stopping performance levels returning completely to Baseline 1 levels is the potential effect of learning. Subjects who effectively learned information processing strategies during the first PRPP Intervention phase may have applied these same strategies during therapy sessions in the second baseline. While there are methods for ‘forcing a reversal’ these practices are not recommended, and were not included in the design of this study (Thompson, 2006).

## **11.4 SIGNIFICANCE**

The current research makes a significant contribution to occupational therapy theory and practice in the area of acute TBI rehabilitation and occupational performance.

### **11.4.1 Theoretical contribution**

This research represents an attempt to integrate information processing theory, the neurorehabilitation approach to managing agitated behaviour during acute TBI rehabilitation, and occupational performance. This research focused on several constructs defined by the OPM(A) (Chapparo & Ranka, 1997a) as internal and external aspects of human function that influence occupational performance. This research makes a significant contribution to understanding the relationship *between* selected constructs of the OPM(A), examining the relationship between core elements and performance components impacted by TBI, and how TBI affects the application of cognition to performance of human occupations, in the current time and environmental context.

This represents a major departure from previous occupational therapy research in regard to brain injury rehabilitation. Previous research has often assumed the medical model as a basis for assessment and intervention at discrete levels of functioning, typically the remediation of component capacities (biomechanical, sensory-motor, cognitive, inter- and intra-personal) or adaptation of the surrounding environment to compensate for residual changes in function.

The findings from the current research provide a significant contribution to the understanding of information processing theory as a framework for occupational

therapy assessment and intervention with adults following TBI. This research supports the information processing foundation of the PRPP System of Assessment and Intervention, in particular through the generation of a theoretical hierarchy of information processing strategies. The generated hierarchy links occupational therapy process with the underlying theories of information processing and learning.

#### **11.4.2 Clinical contribution**

Findings from this research make a significant contribution to occupational therapy practice in the area of brain injury rehabilitation. This research has demonstrated the clinical utility of an occupation based assessment system that has sound reliability and validity in the context of acute TBI rehabilitation with patients demonstrating agitated behaviour during PTA. Of greatest importance to clinical practice is the ability to assess patients who are otherwise deemed inappropriate for traditional, standardised testing, and to determine how patients apply information processing strategies during occupational performance, specific to that patient in the 'here and now' for the direct purpose of planning occupational therapy intervention.

This represents a significant addition to the assessment options available to occupational therapists during the acute stage of TBI rehabilitation. Previously therapists were limited to screening tools that provided limited guidance for intervention, and had limited ecological validity as administration was typically removed from any functional context.

This is the first research study to evaluate the effectiveness of PRPP Intervention with adults in the acute stage of TBI rehabilitation. Findings from other areas of

occupational therapy practice suggested the potential to integrate these strategy-training techniques in the field of TBI rehabilitation. The PRPP Intervention approach was highly effective and led to greater improvement in occupational performance than current occupational therapy intervention. While also providing support for current intervention approaches, these findings challenge occupational therapists to continuously review practice and evaluate potential for modifying practice when better client outcomes are possible.

Of particular significance, this research provides evidence supporting this integrated approach for clinical evaluation and treatment of adults with TBI while they remain in PTA. Findings demonstrated that changes in information processing capacity are possible during PTA, leading to improvements in occupational performance over a relatively short intervention period. This finding is significant in its questioning of traditional beliefs regarding the appropriate time to commence TBI rehabilitation. Evidence for change in information processing capacity and improved occupational performance during PTA suggests a re-examination of conventional procedures for delaying active rehabilitation until after PTA emergence (Tate et al., 2001; Tate & Pfaff, 2000).

#### **11.4.3 Empirical contribution**

Data generated in the course of this research adds to the empirical evidence supporting the PRPP System of Task Analysis and Intervention.

This research is the first to apply Rasch modelling to data generated by the PRPP System of Task Analysis and provides the first empirical data outlining a hierarchy of



information processing strategies used during occupational performance of adults with brain injury. While further validation of this hierarchy is required, convergent evidence to support the demonstrated hierarchy was gained by replicating the Rasch modelling process in two different phases of the research project.

The final phase of this research is the first empirically driven study into the effectiveness of PRPP Intervention with adults following TBI. As such, these findings make a valuable contribution to establishing evidence to support this occupational therapy intervention, and provide a platform upon which future research can occur.

#### **11.4.4 Methodological contribution**

This research presents a number of methodological models applicable to clinical practice in TBI rehabilitation, and highlights the need for an adaptive and flexible approach to designing and implementing research in a clinical context.

Investigation of a sub-group within a specialist population inevitably reduced the potential sample size, requiring use of small group studies and single-system research designs. While randomised controlled trials remain the 'gold-standard' for clinical research, issues with subject variability, availability and heterogeneity hamper the application of these study designs to cognitive and behavioural research in brain injury. However, this research highlights design features that enhance internal and external validity and reliability within the limitations of these research designs, providing a useful model for occupational therapy practitioners engaging in future research in this area and areas with similar sample limitations. Confirmation of treatment validity and rater reliability using video-analytic methods improved the

research design and enabled external peer review and validation of the research during the study period.

Research methods used during the second research phase were also dependent on video analysis of patient performance. This enabled multiple raters to examine the same footage for the purposes of evaluating rater reliability. This research contributes to the growing recognition of video analysis as a methodological tool within the occupational therapy profession (Joe, Ferraro, & Schwartz, 2002; Pierce, 2005).

The data analytic models used within this study reflect the diversity of occupational therapy practice, and the need to determine suitable analysis methods on the characteristics of the data obtained through different collection techniques and tools. This research provides a model for integrating qualitative descriptive and visual analysis techniques, with quantitative correlational analysis, inferential statistics and Rasch modeling.

## **11.5 RECOMMENDATIONS FOR FUTURE RESEARCH AND PRACTICE**

Each phase of this research contributes preliminary findings upon which some recommendations for future research and practice can be proposed.

### **11.5.1 Recommendations arising from Research Phase One**

This retrospective study represented the first cohort investigation into the incidence and nature of post-TBI agitation in Australia. Findings derived from the retrospective, medical review would benefit from further investigation and confirmation using prospective, objective measures of agitated behaviour. At present, the most suitable

assessment tool to conduct such research may be the Agitated Behaviour Scale, however a scale developed to better capture the behaviours observed in the Australian rehabilitation context may also prove useful.

### **11.5.2 Recommendations arising from Research Phase Two**

Occupational therapists working in acute TBI rehabilitation should consider using observation based assessment such as the PRPP System of Task Analysis as an alternative to standardised, language based assessments that are typically inappropriate for adults with agitated behaviour, who remain in PTA.

### **11.5.3 Recommendations arising from Research Phase Three**

The validity and reliability studies forming Research Phase Three suggest several areas for future research. First, the hierarchy of information processing strategies generated using Rasch modeling requires further research with considerably larger patient samples to test the stability of item ordering within the hierarchy. Initial evidence between Phases Three and Four support the general order, however even the accumulation of patients in these two phases is not sufficient to achieve the required level of stability. Patients with a broader range of capacities applying information processing strategies during occupational performance is necessary to ensure relevant targeting of item and people ability measures within the Rasch model.

Second, future research is necessary to determine the relative use of information processing strategies in different tasks, by different people. The PRPP System of Task Analysis proposes 34 descriptors hypothesised to be used in all functional tasks. It is currently unclear if all people employ all these strategies to the same degree in all

tasks and environments. Future research is necessary to explicate how people select strategies to employ during performance, and in particular, explore how people with TBI select strategies, and determine if it is possible to reliably measure the different applications of these strategies.

Third, the PRPP System of Task Analysis is an emerging clinical tool in the area of occupational therapy. While these findings contribute to the developing body of knowledge regarding the measurement properties of the instrument, ongoing research is continually required to evaluate application of the tool in different clinical settings, across the full spectrum of rehabilitation.

#### **11.5.4 Recommendations arising from Research Phase Four**

Findings from the final research phase contribute recommendations for both clinical practice and future research. This research represents the first attempt to implement and evaluate the PRPP System of Intervention in an adult TBI population. The positive findings are very encouraging, but require further research to replicate these findings with larger numbers of participants, involving adults with brain injury across the spectrum of recovery from the acute context to community reintegration, including therapists practicing in various clinical settings such as acute care, inpatient rehabilitation, transitional living environments, and the wider community.

In addition to replicating findings, future research should consider identifying critical processing strategies that may lead to greater treatment efficacy in adults following TBI. It is possible, that within the currently identified array of processing strategies,

that one or more may represent the lynchpin to more effective intervention with this population.

## **11.6 CONCLUSION**

This research has focused on the occupational performance of adults with TBI during the acute stage of rehabilitation characterised by agitated behaviour and post-traumatic amnesia. In particular, this research has centred on the use of information processing strategies during occupational performance, and considered how agitation following TBI may impact on effective strategy application. By adopting an occupational performance approach, this research has departed from traditional research into agitation.

This research has demonstrated that adults with agitated behaviour following TBI can experience extreme difficulty using information processing strategies during task performance, leading to poor functional outcomes when discharged from inpatient rehabilitation. Strategy use can be reliably measured across different tasks and different therapists using the PRPP System of Task Analysis. This emerging clinical tool enabled valid and clinically useful measurement of strategy application during task performance that directed subsequent intervention planning. Finally, this research recommends that therapists consider adopting a strategy processing approach rather than a direct instructional approach to occupational therapy intervention with this population. Research findings highlight the effectiveness of occupational therapy intervention targeting strategy application, over and above current direct instructional intervention, with adults demonstrating agitated behaviour following TBI.

Conceptualisation of agitation within the framework of occupational performance and information processing has reframed the so called 'problem behaviour' into a construct with identifiable internal and external contributors, that is responsive to intervention targeting application of information processing strategies to everyday actions and behaviours, for the overall purpose of improving occupational performance.

## REFERENCES

- Abreu, B. C. (1998). The quadraphonic approach: holistic rehabilitation for brain injury. In N. Katz (Ed.), *Cognition and occupation in rehabilitation: Cognitive models for intervention in occupational therapy* (pp. 51-98). Bethesda: American Occupational Therapy Association.
- Abreu, B. C. & Peloquin, S. M. (2005). The Quadraphonic Approach: A holistic rehabilitation model for brain injury. In N. Katz (Ed.), *Cognition and occupation across the life span: models for intervention in occupational therapy* (2nd ed., pp. 73-112). Bethesda: The American Occupational Therapy Association Inc.
- Abreu, B. C. & Toglia, J. P. (1987). Cognitive rehabilitation: A model for occupational therapy. *American Journal of Occupational Therapy*, 41(7), 439-448.
- Ahmed, S., Bierley, R., Sheikh, J. I., & Date, E. S. (2000). Post-traumatic amnesia after closed head injury: A review of the literature and some suggestions for further research. *Brain Injury*, 14(9), 765-780.
- Aiken, L. R. (2003). *Psychological testing and assessment* (11th ed.). Boston: Allyn and Bacon.
- Alderman, N., Davies, J. A., Jones, C., & McDonnel, P. (1999). Reduction of severe aggressive behaviour in acquired brain injury: Case studies illustrating clinical use of the OAS-MNR in the management of challenging behaviours. *Brain Injury*, 13(9), 669-704.
- Alderman, N., Knight, C., & Henman, C. (2002). Aggressive behavior observed within a neurobehavioural rehabilitation service: Utility of the OAS-MNR in clinical audit and applied research. *Brain Injury*, 16(6), 469-489.
- Alderman, N., Knight, C., & Morgan, C. (1997). Use of a modified version of the Overt Aggression Scale in the measurement and assessment of aggressive behaviours following brain injury. *Brain Injury*, 11(7), 503-523.
- Anastasi, A. (1988). *Psychological testing*. New York: MacMillan Publishing.
- Andrews, D. (1989). Management of disruptive behaviour in the brain-damaged patient using selective reinforcement. *Journal of Behavior Therapy and Experimental Psychiatry*, 20(3), 261-264.
- AOTA. (2002). Occupational therapy practice framework: Domain and process. *American Journal of Occupational Therapy*, 56(6), 609-639.
- Árnadóttir, G. & Fisher, A. G. (2008). Rasch Analysis of the ADL Scale of the A-ONE. *American Journal of Occupational Therapy*, 62(1), 51-60.
- Árnadóttir, G. (1990). *Brain and behavior: Assessing cortical dysfunction through activity of daily living*. St Louis: Mosby.

- Árnadóttir, G. (1999). Evaluation and intervention with complex perceptual impairment. In C. Unsworth (Ed.), *Cognitive and perceptual dysfunction: a clinical reasoning approach to evaluation and intervention* (pp. 393-454). Philadelphia: F.A. Davis.
- Atkinson, R. C. & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation. Advances in research and theory* (Vol. 2, pp. 89-195). New York: Academic Press.
- Aubin, G., Chapparo, C., Gélinas, I., Stip, E., & Rainville, C. (2008). Use of the Perceive, Recall, Plan and Perform System of Task Analysis for persons with schizophrenia: A preliminary analysis. *Australian Occupational Therapy Journal* (early online). Retrieved 16 August 2008 from <http://www3.interscience.wiley.com.ezproxy2.library.usyd.edu.au/cgi-bin/fulltext/120081637/PDFSTART>
- Aubin, G., Gélinas, I., Stip, E., Chapparo, C., & Rainville, C. (2008). Daily activities, cognition and community functioning in persons with schizophrenia. *Schizophrenia Research*, (in press).
- Auerbach, S. & Katz, N. (1998). Cognitive rehabilitation: a retraining model for clients following brain injuries. In N. Katz (Ed.), *Cognition and occupation in rehabilitation: cognitive models for intervention in occupational therapy* (pp. 99-123). Bethesda: American Occupational Therapy Association.
- Azouvi, P. (2000). Neuroimaging correlates of cognitive and functional outcome after traumatic brain injury. *Current Opinion in Neurology*, 13(6), 665-669.
- Azouvi, P., Jokic, C., Attal, N., Denys, P., Markabi, S., & Bussel, B. (1999). Carbamazepine in agitation and aggressive behaviour following severe closed-head injury: Results of an open trial. *Brain Injury*, 13(10), 797-804.
- Backman, C. L., Harris, S. R., Chisholm, J-A. M., & Monette, A. D. (1997). Single-subject research in rehabilitation: A review of studies using AB, withdrawal, multiple baseline, and alternating treatments designs. *Archives of Physical Medicine and Rehabilitation*, 78(10), 1145-1153.
- Baddeley, A. D. (1990). *Human memory: Theory and practice*. Hove: Lawrence Erlbaum Associates.
- Baddeley, A. D. (2004). *Your memory: a user's guide* (4th ed.). London: Carlton Books.
- Baddeley, A. D. & Della Sergio, S. (1996). Working memory and executive control. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 351(1346), 1397-1404.
- Baddeley, A. D. & Logie, R. H. (1999). Working memory. The multiple-component model. In A. Miyake & P. Shah (Eds.), *Models of working memory: mechanisms of active maintenance and executive control* (pp. 28-61). Cambridge: Cambridge University Press.



- Bakeman, R. (2005). Recommended effect size statistics for repeated measures designs. *Behavior Research Methods*, 37(3), 379-384.
- Barreca, S., Velikonja, D., Brown, L., Williams, L., Davis, L., & Sigouin, C. S. (2003). Evaluation of the effectiveness of two clinical training procedures to elicit yes/no responses from patients with a severe acquired brain injury: a randomized single-subject design. *Brain Injury*, 17(12), 1065 - 1075.
- Barry, P., Clark, D. E., Yaguda, M., Higgins, G. E., & Mangel, H. (1989). Rehabilitation inpatient screening of early cognitive recovery. *Archives of Physical Medicine and Rehabilitation*, 70(13), 902-906.
- Baum, C. M. & Christiansen, C. H. (2005). Person-environment-occupation-performance (PEOP): an occupational therapy model to enable performance, participation and well-being. In C. M. Baum, C. H. Christiansen & J. Bass-Haugen (Eds.), *Occupational therapy: performance, participation, and well-being* (3rd ed.). Thorofare: Slack Inc.
- Baum, C. M. & Edwards, D. F. (1993). Cognitive performance in senile dementia of the Alzheimer's type: the Kitchen Task Assessment. *American Journal of Occupational Therapy*, 47(5), 431-436.
- Baum, C. M., Morrison, T., Hahn, M., & Edwards, D. F. (2007). *Executive Function Performance Test: Test Protocol Booklet*. Washington University School of Medicine, Cognitive Rehabilitation Research Group. Retrieved June 6, 2008 from <http://crrg.wustl.edu/documents/EFPT%20-Test%20Booklet.pdf>
- Beaulieu, K. (2007). Occupational therapists' perceptions and management of aggression related to adults with a brain injury. *British Journal of Occupational Therapy*, 70(4), 161-170.
- Beck, J. & Horne, D. (1992). A whole school implementation of the Stop, Think, Do! Social skills training program. In B. Willis & J. Izard (Eds.), *Student behavior problems: directions, perspectives and expectations*. Hawthorn: Australian Council for Educational Research.
- Bellg, A. J., Borrelli, B., Resnick, B., Hecht, J., Minicucci, D. S., Ory, M., et al. (2004). Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH Behavior Change Consortium. *Health Psychology*, 23(5), 443-451.
- Ben-Yishay, Y. & Diller, L. (1993). Cognitive remediation in traumatic brain injury: update and issues. *Archives of Physical Medicine and Rehabilitation*, 74(2), 204-213.
- Berkeland, R. & Flinn, N. (2005). Therapy as learning. In C. H. Christianson, C. M. Baum & J. Bass-Haugen (Eds.), *Occupational therapy: Performance, participation, and well-being* (3rd ed., pp. 421-442). Thorofare: SLACK Inc.
- Bermann, D. E. (1988). Psychosocial elements of head injury. In K. M. Kovich & D. E. Bermann (Eds.), *Head Injury. A guide to functional outcomes in occupational therapy*. (pp. 35-44). Rockville: Aspen Publishers.

- Bermann, D. E. & Bush, T. (1988). Treatment of sensory-perceptual and cognitive deficits. In K. M. Kovich & D. E. Bermann (Eds.), *Head injury. A guide to functional outcomes in occupational therapy*. (pp. 45-65). Rockville: Aspen Publishers.
- Bernspång, B. (1999). Rater calibration stability for the Assessment of Motor and Process Skills. *Scandinavian Journal of Occupational Therapy*, 6(3), 101-109.
- Bland, J. M. & Altman, D. G. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *The Lancet*, 327(8476), 307-310.
- Bland, J. M. & Altman, D. G. (1997). Cronbach's alpha. *British Medical Journal*, 314(7080), 572.
- Bode, R. K., Heinemann, A. W., & Semik, P. (2000). Measurement properties of the Galveston Orientation and Amnesia Test (GOAT) and improvement patterns during inpatient rehabilitation. *Journal of Head Trauma Rehabilitation*, 15(1), 637-655.
- Bogner, J. A. & Corrigan, J. D. (1995). Epidemiology of agitation following brain injury. *Neurorehabilitation*, 5, 293-297.
- Bogner, J. A., Corrigan, J. D., Bode, R. K., & Heinemann, A. W. (2000). Rating scale analysis of the Agitated Behavior Scale. *Journal of Head Trauma Rehabilitation*, 15(1), 656-669.
- Bogner, J. A., Corrigan, J. D., Fugate, L., Mysiw, W. J., & Clinchot, D. (2001). Role of agitation in prediction of outcomes after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation*, 80(9), 636-644.
- Bogner, J. A., Corrigan, J. D., Stange, M., & Rabold, D. (1999). Reliability of the Agitated Behavior Scale. *Journal of Head Trauma Rehabilitation*, 14(1), 91-96.
- Boland, K. (2004). *Assessing information processing in the context of pretend play*. Thesis. The University of Sydney.
- Boman, I., Lindstedt, M., Hemmingsson, H., & Bartfai, A. (2004). Cognitive training in home environment. *Brain Injury*, 18(10), 985-995.
- Bond, T. G. & Fox, C. M. (2007). *Applying the Rasch model: fundamental measurement in the human sciences* (2nd ed.). Mahwah: Lawrence Erlbaum Associates.
- Borrelli, B., Sepinwall, D., Ernst, D., Bellg, A. J., Czajkowski, S., Breger, R., et al. (2005). A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. *Journal of Consulting & Clinical Psychology*, 73(5), 852-860.
- Brasic Royeen, C. & Duncan, M. (1999). Acquisitional frame of reference. In J. Kramer & J. Hinojosa (Eds.), *Frames of references for pediatric occupational therapy* (2nd ed., pp. 377-400). Baltimore: Lippincott, Williams & Wilkins.

- Bray, K., Fisher, A. G., & Duran, L. (2001). The validity of adding new tasks to the Assessment of Motor and Process Skills. *American Journal of Occupational Therapy*, 55(4), 409-415.
- Brigman, C., Dickey, C., & Zegeer, L. J. (1983). The agitated aggressive patient... during recovery from a head injury. *American Journal of Nursing*, 83(10), 1408-1412.
- Brooke, M. M., Patterson, D. R., Questad, K. A., Cardenas, D., & Farrel-Roberts, L. (1992). The treatment of agitation during initial hospitalization after traumatic brain injury. *Archives of Physical Medicine & Rehabilitation*, 73(10), 917-921.
- Brooke, M. M., Questad, K. A., Patterson, D. R., & Bashak, K. J. (1992). Agitation and restlessness after closed head injury: a prospective study of 100 consecutive admissions. *Archives of Physical Medicine & Rehabilitation*, 73(4), 320-323.
- Buchan, T. (2002). The impact of language and culture when administering the Assessment of Motor and Process Skills: a case study. *The British Journal of Occupational Therapy*, 65, 371-373.
- Burgess, P. W. & Wood, R. L. (1990). Neuropsychiatry of behaviour disorders following brain injury. In R. L. Wood (Ed.), *Neurobehavioural sequelae of TBI*. London: Taylor & Francis.
- Burnett, D. M., Kennedy, R. E., Cifu, D. X., & Levenson, J. (1999). Using atypical neuroleptic drugs to treat agitation in patients with a brain injury: a review. *Neurorehabilitation*, 13(3), 165-172.
- Busch, R. M., McBride, A., Curtiss, G., & Vanderploeg, R. D. (2005). The components of executive functioning in traumatic brain injury. *Journal of Clinical & Experimental Neuropsychology: Official Journal of the International Neuropsychological Society*, 27(8), 1022-1032.
- Cantagallo, A. & Dimarco, F. (2002). Prevalence of neuropsychiatric disorders in traumatic brain injury patients. *Europa Medicophysica*, 38(4), 167-178.
- Chapparo, C. & Ranka, J. (1997a). *Occupational Performance Model (Australia), Monograph 1*. Sydney: Total Print Control.
- Chapparo, C. & Ranka, J. (1997b). The Perceive, Recall, Plan and Perform System of Task Analysis. In C. Chapparo & J. Ranka (Eds.), *Occupational Performance Model (Australia), Monograph 1* (pp. 189-198). Sydney: Total Print Control.
- Chapparo, C. & Ranka, J. (2005). *The PRPP System of Task Analysis: user's training manual*. The University of Sydney.
- Chapparo, C. & Ranka, J. (2007). *The PRPP System: intervention*. The University of Sydney.
- Chong, D. K-H. (1995). Measurement of instrumental activities of daily living in stroke. *Stroke*, 26(6), 1119-1122.

- Christodoulou, C., DeLuca, J., Ricker, J. H., Madigan, N. K., Bly, B. M., Lange, G., et al. (2001). Functional magnetic resonance imaging of working memory impairment after traumatic brain injury. *Journal of Neurology, Neurosurgery & Psychiatry*, *71*(2), 161-168.
- Cicerone, K. D., Dahlberg, C., Kalmar, K., Langenbahn, D. M., Malec, J. F., Bergquist, T. F., et al. (2000). Evidence-based cognitive rehabilitation: recommendations for clinical practice. *Archives of Physical Medicine and Rehabilitation*, *81*(12), 1596-1615.
- Clemson, L., Bundy, A. C., Cumming, R. G., Kay, L., & Lockett, T. (2008). Validating the Falls Behavioural (FaB) scale for older people: a Rasch analysis. *Disability & Rehabilitation*, *30*(7), 498-406.
- Cohen, M. E. & Marino, R. J. (2000). The tools of disability outcomes research functional status measures. *Archives of Physical Medicine and Rehabilitation*, *81*(12, Part 2), S21-S29.
- Constantinidou, F., Thomas, R. D., & Best, P. J. (2004). Principles of cognitive rehabilitation: an integrated approach. In M. J. Ashley (Ed.), *Traumatic brain injury: rehabilitative treatment and case management* (2nd ed., pp. 337-363). Boca Raton: CRC Press.
- Corrigan, J. D. (1989). Development of a scale for assessment of agitation following traumatic brain injury. *Journal of Clinical & Experimental Neuropsychology*, *11*(2), 261-277.
- Corrigan, J. D. & Bogner, J. A. (1994). Factor structure of the Agitated Behavior Scale. *Journal of Clinical & Experimental Neuropsychology*, *16*(3), 386-392.
- Corrigan, J. D. & Mysiw, W. J. (1988). Agitation following traumatic head injury: equivocal evidence for a discrete stage of cognitive recovery. *Archives of Physical Medicine & Rehabilitation*, *69*(7), 487-492.
- Corrigan, J. D., Mysiw, W. J., Gribble, M. W., & Chock, S. K. (1992). Agitation, cognition and attention during post-traumatic amnesia. *Brain Injury*, *6*(2), 155-160.
- Corrigan, J. D., Smith-Knapp, K., & Granger, C. V. (1997). Validity of the Functional Independence Measure for persons with traumatic brain injury. *Archives of Physical Medicine & Rehabilitation*, *78*(8), 828-834.
- Craik, F. I. M. (2002). Levels of processing: Past, present ... and future? *Memory*, *10*(5), 305-318.
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297-334.
- Cummings, J. L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D. A., & Gornbein, J. (1994). The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology*, *44*(12), 2308-2314.

- Darragh, A. R., Sample, P. L., & Fisher, A. G. (1998). Environment effect on functional task performance in adults with acquired brain injuries: use of the assessment of motor and process skills. *Archives of Physical Medicine and Rehabilitation*, 79(4), 418-423.
- Das-Gupta, R. & Turner-Stokes, L. (2002). Traumatic brain injury. *Disability & Rehabilitation*, 24(13), 654-665.
- Denny-Brown, D. (1945). Disability arising from closed head injury. *JAMA*, 73, 429-436.
- DePoy, E. & Burke, J. P. (1992). Viewing cognition through the lens of the Model of Human Occupation. In N. Katz (Ed.), *Cognitive rehabilitation: models for intervention in occupational therapy*. Stoneham: Butterworth-Heinemann.
- Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment*, 49(1), 71-75.
- Dirette, D. K. & Hinojosa, J. (1999). The effects of a compensatory intervention on processing deficits of adults with acquired brain injuries. *The Occupational Therapy Journal of Research*, 19(4), 223-240.
- Doble, S. E. (1991). Test-retest and inter-rater reliability of a Process Skills Assessment. *Occupational Therapy Journal of Research*, 11(1), 8-23.
- Doble, S. E., Fisk, J. D., Lewis, N., & Rockwood, K. (1999). Test-retest reliability of the Assessment of Motor and Process Skills in elderly adults. *Occupational Therapy Journal of Research*, 19(3), 203-215.
- Dodds, T. A., Martin, D. P., Stolov, W. C., & Deyo, R. A. (1993). A validation of the Functional Independence Measure and its performance among rehabilitation inpatients. *Archives of Physical Medicine & Rehabilitation*, 74, 531-536.
- Doninger, N. A., Bode, R. K., Ehde, D. M., Knight, K., & Bombardier, C. H. (2006). Measurement properties of the Neurobehavioral Cognitive Status Examination (Cognistat) in traumatic brain injury rehabilitation. *Rehabilitation Psychology*, 51(4), 281-288.
- Doninger, N. A., Bode, R. K., Heinemann, A. W., & Ambrose, C. (2000). Rating scale analysis of the Neurobehavioral Cognitive Status Examination. *Journal of Head Trauma Rehabilitation*, 15(1), 683-695.
- Donkervoort, M., Dekker, J., Stehmann-Saris, F. C., & Deelman, B. G. (2001). Efficacy of strategy training in left hemisphere stroke patients with apraxia: A randomised clinical trial. *Neuropsychological Rehabilitation*, 11(5), 549 - 566.
- Donnelly, C. & Carswell, A. (2002). Individualized outcome measures: a review of the literature. *Canadian Journal of Occupational Therapy*, 69(2), 84-94.
- Ducharme, J. M. (1999). A conceptual model for treatment of externalizing behaviour in acquired brain injury. *Brain Injury*, 13(9), 645-668.

- Dunn, L., Morgan, C., Reilly, M., & Parry, S. (2004). *The student assessment handbook. New directions in traditional and on-line assessment*. London: Taylor & Francis.
- Eakman, A. M. & Nelson, D. L. (2001). The effect of hands-on occupation on recall memory in men with traumatic brain injuries. *Occupational Therapy Journal of Research, 21*(2), 109-114.
- Eames, P. (1990). Organic bases of behaviour disorders after traumatic brain injury. In R. L. Wood (Ed.), *Neurobehavioural sequelae of traumatic brain injury* (pp. 134-150). London: Taylor & Francis.
- Ehlhardt, L. A., Sohlberg, M. M., Glang, A., & Albin, R. (2005). TEACH-M: A pilot study evaluating an instructional sequence for persons with impaired memory and executive functions. *Brain Injury, 19*(8), 569 - 583.
- Eisner, E. W. (1993). Reshaping assessment in education: Some criteria in search of practice. *Journal of Curriculum Studies, 25*(3), 219-233.
- Elder, J. H. (1999). Videotaped behavioral observations: enhancing validity and reliability. *Applied Nursing Research, 12*(4), 206-209.
- Elliott, R. (2003). Executive functions and their disorders. *British Medical Bulletin, 65*, 49-59.
- Ewert, J., Levin, H. S., Watson, M. G., & Kalisky, Z. (1989). Procedural memory during posttraumatic amnesia in survivors of severe closed head injury. *Archives of Neurology, 46*, 911-916.
- Eysenck, M. W. & Keane, M. T. (2000). *Cognitive neuropsychology: a student's handbook* (4th ed.). Hove: Psychology Press.
- Feeney, T. J. & Ylvisaker, M. (2003). Context-sensitive behavioral supports for young children with TBI: short-term effects and long-term outcome. *Journal of Head Trauma Rehabilitation, 18*(1), 33-51.
- Feeney, T. J. & Ylvisaker, M. (2006). Context-sensitive cognitive-behavioural supports for young children with TBI: a replication study. *Brain Injury, 20*(6), 629-645.
- Felmingham, K. L., Baguley, I. J., & Crooks, J. (2001). A comparison of acute and postdischarge predictors of employment 2 years after traumatic brain injury. *Archives of Physical Medicine & Rehabilitation, 82*(4), 435-439.
- Felmingham, K. L., Baguley, I. J., & Green, A. M. (2004). Effects of diffuse axonal injury on speed of information processing following severe traumatic brain injury. *Neuropsychology, 18*(3), 564-571.
- Fichera, S., Zielinski, R., & Mittenberg, W. (1993). Neuropsychological correlates of post-traumatic agitation. *Journal of Clinical & Experimental Neuropsychology, 15*(1), 105.

- Fish, J., Evans, J. J., Nimmo, M., Martin, E., Kersel, D., Bateman, A., et al. (2007). Rehabilitation of executive dysfunction following brain injury: "Content-free" cueing improves everyday prospective memory performance. *Neuropsychologia*, 45(6), 1318-1330.
- Fisher, A. G. (1995). *AMPS manual*. Fort Collins: Three Star Press.
- Fisher, A. G. & Bernspång, B. (2007). Response to: A critique of the Assessment of Motor and Process Skills (AMPS) in mental health practice. *Mental Health Occupational Therapy*, 12(1), 10-11.
- Fisher, A. G. (1993). The assessment of IADL motor skills: an application of many-faceted Rasch analysis. *American Journal of Occupational Therapy*, 47(4), 319-329.
- Fisher, I., & Ziviani, J. (2004). Explanatory case studies: implications and applications for clinical research. *Australian Occupational Therapy Journal*, 51, 185-191.
- Fisher, W. P. J. & Fisher, A. G. (1993). Applications of Rasch Analysis to studies in occupational therapy. *Physical Medicine and Rehabilitation Clinics of North America*, 4(3), 551-569.
- Flannery, J. (1998). Using the Levels of Cognitive Functioning Assessment Scale with patients with traumatic brain injury in an acute care setting. *Rehabilitation Nursing*, 23(2), 88-94.
- Fleminger, S., Greenwood, R. J., & Oliver, D. L. (2003). Pharmacological management for agitation and aggression in people with acquired brain injury. *Cochrane Database of Systematic Reviews*, 2003(1), CD003299; PMID: 12535468.
- Fluharty, G. & Glassman, N. (2001). Use of antecedent control to improve the outcome of rehabilitation for a client with frontal lobe injury and intolerance for auditory and tactile stimuli. *Brain Injury*, 15(11), 995-1002.
- Fontaine, A., Azouvi, P., Remy, P., Bussel, B., & Samson, Y. (1999). Functional anatomy of neuropsychological deficits after severe traumatic brain injury. *Neurology*, 53(9), 1963-1968.
- Fordham, M. (2001). *Perceive, Recall, Plan, Perform (PRPP) rating scales (parent and teacher): reliability and validity*. Thesis. The University of Sydney.
- Fortin, S., Godbout, L., & Braun, C. M. J. (2003). Cognitive structure of executive deficits in frontally lesioned head trauma patients performing activities of daily living. *Cortex*, 39, 273-291.
- Freeman, M. R., Mittenberg, W., Dicowden, M., & Bat-Ami, M. (1992). Executive and compensatory memory retraining in traumatic brain injury. *Brain Injury*, 6(1), 65-70.

- Fry, K. & O'Brien, L. (2002). Using the Perceive, Recall, Plan and Perform system to assess cognitive deficits in adults with traumatic brain injury: a case study. *Australian Occupational Therapy Journal*, 49(4), 182-187.
- Fugate, L. P., Spacek, L. A., Kresty, L. A., Levy, C. E., Johnson, J. C., & Mysiw, W. J. (1997a). Definition of agitation following traumatic brain injury: I. A survey of the Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation. *Archives of Physical Medicine & Rehabilitation*, 78(9), 917-923.
- Fugate, L. P., Spacek, L. A., Kresty, L. A., Levy, C. E., Johnson, J. C., & Mysiw, W. J. (1997b). Measurement and treatment of agitation following traumatic brain injury: II. A survey of the Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation. *Archives of Physical Medicine & Rehabilitation*, 78(9), 924-928.
- Gaber, T. A. K. (2006). Medico-legal and ethical aspects in the management of wandering patients following brain injury: questionnaire survey. *Disability and Rehabilitation*, 28(22), 1413-1416.
- Gagné, R. M., Wagner, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of instructional design* (5th ed.). Belmont: Wadsworth/Thomson Learning.
- Galski, T., Palasz, J., Bruno, R. L., & Walker, J. E. (1994). Predicting physical and verbal aggression on a brain trauma unit. *Archives of Physical Medicine & Rehabilitation*, 75(4), 380-383.
- Gardarsdóttir, S. & Kaplan, S. (2002). Validity of the Árnadóttir OT-ADL Neurobehavioral Evaluation (A-ONE): performance in activities of daily living and neurobehavioral impairments of persons with left and right hemisphere damage. *American Journal of Occupational Therapy* 56(5), 499-508.
- Gasquoine, P. G. (1991). Learning in post-traumatic amnesia following extremely severe closed head injury. *Brain Injury*, 5(2), 169-175.
- Geffen, G., Encel, J. S., & Forrester, G. M. (1991). Stages of recovery during post-traumatic amnesia and subsequent everyday memory deficits. *NeuroReport*, 2(2), 105-108.
- Geffen, G., Bishop, K., Connell, J., & Hopkins, P. (1994). Inter-rater reliability of the Westmead Post-traumatic Amnesia (PTA) scale. *Australian Occupational Therapy Journal*, 41(1), 31-36.
- Gianutsos, R. & Gianutsos, J. (1987). Single-case experimental approaches to the assessment of interventions in rehabilitation. In B. Caplan (Ed.), *Rehabilitation psychology desk reference* (pp. 453-470). Rockville: Aspen Publishers.
- Giles, G. M. (1998). A neurofunctional approach to rehabilitation following severe brain injury. In N. Katz (Ed.), *Cognition and occupation in rehabilitation: cognitive models for intervention in occupational therapy* (pp. 125-147). Bethesda: American Occupational Therapy Association.



- Giles, G. M. & Clark-Wilson, J. (1988). The use of behavioral techniques in functional skills training after severe brain injury. *American Journal of Occupational Therapy*, 42(10), 658-665.
- Giles, G. M. & Clark-Wilson, J. (1999). Functional skills training following severe brain injury. In G. M. Giles & J. Clark-Wilson (Eds.), *Rehabilitation of the severely brain-injured adult* (2nd ed., pp. 97-134). Cheltenham: Stanley Thornes Ltd.
- Giles, G. M., Ridley, J. E., & Frye, S. (1997). A consecutive series of adults with brain injury treated with a washing and dressing retraining program. *The American Journal of Occupational Therapy*, 51(4), 256-266.
- Gillen, G. (2009). *Cognitive and perceptual rehabilitation: optimizing function*. St Louis: Mosby Inc.
- Glaser, R. (1981). The future of testing: A research agenda for cognitive psychology and psychometrics. *American Psychologist*, 36(923-936).
- Glisky, E. L. & Delaney, S. M. (1996). Implicit memory and new semantic learning in posttraumatic amnesia. *Journal of Head Trauma Rehabilitation*, 11(2), 31-42.
- Godbout, L., Grenier, M. C., Braun, C. M. J., & Gagnon, S. (2005). Cognitive structure of executive deficits in patients with frontal lesions performing activities of daily living. *Brain Injury*, 19(5), 337-348.
- Goldenberg, G., Oder, W., Spatt, J., & Podreka, I. (1992). Cerebral correlates of disturbed executive function and memory in survivors of severe closed head injury: A SPECT study. *Journal of Neurology, Neurosurgery & Psychiatry*, 55(5), 362-368.
- Gordon, W. A., Zafonte, R. D., Cicerone, K., Cantor, J., Brown, M., Lombard, L. A., et al. (2006). Traumatic brain injury rehabilitation: State of the science. *American Journal of Physical Medicine & Rehabilitation*, 85(4), 343-382.
- Goverover, Y., Kalmar, J., Gaudino-Goering, E., Shawaryn, M., Moore, N. B., Halper, J., et al. (2005). The relation between subjective and objective measures of everyday life activities in persons with Multiple Sclerosis. *Archives of Physical Medicine and Rehabilitation*, 86(12), 2303-2308.
- Greber, C., Ziviani, J., & Rodger, S. (2007a). The Four-Quadrant Model of Facilitated Learning (part 1): Using teaching-learning approaches in occupational therapy. *Australian Occupational Therapy Journal*, 54 (Supplement 1), S31-39.
- Greber, C., Ziviani, J., & Rodger, S. (2007b). The Four-Quadrant Model of Facilitated Learning (part 2): sStrategies and applications. *Australian Occupational Therapy Journal*, 54 (Supplement 1), S40-48.
- Greene, J. C., & Caracelli, V. J. (2003). Making pragmatic sense of mixed methods practice. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 91-110). Thousand Oaks: SAGE Publications.

- Greve, K. W., Love, J., Sherwin, E., Stanford, M. S., Mathias, C., & Houston, R. (2002). Cognitive strategy usage in long-term survivors of severe traumatic brain injury with persisting impulsive aggression. *Personality & Individual Differences*, 32(4), 639-647.
- Griffin, P. (1995). Competency assessment: Avoiding the pitfalls from the past. *Australian New Zealand Journal of Vocational Education Research*, 3, 34-59.
- Gurka, J. A. (2005). Structured programmes – Dealing with the agitated patient. Abstract. *Brain Injury*, 19(5; Suppl 1), 1-133.
- Hagedorn, R. (2001). *Foundations for practice in occupational therapy* (3rd ed.). Edinburgh: Churchill Livingstone.
- Hagen, C. (2001). The expert's corner. Proper use of the Rancho Levels of Cognitive Functioning. *re-Learning Times*, 8(1), 1, 4-6.
- Hagen, C., Malkmus, D., & Durham, P. (1979). Levels of cognitive functioning. In *Rehabilitation of the head injured adult: Comprehensive cognitive management* (pp. 87-88). Downey: Professional Staff Association of Rancho Los Amigos Hospital, Inc.
- Hajek, V. E., Gagnon, S., & Ruderman, J. E. (1997). Cognitive and functional assessments of stroke patients: An analysis of their relation. *Archives of Physical Medicine and Rehabilitation*, 78(12), 1331-1337.
- Hall, K. M., Bushnik, T., Lakisic-Kazazic, B., Wright, J., & Cantagallo, A. (2001). Assessing traumatic brain injury outcome measures for long-term follow-up of community-based individuals. *Archives of Physical Medicine & Rehabilitation*, 82(3), 367-374.
- Hall, K. M., Hamilton, B. B., Gordon, W. A., & Zasler, N. D. (1993). Characteristics and comparisons of functional assessment indices: Disability Rating Scale, Functional Independence Measure, and Functional Assessment Measure. *Journal of Head Trauma Rehabilitation*, 8(2), 60-74.
- Hamilton, B. B., Granger, C. V., Sherwin, F. S., Zielesny, M., & Tashman, J. S. (1987). A uniform national data system for medical rehabilitation. In M. J. Fuhrer (Ed.), *Rehabilitation outcomes: analysis and measurement* (pp. 137-147). Baltimore: Paul Brookes Publishing.
- Harmsen, M., Geurts, A. C. H., Fasotti, L., & Bevaart, B. J. W. (2004). Positive behavioural disturbances in the rehabilitation phase after severe traumatic brain injury: An historic cohort study. *Brain Injury*, 18(8), 787-796.
- Hart, T. & Jacobs, H. E. (1993). Rehabilitation and management of behavioural disturbances following frontal lobe injury. *Journal of Head Trauma Rehabilitation*, 1993(8), 1.
- Hart, T., Whyte, J., Millis, S., Bode, R., Malec, J., Richardson, R. N., et al. (2006). Dimensions of disordered attention in traumatic brain injury: Further validation

- of the Moss Attention Rating Scale. *Archives of Physical Medicine and Rehabilitation*, 87(5), 647-655.
- Hartnedy, S. & Mozzoni, M. P. (2000). Managing environmental stimulation during meal time: Eating problems in children with traumatic brain injury. *Behavioral Intervention*, 15(3), 261-268.
- Haslam, T-M. & Beaulieu, K. (2007). A comparison of the evidence of two interventions for self-care with stroke patients. *International Journal of Therapy and Rehabilitation*, 14(3), 118-128.
- Hegel, M. T. (1988). Application of a token economy with a non-compliant closed head-injured male. *Brain Injury*, 2, 333-338.
- Heinemann, A. W., Linacre, J. M., Wright, B. D., Hamilton, B. B., & Granger, C. (1994). Prediction of rehabilitation outcomes with disability measures. *Archives of Physical Medicine and Rehabilitation*, 75(2), 133-143.
- Herbel, K., Schermerhorn, L., & Howard, J. (1990). Management of agitated head-injured patients: A survey of current techniques. *Rehabilitation Nursing*, 15(2), 66-69.
- Houlden, H., Edwards, M., McNeil, J., & Greenwood, R. (2006). Use of the Barthel Index and the Functional Independence Measure during early inpatient rehabilitation after single incident brain injury. *Clinical Rehabilitation*, 20(2), 153-159.
- Huitt, W. (2003). The information processing approach to cognition. *Educational Psychology Interactive*. Retrieved 10 April, 2006, from <http://chiron.valdosta.edu/whuitt/col/cogsys/infoproc.html>
- Humayun, M. S., Presty, S. K., Lafrance, N. D., Holcomb, H. H., Loats, H., Long, D. M., et al. (1989). Local cerebral glucose abnormalities in mild closed head injured patients with cognitive impairments. *Nuclear Medicine Communications*, 10(5), 335-344.
- Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods*, 18(1), 3-20.
- Joe, W. Q., Ferraro, M., & Schwartz, M. F. (2002). Sequencing and interleaving in routine action production. *Neurocase*, 8(1/2), 135-150.
- Josman, N. & Birnboim, S. (2001). Measuring kitchen performance: What assessment should we choose? *Scandinavian Journal of Occupational Therapy*, 8(4), 193-202.
- Kadyan, V., Mysiw, W. J., Bogner, J. A., Corrigan, J. D., Fugate, L. P., & Clinchot, D. M. (2004). Gender differences in agitation after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation*, 83(10), 747-752.

- Katz, D. I. (1992). Neuropathology and neurobehavioral recovery from closed head injury. *Journal of Head Trauma Rehabilitation*, 7(2), 1-15.
- Katz, N., Tadmor, I., Felzen, B., & Hartman-Maeir, A. (2007). Validity of the Executive Function Performance Test in individuals with schizophrenia. *OTJR: Occupation, Participation and Health*, 27(2), 44-51.
- Kazdin, A. E. (2003). *Research design in clinical psychology* (4 ed.). Boston: Allyn & Bacon.
- Kennedy, M. R. T. & Coelho, C. (2005). Self-regulation after traumatic brain injury: A framework for intervention of memory and problem solving. *Seminars in Speech and Language*, 26(4), 242-255.
- Kennedy, M. R. T., Coelho, C., Turkstra, L., Ylvisaker, M., Sohlberg, M. M., Yorkston, K., et al. (2008). Intervention for executive functions after traumatic brain injury: A systematic review, meta-analysis and clinical recommendations. *Neuropsychological Rehabilitation*, 18(3), 257-299.
- Khan, F., Baguley, I. J., & Cameron, I. D. (2003). Rehabilitation after traumatic brain injury. *Medical Journal of Australia*, 178(6), 290-295.
- Kidd, D., Stewart, G., Baldry, J., Johnson, J., Rossitier, D., Petruckevitch, A., et al. (1995). The Functional Independence Measure: A comparative validity and reliability study. *Disability & Rehabilitation*, 17(1), 10-14.
- Kielhofner, G. (2004). *Conceptual foundations of occupational therapy* (3rd ed.). Philadelphia: F.A. Davis Company.
- Kiernan, R. J., Mueller, J., Langston, J. W., & Van Dyke, C. (1987). The Neurobehavioral Cognitive Status Examination: A brief but differentiated approach to cognitive assessment. *Annals of Internal Medicine*, 107, 481-485.
- Kim, E. (2002). Agitation, aggression, and disinhibition syndromes after traumatic brain injury. *Neurorehabilitation*, 17(4), 297-310.
- Kirby, J. R. (1980). Individual difference and cognitive processes: instructional application and methodological difficulties. In J. B. Biggs & J. R. Kirby (Eds.), *Cognition, development, and instruction* (pp. 119-143). New York: Academic Press.
- Kirwan, B. & Ainsworth, L. K. (1992). *A guide to task analysis*. London: Taylor & Francis.
- Kolanowski, A., Buettner, L., & Moeller, J. (2006). Treatment fidelity plan for an activity intervention designed for persons with dementia. *American Journal of Alzheimer's Disease and Other Dementias*, 21(5), 326-332.
- Krumlinde-Sundholm, L., Holmefur, M., Kottorp, A., & Eliasson, A. C. (2007). The Assisting Hand Assessment: Current evidence of validity, reliability, and responsiveness to change. *Developmental Medicine & Child Neurology*, 49(4), 259-264.

- Landa-Gonzalez, B. (2001). Multicontextual occupational therapy intervention: A case study of traumatic brain injury. *Occupational Therapy International*, 8(1), 49-62.
- Languis, M. L. & Miller, D. C. (1992). Luria's theory of brain functioning: A model for research in cognitive psychophysiology. *Educational Psychologist*, 27(4), 493-511.
- Lannin, N. A. & Scarcia, M. (2004). Multidisciplinary screening of cognitive impairment following acquired brain impairment. Is there repetition? *Journal of Cognitive Rehabilitation*, 22(4), 19-25.
- Lautamo, T., Kottorp, A., & Salminen, A. L. (2005). Play assessment for group settings: A pilot study to construct an assessment tool. *Scandinavian Journal of Occupational Therapy*, 12(3), 136-144.
- Law, M. (1987). Measurement in occupational therapy: Scientific criteria for evaluation. *Canadian Journal of Occupational Therapy*, 54(3), 133-138.
- Law, M., Baum, C. M., & Dunn, W. (2001). *Measuring occupational performance: supporting best practice in occupational therapy*. Thorofare: SLACK Inc.
- Lawson, M. J. (1980). Metamemory: Making decisions about strategies. In J. R. Kirby & J. B. Biggs (Eds.), *Cognition, development, and instruction* (pp. 145-159). New York: Academic Press.
- Leach, K., Kinsella, G., Jackson, M., & Matyas, T. (2006). Recovery of components of memory in post-traumatic amnesia. *Brain Injury*, 20(12), 1241-1249.
- Lee, S. S., Powell, N. J., & Esdaile, S. (2001). A functional model of cognitive rehabilitation in occupational therapy. *Canadian Journal of Occupational Therapy*, 68(1), 41-50.
- Lenze, E. J., Munin, M. C., Quear, T., Dew, M. A., Rogers, J. C., Begley, A. E., et al. (2004). The Pittsburgh Rehabilitation Participation Scale: Reliability and validity of a clinician-rated measure of participation in acute rehabilitation. *Archives of Physical Medicine and Rehabilitation*, 85(3), 380-384.
- Lequerica, A. H., Rapport, L. J., Loehner, K., Axelrod, B. N., Vangel, S. J., Jr., & Hanks, R. A. (2007). Agitation in acquired brain injury: Impact on acute rehabilitation therapies. *Journal of Head Trauma Rehabilitation*, 22(3), 177-183.
- Lequerica, A. H., Rapport, L. J., Whitman, R. D., Millis, S. R., Vangel, S. J., Jr., Hanks, R. A., et al. (2006). Psychometric properties of the rehabilitation therapy engagement scale when used among individuals with acquired brain injury. *Rehabilitation Psychology*, 51(4), 331-337.
- Lerner, J.W. (2002). *Learning disabilities. Theories, diagnosis, and teaching strategies* (8th ed). Boston: Houghton Mifflin Company.

- Levin, H. S., Benton, A. L., & Grossman, R. G. (1982). *Neurobehavioral consequences of head injury*. Oxford: Oxford University Press.
- Levin, H. S. & Grossman, R. G. (1978). Behavioral sequelae of closed head injury. A quantitative study. *Archives of Neurology*, 35(11), 720-727.
- Levin, H. S., High, W. M., Goethe, K. E., Sisson, R. A., Overall, J. E., Rhoades, H. M., et al. (1987). The neurobehavioural rating scale: Assessment of the behavioural sequelae of head injury by the clinician. *Journal of Neurology, Neurosurgery & Psychiatry*, 50(2), 183-193.
- Levin, H. S., O'Donnell, V. M., & Grossman, R. G. (1979). The Galveston Orientation and Amnesia Test: A practical scale to assess cognition after head injury. *Journal of Nervous & Mental Disease*, 167(11), 675-684.
- Levine, B., Robertson, I. H., Clare, L., Carter, G., Hong, J., Wilson, B. A., et al. (2000). Rehabilitation of executive functioning: An experimental-clinical validation of goal management training. *Journal of the International Neuropsychological Society*, 6(3), 299-312.
- Levy, M., Berson, A., Cook, T., Bollegala, N., Seto, E., Tursanski, S., et al. (2005). Treatment of agitation following traumatic brain injury: A review of the literature. *Neurorehabilitation*, 20(4), 279-306.
- Linacre, J. M. (2007). FACETS Rasch measurement computer program [computer software]. Chicago: Winsteps.com.
- Linacre, J. M., Heinemann, A. W., Wright, B. D., Granger, C. V., & Hamilton, B. B. (1994). The structure and stability of the Functional Independence Measure. *Archives of Physical Medicine & Rehabilitation*, 75, 127-132.
- Linden, A., Boschian, K., Eker, C., Schalen, W., & Nordstrom, C. H. (2005). Assessment of motor and process skills reflects brain-injured patients' ability to resume independent living better than neuropsychological tests. *Acta Neurologica Scandinavica*, 111(1), 48-53.
- Lockhart, R. S. & Craik, F. I. M. (1990). Levels of processing: A retrospective commentary on a framework for memory research. *Canadian Journal of Experimental Psychology*, 44(1), 87-112.
- Lohri, J. (2005). *Information and sensory processing abilities of young children with autism spectrum disorder*. Thesis. The University of Sydney.
- Lombard, L. A. & Zafonte, R. D. (2005). Agitation after traumatic brain injury: considerations and treatment options. *American Journal of Physical Medicine & Rehabilitation*, 84(10), 797-812.
- Lombardi, W. J., Andreason, P. J., Sirocco, K. Y., Rio, D. E., Gross, R. E., Umhau, J. C., et al. (1999). Wisconsin card sorting test performance following head injury: dorsolateral fronto-striatal circuit activity predicts perseveration. *Journal of Clinical and Experimental Neuropsychology*, 21(1), 2-16.

- Lou, J. Q. & Lane, S. J. (2005). Personal performance capabilities and their impact on occupational performance. In C. H. Christiansen, C. M. Baum & J. Bass-Haugen (Eds.), *Occupational therapy: Performance, participation, and well-being* (3rd ed., pp. 269-289). Thorofare: SLACK Inc.
- Luria, A. R. (1970). The functional organization of the brain. *Scientific American*, 222(3), 66-72.
- Nyberg, L. (2002). Levels of processing: A view from functional brain imaging. *Memory*, 10(5), 345-348.
- Mahoney, F. I. & Barthel, D. W. (1965). Functional evaluation: the Barthel Index. *Maryland State Medical Journal*, 14, 61-65.
- Marosszeky, N. E. V., Ryan, L., Shores, E. A., Batchelor, J., & Marosszeky, J. E. (1997). *The PTA Protocol: Guidelines for using the Westmead Post-Traumatic Amnesia (PTA) Scale*. Sydney: Wild & Wooley.
- Maryniak, O., Manchanda, R., & Velani, A. (2001). Methotrimeprazine in the treatment of agitation in acquired brain injury patients. *Brain Injury*, 15(2), 167-174.
- Massaro, D. W. & Cowan, N. (1993). Information processing models: microscopes of the mind. *Annual Review of Psychology*, 44, 383-425.
- Mateer, C. A. & Sohlberg, M. M. (2003). Cognitive rehabilitation revisited. *Brain Impairment*, 4(1), 17-25.
- Mattson, A. J. & Levin, H. S. (1990). Frontal lobe dysfunction following closed head injury. A review of the literature. *Journal of Nervous & Mental Disease*, 178(5), 282-291.
- McCauley, S. R., Levin, H. S., Vanier, M., Mazaux, J. M., Boake, C., Goldfader, P. R., et al. (2001). The neurobehavioural rating scale-revised: Sensitivity and validity in closed head injury assessment. *Journal of Neurology, Neurosurgery & Psychiatry*, 71(5), 643-651.
- McFarland, K., Jackson, L., & Geffen, G. (2001). Post-traumatic amnesia: consistency-of-recovery and duration-to-recovery following traumatic brain impairment. *Clinical Neuropsychologist*, 15(1), 59-68.
- McIntyre, L. L., Gresham, F. M., Di Gennaro, F. F., & Reed, D. D. (2007). Treatment integrity of school-based interventions with children in the Journal of Applied Behavior Analysis 1991-2005. *Journal of Applied Behavior Analysis*, 40(4), 659-672.
- McPherson, K. M. & Pentland, B. (1997). Disability in patients following traumatic brain injury - which measure? *International Journal of Rehabilitation Research*, 20(1), 1-10.

- Meichenbaum, D. H. & Goodman, J. (1971). Training impulsive children to talk to themselves: A means of developing self-control. *Journal of Abnormal Psychology*, 77(2), 115-126.
- Miles, M. & Huberman, A. M. (1994). *An expanded sourcebook: Qualitative data analysis* (2nd ed.). California: SAGE Publications.
- Militello, L. G. & Hutton, R. J. B. (1998). Applied Cognitive Task Analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41(11), 1618-1641.
- Missiuna, C., Malloy-Miller, T., & Mandich, A. (1998). Mediation techniques: origins and application to occupational therapy in paediatrics. *Canadian Journal of Occupational Therapy*, 65(4), 202-209.
- Missiuna, C., Mandich, A. D., Polatajko, H. J., & Malloy-Miller, T. (2001). Cognition Orientation to Daily Occupational Performance (CO-OP): Part I - theoretical foundations. *Physical and Occupational Therapy in Pediatrics*, 20(2/3), 69-81.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49-100.
- Moncher, F. J. & Prinz, R. J. (1991). Treatment fidelity in outcome studies. *Clinical Psychology Review*, 11(3), 247-266.
- Montgomery, P., Kitten, M., & Niemiec, C. (1997). The agitated patient with brain injury and the rehabilitation staff: Bridging the gap of misunderstanding. *Rehabilitation Nursing*, 22(1), 20-23.
- Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: applications to health research. *Qualitative Health Research*, 8(3), 362-376.
- Munkhetvit, P. (2005). *Cognitive assessment in patients with acquired brain injury in Thailand*. PhD Thesis, The University of Sydney.
- Murphy, D. P. & Cooke, J. (1999). Traffic light lessons: Problem solving skills with adolescents. *Community Practitioner*, 72(10), 322-324.
- Mysiw, W. J., Fugate, L. P., & Clinchot, D. M. (2007). Assessment, early rehabilitation intervention, and tertiary prevention. In N. D. Zasler, D. I. Katz & R. D. Zafonte (Eds.), *Brain injury medicine: principles and practice* (pp. 283-301). New York: Demos Medical Publishing.
- Mysiw, W. J., Jackson, R. D., & Corrigan, J. D. (1988). Amitriptyline for post-traumatic agitation. *American Journal of Physical Medicine & Rehabilitation*, 67(1), 29-33.



- Nabors, N. A., Millis, S. R., & Rosenthal, M. (1997). Use of the Neurobehavioral Cognitive Status Examination (Cognistat) in traumatic brain injury. *Journal of Head Trauma Rehabilitation, 12*(3), 79-84.
- Neistadt, M. E. (1994). A meal preparation treatment protocol for adults with brain injury. *The American Journal of Occupational Therapy, 48*(5), 431-438.
- Nelson, D. L. & Mathiowetz, V. (2004). Randomized controlled trials to investigate occupational therapy research questions. *American Journal of Occupational Therapy, 58*(1), 24-34.
- Norman, D. A. & Shallice, T. (1986). Attention to action: Willed automatic control of behavior. In R. J. Davidson, G. E. Schwartz & D. Shapiro (Eds.), *Consciousness and self regulation: advances in research* (Vol. 4, pp. 1-18). New York: Plenum Press.
- Oder, W., Goldenberg, G., Spatt, J., Podreka, I., Binder, H., & Deecke, L. (1992). Behavioural and psychosocial sequelae of severe closed head injury and regional cerebral blood flow: A SPECT study. *Journal of Neurology, Neurosurgery & Psychiatry, 55*(6), 475-480.
- O'Kelly, M. (2004). Evaluation in clinical practice. *Clinical Psychologist, 8*(1), 43-47.
- Ottenbacher, K. J. (1986). *Evaluating clinical change: strategies for occupational and physical therapists*. Baltimore: Williams & Wilkins.
- Ottenbacher, K. J., Hsu, Y., Granger, C. V., & Fieldler, R. C. (1996). The reliability of the Functional Independence Measure: a quantitative review. *Archives of Physical Medicine & Rehabilitation, 77*(12), 1226-1232.
- Painter, J. (1990). Family intervention with the traumatically brain injured patient. In J. A. Johnson & L. H. Krefting (Eds.), *Occupational therapy approaches to traumatic brain injury*. New York: Haworth Press.
- Park, S., Fisher, A. G., & Velozo, C. A. (1994). Using the Assessment of Motor and Process Skills to compare occupational performance between clinic and home settings. *American Journal of Occupational Therapy, 48*(8), 775-780.
- Patterson, T. S. & Sargent, M. (1990). Behavioral management of the agitated head trauma client. *Rehabilitation Nursing, 15*(5), 248-249.
- Petrides, M. & Pandya, D. N. (2002). Association pathways of the prefrontal cortex and functional observations. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function*. New York: Oxford University Press.
- Pierce, D. (2005). The usefulness of video methods for occupational therapy and occupational science research. *American Journal of Occupational Therapy, 59*(1), 9-19.
- Plylar, P. A. (1989). Management of the agitated and aggressive head injury patient in an acute hospital setting. *Journal of Neuroscience Nursing, 21*(6), 353-356.

- Polatajko, H. J., Mandich, A. D., Miller, L. T., & Macnab, J. J. (2001). Cognitive Orientation to Daily Occupational Performance (CO-OP): Part II - the evidence. *Physical and Occupational Therapy in Pediatrics, 20*(2/3), 83-106.
- Polatajko, H. J., Mandich, A. D., Missiuna, C., Miller, L. T., Macnab, J. J., Malloy-Miller, T., et al. (2001). Cognitive Orientation to Daily Occupational Performance (CO-OP): Part III - the protocol in brief. *Physical and Occupational Therapy in Pediatrics, 20*(2/3), 107-123.
- Polgar, S., & Thomas, S. A. (2000). *Introduction to research in the health sciences* (4th ed.). Edinburgh: Elsevier Churchill Livingstone.
- Ponsford, J., Facem, P. C., Willmott, C., Rothwell, A., Kelly, A.-M., Nelms, R., et al. (2004). Use of the Westmead PTA scale to monitor recovery of memory after mild head injury. *Brain Injury, 18*(6), 603 - 614.
- Pool, J. (2006). The functional information-processing model. In E. A. S. Duncan (Ed.), *Foundations for practice in occupational therapy* (4th ed., pp. 125-141). Edinburgh: Elsevier Churchill Livingstone.
- Portney, L. G. & Watkins, M. P. (2000). *Foundations of clinical research: applications to practice* (2nd ed.). New Jersey: Prentice Hall.
- Prigatano, G. P. (1986). Personality and psychosocial consequences of brain injury. In G. P. Prigatano, D. J. Fordyce, H. K. Zeiner, J. R. Roueche, M. Pepping & B. Case Wood (Eds.), *Neuropsychological rehabilitation after brain injury* (pp. 29-50). London: Johns Hopkins University Press.
- Prigatano, G. P. (1992). Personality disturbances associated with traumatic brain injury. *Journal of Consulting & Clinical Psychology, 60*(3), 360-368.
- Pryor, J. (2004). What environmental factors irritate people with acquired brain injury? *Disability and Rehabilitation, 26*(16), 974-980.
- Pulis, J. (2002). *Assessing information processing deficits in children: The PRPP System of Task Analysis*. Thesis. The University of Sydney.
- Radomski, M. V. (2008). Traumatic brain injury. In C. A. Trombly Latham & M. V. Radomski (Eds.), *Occupational therapy for physical dysfunction* (6 ed., pp. 748-773). Baltimore: Lippincott, Williams & Wilkins.
- Rankin, G. & Stokes, M. (1998). Reliability of assessment tools in rehabilitation: an illustration of appropriate statistical analyses. *Clinical Rehabilitation, 12*(3), 187-199.
- Rasch, G. (1960). *Probabilistic models for some intelligence and attainment tests*. Copenhagen: Danmarks Paedagogiske Institut.
- Rath, J. F., Simon, D., Langenbahn, D. M., Sherr, R. L., & Diller, L. (2003). Group treatment of problem-solving deficits in outpatients with traumatic brain injury: A randomised outcome study. *Neuropsychological Rehabilitation, 13*(4), 461 - 488.

- Resnick, B., Inguito, P., Orwig, D., Yahiro, J. Y., Hawkes, W., Werner, M., et al. (2005). Treatment fidelity in behavior change research: A case example. *Nursing Research*, 54(2), 139-143.
- Reyes, R. L., Bhattacharyya, A. K., & Heller, D. (1981). Traumatic head injury: Restlessness and agitation as prognosticators of physical and psychologic improvement in patients. *Archives of Physical Medicine & Rehabilitation*, 62(1), 20-23.
- Riedel, D. & Shaw, V. (1997). Nursing management of patients with brain injury requiring one-on-one care. *Rehabilitation Nursing*, 22(1), 36-39.
- Robinson, S. E. & Fisher, A. G. (1996). A study to examine the relationship of the assessment of motor and process skills (AMPS) to other tests of cognition and function. *British Journal of Occupational Therapy*, 59(6), 260-263.
- Rodger, S., Pham, C., & Mitchell, S. (2008). Cognitive strategy use by children with Asperger's syndrome during intervention for motor-based goals. *Australian Occupational Therapy Journal*, (early online). Retrieved 16 August 2008 from <http://www3.interscience.wiley.com.ezproxy2.library.usyd.edu.au/cgi-bin/fulltext/120173859/PDFSTART>
- Romiszowski, A. (1984). *Designing instructional systems*. London: Hogan Page.
- Ruff, R. M., Crouch, J. A., Troster, A. I., Marshall, L. F., Buchsbaum, M. S., Lottenberg, S., et al. (1994). Selected cases of poor outcome following a minor brain trauma: Comparing neuropsychological and positron emission tomography assessment. *Brain Injury*, 8(4), 297 - 308.
- Salminen, A. L., Harra, T., & Lautamo, T. (2006). Conducting case study research in occupational therapy. *Australian Occupational Therapy Journal*, 53, 3-8.
- Sandel, M. E. & Mysiw, W. J. (1996). The agitated brain injured patient. Part 1: Definitions, differential diagnosis, and assessment. *Archives of Physical Medicine & Rehabilitation*, 77(6), 617-623.
- Sander, A. M., Fuchs, K. L., High, W. M., Jr., Hall, K. M., Kreutzer, J. S., & Rosenthal, M. (1999). The Community Integration Questionnaire revisited: An assessment of factor structure and validity. *Archives of Physical Medicine & Rehabilitation*, 80(10), 1303-1308.
- SAS Institute (1999-2001). *The SAS System (Version 8.2)*. [Computer software]. Cary: SAS Institute Inc
- Schmidt, R. & Wrisberg, C. (2004). *Motor learning and performance* (3rd ed.). Champaign: Human Kinetics.
- Schraagen, J. M., Chipman, S. F., & Shalin, V. (2000). *Cognitive task analysis*. Mahwah: Lawrence Erlbaum Associates.

- Selznick, L. & Savage, R. C. (2000). Using self-monitoring procedures to increase on-task behavior with three adolescent boys with brain injury. *Behavioral Intervention, 15*(3), 243-260.
- Shah, S. & Muncer, S. J. (2003). A comparison of rehabilitation outcome measures for traumatic brain injury. *OTJR: Occupation, Participation and Health, 23*(1), 2-9.
- Shah, S., Muncer, S. J., Griffin, J., & Elliott, L. (2000). The utility of the Modified Barthel Index for traumatic brain injury rehabilitation and prognosis. *British Journal of Occupational Therapy, 63*(10), 469-475.
- Shallice, T. & Burgess, P. W. (1996). The domain of supervisory processes and temporal organization of behavior. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 351*(1346), 1405-1412.
- Shiffrin, R. M. & Schneider, W. (1977). Controlled and automatic human information processing II. Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84*(2), 127-190.
- Shores, E. A. (1995). Further concurrent validity data on the Westmead PTA Scale. *Applied Neuropsychology, 2*, 167-169.
- Shores, E. A., Marosszeky, J. E., Sandanam, J., & Batchelor, J. (1986). Preliminary validation of a clinical scale for measuring the duration of post-traumatic amnesia. *Medical Journal of Australia, 144*, 569-572.
- Shrout, P. E. & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86*(2), 420-428.
- Shumway-Cook, A. & Woollacott, M. H. (2007). *Motor control: Translating research into clinical practice* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins.
- Silver, J. M. & Yudofsky, S. C. (1991). The Overt Aggression Scale: Overview and guiding principles. *Journal of Neuropsychiatry & Clinical Neurosciences, 3*(2), S22-29.
- Singer, R. N. & Cauraugh, J. H. (1985). The generalizability effect of learning strategies for categories of psychomotor skills. *Quest, 37*(1), 103-119.
- Singer, R. N. (1980). *Motor learning and human performance: An application to motor skills and movement behaviors* (3rd ed.). New York: Macmillan Publishing.
- Smith, R. M. (1991). The distributional properties of Rasch item fit statistics. *Educational and Psychological Measurement, 51*(3), 541-565.
- Snell, M. E. & Zirpoli, T. J. (1987). Intervention strategies. In M. E. Snell (Ed.), *Systematic instruction of persons with severe handicaps* (3rd ed., pp. 110-149). Columbus: Merrill Publishing

- Soeda, A., Nakashima, T., Okumura, A., Kuwata, K., Shinoda, J., & Iwama, T. (2005). Cognitive impairment after traumatic brain injury: A functional magnetic resonance imaging study using the Stroop task. *Neuroradiology*, *47*(7), 501-506.
- Sohlberg, M. M. & Mateer, C. A. (1989). Training use of compensatory memory books: a three stage behavioural approach. *Journal of Clinical & Experimental Neuropsychology*, *11*(6), 871-891.
- Sohlberg, M. M. & Mateer, C. A. (2001). *Cognitive rehabilitation: an integrative neuropsychological approach*. New York: Guildford Press.
- Sohlberg, M. M., Ehlhardt, L., & Kennedy, M. (2005). Instructional techniques in cognitive rehabilitation: a preliminary report. *Seminars in Speech and Language*, *26*(4), 268-279.
- Sohlberg, M. M., Mateer, C. A., & Mateer, D. T. (1993). Contemporary approaches to the management of executive control dysfunction. *Journal of Head Trauma Rehabilitation*, *8*(1), 45-58.
- SPSS Inc (2006). SPSS 15.0 for Windows [computer software]. Chicago: SPSS Inc.
- Still, M., Beltran, R., Catts, S., Chapparo, C., & Langdon, R. (2002). Cognitive and functional assessment of patients with early psychosis. *Acta Psychiatrica Scandinavica*, *106*(413), s40-41.
- Strangman, G., O'Neil-Pirozzi, T. M., Burke, D., Cristina, D., Goldstein, R., Rauch, S. L., et al. (2005). Functional neuroimaging and cognitive rehabilitation for people with traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation*, *84*(1), 62-75.
- Stuss, D. T. (1991). Self, awareness, and the frontal lobes: a neuropsychological perspective. In J. Strauss & G. R. Goethals (Eds.), *The self: Interdisciplinary approaches* (pp. 255-278). New York: Springer-Verlag.
- Stuss, D. T. & Gow, C. A. (1992). "Frontal Dysfunction" after traumatic brain injury. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology*, *5*(4), 272-282.
- Sudsawad, P. (2005). Concepts in clinical scholarship. A conceptual framework to increase usability of outcome research for evidence-based practice. *American Journal of Occupational Therapy*, *59*(3), 351-355.
- Sumison, T. & Blank, A. (2006). The Canadian Model of Occupational Performance. In E. A. S. Duncan (Ed.), *Foundations for practice in occupational therapy* (4th ed., pp. 109-124). Edinburgh: Elsevier Churchill Livingstone.
- Swanson, H. L. & Sachse-Lee, C. (2000). A meta-analysis of single-subject-design intervention research for students with LD. *Journal of Learning Disabilities*, *33*(2), 114-136.
- Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston: Pearson Education Inc.

- Tate, R. L. & Pfaff, A. (2000). Problems and pitfalls in the assessment of Posttraumatic Amnesia. *Brain Impairment*, 1(2), 116-130.
- Tate, R. L., Perdices, M., Pfaff, A., & Jurjevic, L. (2001). Predicting duration of posttraumatic amnesia (PTA) from early PTA measurements. *Journal of Head Trauma Rehabilitation*, 16(6), 525-542.
- Tate, R. L., Pfaff, A., & Jurjevic, L. (2000). Resolution of disorientation and amnesia during post-traumatic amnesia. *Journal of Neurology, Neurosurgery & Psychiatry*, 68(2), 178-185.
- Taylor, S., Fayed, N., & Mandich, A. (2007). CO-OP intervention for young children with developmental coordination disorder. *OTJR: Occupation, Participation and Health*, 27(4), 124.
- Thompson, C. K. (2006). Single subject controlled experiments in aphasia: The science and the state of the science. *Journal of Communication Disorders*, 39(4), 266-291.
- Toglia, J. P. (1991). Generalization of treatment: A multicontext approach to cognitive perceptual impairments in adults with brain injury. *The American Journal of Occupational Therapy*, 45(6), 505-516.
- Toglia, J. P. (1998). A dynamic interactional model to cognitive rehabilitation. In N. Katz (Ed.), *Cognition and occupation in rehabilitation: cognitive models for intervention in occupational therapy* (pp. 5-50). Bethesda: American Occupational Therapy Association.
- Toglia, J. P. (2005). A dynamic interactional approach to cognitive rehabilitation. In N. Katz (Ed.), *Cognition and occupation across the life span: models for intervention in occupational therapy* (2nd ed., pp. 29-72). Bethesda: The American Occupational Therapy Association.
- Treadwell, K. & Page, T. J. (1996). Functional analysis: Identifying the environmental determinants of severe behavior disorders. *Journal of Head Trauma Rehabilitation*, 11(1), 62-74.
- Trombly, C. A. (1993). Anticipating the future: Assessment of occupational function. *American Journal of Occupational Therapy*, 47(3), 253-257.
- van Baalen, B., Odding, E., & Stam, H. J. (2008). Cognitive status at discharge from the hospital determines discharge destination in traumatic brain injury patients. *Brain Injury*, 22(1), 25 - 32.
- van Baalen, B., Odding, E., Maas, A. I. R., Ribbers, G. M., Bergen, M. P., & Stam, H. J. (2003). Traumatic brain injury: Classification of initial severity and determination of functional outcome. *Disability and Rehabilitation*, 25(1), 9-18.
- van Baalen, B., Odding, E., van Woensel, M. P. C., van Kessel, M. A., Roebroek, M. E., & Stam, H. J. (2006). Reliability and sensitivity to change of measurement instruments used in a traumatic brain injury population. *Clinical Rehabilitation*, 20(8), 686-700.

- van der Naalt, J., van Zomeren, A. H., Sluiter, W. J., & Minderhoud, J. M. (2000). Acute behavioural disturbances related to imaging studies and outcome in mild-to-moderate head injury. *Brain Injury*, 14(9), 781-788.
- van Zomeren, A. H. & Brouwer, W. H. (1994). *Clinical neuropsychology of attention*. New York: Oxford Press.
- von Cramon, D. Y. & Matthes-von Cramon, G. (1992). Reflections on the treatment of brain-injured patients suffering from problem-solving disorders. *Neuropsychological Rehabilitation*, 2(3), 207-229.
- Wæhrens, E. E. & Fisher, A. G. (2007). Improving quality of ADL performance after rehabilitation among people with acquired brain injury. *Scandinavian Journal of Occupational Therapy*, 14(4), 250 - 257.
- Weir, N., Doig, E. J., Fleming, J. M., Wiemers, A., & Zemljic, C. (2006). Objective and behavioural assessment of the emergence from post-traumatic amnesia (PTA). *Brain Injury*, 20(9), 927-935.
- Whiting, S. & Lincoln, N. B. (1980). An A.D.L. Assessment for stroke patients. *British Journal of Occupational Therapy*, 43, 44-46.
- Whiting, S., Lincoln, N. B., Bhavnani, G., & Cockburn, J. (1985). *The Rivermead Perceptual Assessment Battery*. Windsor: NFER - Nelson.
- Whyte, J., Hart, T., Bode, R. K., & Malec, J. F. (2003). The Moss Attention Rating Scale for traumatic brain injury: Initial psychometric assessment. *Archives of Physical Medicine & Rehabilitation*, 84(2), 268-276.
- Wilson, B. A., Alderman, N., Burgess, P. W., Emslie, H., & Evans, J. J. (1996). *Behavioral Assessment of Dysexecutive Syndrome*. St. Edmunds: Thames Valley Test Company.
- Wilson, B. A., Cockburn, J., & Baddeley, A. (2003). *Rivermead Behavioural Memory Test II*. St Edmunds: Thames Valley Test Company.
- Wilson, B. A., Herbert, C. M., & Shiel, A. (2003). *Behavioural approaches in neuropsychological rehabilitation: Optimising rehabilitation procedures*. New York: Psychology Press.
- Wilson, J. C. & Dailey, W. (1999). The practice of behavioural treatment in the acute rehabilitation setting. In G. M. Giles & J. Clark-Wilson (Eds.), *Rehabilitation of the severely brain-injured adult: A practical approach* (2nd ed., p. 54). Cheltenham: Stanley Thornes Ltd.
- Wong, S. P. & McGraw, K. O. (1999). Confidence intervals and *F* tests for intraclass correlations based on three-way random effects models. *Educational and Psychological Measurement*, 59(2), 270-288.
- Wood, W. (1995). Weaving the warp and weft of occupational therapy: an art and science for all times. *The American Journal of Occupational Therapy*, 49(1), 44-52.

- Wright, B. D. & Linacre, J. M. (1994). Reasonable mean-square fit values [Electronic version]. *Rasch Measurement Transactions*, 8. Retrieved from [www.rasch.org/rmt/rmt83b.htm](http://www.rasch.org/rmt/rmt83b.htm).
- Yin, R. K. (2003). *Case study research: design and methods* (3rd ed.). Thousand Oaks: SAGE INC.
- Ylvisaker, M., Turkstra, L., Coehlo, C., Yorkston, K., Kennedy, M., Sohlberg, M. M., et al. (2007). Behavioural interventions for children and adults with behaviour disorders after TBI: A systematic review of the evidence. *Brain Injury*, 21(8), 769 - 805.
- Yudofsky, S. C., Silver, J. M., Jackson, W., Endicott, J., & Williams, D. (1986). The Overt Aggression Scale for the objective rating of verbal and physical aggression. *American Journal of Psychiatry*, 143(1), 35-39.
- Yuen, H. K. & Benzing, P. (1996). Guiding of behaviour through redirection in brain injury rehabilitation. *Brain Injury*, 10(3), 229-238.



## APPENDICES

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## **APPENDIX I – ETHICS APPROVALS**

**WESTERN SYDNEY AREA HEALTH SERVICE**  
**HUMAN RESEARCH ETHICS COMMITTEE**

Research Office, Clinical Sciences,  
Westmead Hospital  
Westmead NSW 2145

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In reply please quote:  
HS/TG HREC2002/12/4.21(1576)

**Committee Secretariat:**

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Immunologist

**Dr Howard Smith**  
Secretary  
Medical Graduate -  
Endocrinologist

**Committee Members:**

**Mr Leonard Burney**  
Layman

**Dr Michael Cole**  
Neonatal Paediatrician

**Dr Peter Ellis**  
Forensic Pathologist

**Mrs Patricia Fa**  
Clinical Trials Pharmacist

**Ms Jillian Gwynne Lewis**  
Patient Representative

**Dr Vivien Lane RN**  
Nursing Professional  
Development Unit - Research

**Father Laurence McNamara**  
Minister of Religion

**Dr Geoff Shead**  
Medical Graduate - Surgeon

**Rev Janine Steele**  
Chaplain

**Mr John Watts**  
Lawyer

**Miss Freda Whittam AM**  
Laywoman

13 February, 2003

Ms Melissa Nott  
Inpatient Occupational Therapist  
Brain Injury Unit  
Westmead Hospital

Dear Miss Nott

Research Proposal: 'Outcomes of Agitated Clients following Traumatic Brain Injury'

Your abovenamed research proposal was considered at the meeting of the Western Sydney Area Health Service Human Research Ethics Committee on 28 January 2003.

The Committee found no ethical objections to your proposal and agreed to give its approval conditional upon the following amendments being made to the participant information and consent forms:

- The apostrophe in 'Clients' in the title of the study should be omitted.
- The participant information sheet needs to be formatted in the standard way with headings ie **What is the purpose of the study?** and **What will happen on the study?** etc in bold font.
- In the first paragraph 'functional outcomes' should be rewritten in more user friendly language.
- The last paragraph regarding the Westmead Hospital patient representative should be headed **Complaints**. Ms Gwynne Lewis' email address jillian\_lewis@wsahs.nsw.gov.au should be added after her telephone number.
- The paragraph beginning 'If you have any questions during the course of the study ... etc' should be the last paragraph of the participant information sheet and should be headed **Contact details**.
- The consent form should be in the current format with numbered points, in full.

Please note that **approval** of this research proposal applies to the ethical content of the trial and individual arrangements should be negotiated with heads of departments in those situations where the use of their resources is involved (eg nursing etc).

The Committee requests notification of the date of commencement of the study and recruitment of subjects. In accordance with the NH&MRC Statement on Human Experimentation 'Supplementary Note 1', the Committee requires you to

2.

furnish it with a brief report on progress at the end of each 12 months and a final report at the completion of the study. A copy of the HREC's Standard Operating Procedures is attached.

In all future correspondence concerning this study, please quote your approval number **HREC2002/12/4.21(1576)**.

The project approval becomes operative when the attached copy letter, signed and dated in acknowledgement, is received in the Research Office, together with revised participant information and consent forms as set out above. Please ensure all amendments are highlighted and a version number and date appears at the foot of each page.

Yours sincerely



Dr Howard Smith  
Secretary  
Western Sydney Area Health Service  
Human Research Ethics Committee

**WESTERN SYDNEY AREA HEALTH SERVICE**  
**HUMAN RESEARCH ETHICS COMMITTEE**

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Medical Graduate -  
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**Dr Howard Smith**  
Secretary  
Medical Graduate -  
Endocrinologist

**Committee Members:**

**Mr Leonard Burney**  
Layman

**Dr Michael Cole**  
Neonatal Paediatrician

**Dr Peter Ellis**  
Forensic Pathologist

**Mrs Patricia Fa**  
Clinical Trials Pharmacist

**Ms Jillian Gwynne Lewis**  
Patient Representative

**Dr Vivien Lane RN**  
Nursing Professional  
Development Unit - Research

**Father Laurence McNamara**  
Minister of Religion

**Dr Geoff Shead**  
Medical Graduate - Surgeon

**Rev Janine Steele**  
Chaplain

**Mr John Watts**  
Lawyer

**Miss Freda Whitlam AM**  
Laywoman

14 March, 2003

Ms Melissa Nott / Dr Christine Chapparo  
Brain Injury Unit  
Westmead Hospital

Dear Ms Nott and Dr Chapparo

Research Proposal: 'Outcomes of Agitated Clients following Traumatic Brain Injury'

Thank you for your letter dated 12 March 2003 seeking approval to collect and analyse further data from the participants of the abovenamed study.

The Committee notes your advice that you will be utilising the previously collected data for the same purposes as outlined at the time of data collection. As the participants consented to this data being collected at the time of the original follow-up study, the Committee has no ethical objection to your current request.

Yours sincerely



Dr Howard Smith  
Secretary  
Western Sydney Area Health Service  
Human Research Ethics Committee

**WESTERN SYDNEY AREA HEALTH SERVICE**  
**HUMAN RESEARCH ETHICS COMMITTEE**

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**A/Prof Vivien Lane RN**  
Nursing Professional  
Development Unit - Research

**Dr Geoff Shead**  
Medical Graduate - Surgeon

**Rev Janine Steole**  
Minister of Religion

**Miss Freda Whitlam AM**  
Laywoman

1 April, 2003

Ms Melissa Nott  
Inpatient Occupational Therapist  
Brain Injury Unit  
Westmead Hospital

Dear Ms Nott

Research Proposal: 'Outcomes of Agitated Clients following Traumatic Brain Injury'

Thank you for your letter dated 31 March 2003 enclosing signed copy of the approval letter.

The Committee wishes you well with the study and looks forward to receiving progress reports in due course.

Yours sincerely



Dr Howard Smith  
Secretary  
Western Sydney Area Health Service  
Human Research Ethics Committee





# The University of Sydney

NSW 2006 Australia

**Human Research Ethics Committee**  
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26 April 2005

Dr C Chapparo  
School of Occupation and Leisure Sciences  
Faculty of Health Sciences  
Cumberland Campus - C42  
The University of Sydney

Dear Dr Chapparo

I am pleased to inform you that the Human Research Ethics Committee at its meeting on 19 April 2005 approved your protocol entitled "**Using the Perceived, Recall, Plan and Perform (PRPP) System of Task Analysis to measure information processing in agitated clients following traumatic brain injury: A reliability study**"

Details of the approval are as follows:

<b>Ref No.:</b>	<b>04-2005/1/8193</b>
<b>Approval Period:</b>	<b>April 2005 – April 2006</b>
<b>Completion Date of Project:</b>	<b>31 October 2005</b>
<b>No. of Participants:</b>	<b>35 (15 patients and 20 Occupational Therapist)</b>
<b>Authorised Personnel:</b>	<b>Dr C Chapparo Ms M Nott</b>

To comply with the *National Statement on Ethical Conduct in Research Involving Humans*, and in line with the Human Research Ethics Committee requirements this approval is for a 12-month period. At the end of the approval period, the HREC will approve extensions for a further 12-month, subject to a satisfactory annual report. The HREC will forward to you an Annual Progress Report form, at the end of each 12-month period. **Your first report will be due on 30 April 2006.**

### Conditions of Approval Applicable to all Projects

- (1) Modifications to the protocol cannot proceed until such approval is obtained in writing. (Refer to the website [www.usyd.edu.au/ethics/human](http://www.usyd.edu.au/ethics/human) under 'Forms and Guides' for a Modification Form).

- (2) The confidentiality and anonymity of all research subjects is maintained at all times, except as required by law.
- (3) All research subjects are provided with a Participant Information Sheet and Consent Form, unless otherwise agreed by the Committee.
- (4) The Participant Information Sheet and Consent Form are to be on University of Sydney letterhead and include the full title of the research project and telephone contacts for the researchers, unless otherwise agreed by the Committee.
- (5) The following statement must appear on the bottom of the Participant Information Sheet. ***Any person with concerns or complaints about the conduct of a research study can contact the Manager, Ethics Administration, University of Sydney, on (02) 9351 4811.***
- (6) The standard University policy concerning storage of data and tapes should be followed. While temporary storage of data or tapes at the researcher's home or an off-campus site is acceptable during the active transcription phase of the project, permanent storage should be at a secure, University controlled site for a minimum of seven years.
- (7) A report and a copy of any published material should be provided at the completion of the Project.

Yours sincerely



**Associate Professor J D Watson  
Chairman  
Human Research Ethics Committee**

Encl. Participant Information Sheet – Group one  
Participant Information Sheet – group two (clinicians)  
Video Subject Consent Form  
Advertisement  
The PRPP System Scoring Sheet (Ranka & Chapparo 1999 (Original 1995) The University of Sydney)





**Department of Health**  
Government of Western Australia  
North Metropolitan Area Health Service - North East

**Royal Perth Hospital**

ABN 13 993 250 709



## ETHICS COMMITTEE

**Clin Prof J A Millar PhD FRCP FRACP**  
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Room 4112 Level 4, Kirkman House  
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**Ref: EC RA-04-45**

*(This number must be quoted on all correspondence)*

15 June 2005

Ms Melissa Nott  
Senior Occupational Therapist  
Neurosciences  
Shenton Park Campus

Dear Ms Nott

**RA-04/45 – Using the perceive, recall, plan and perform (PRPP) system of task analysis to measure information processing abilities in agitated clients following traumatic brain injury: a pilot study**

I am pleased to inform you that the study has been **APPROVED** under assumed reciprocity with The University of Sydney Human Research Ethics Committee Ethics Committee, on the basis that it is recognised by AHEC.

The study has been assigned the Royal Perth Hospital reference Number **EC RA-04/45** and this should be quoted on all future correspondence regarding the trial.

Kind regards

Yours sincerely

J A Millar  
*Chairman, Royal Perth Hospital Ethics Committee*

*The Royal Perth Hospital Ethics Committee is constituted and operates in accordance with NHC & MRC Guidelines. An Annual Report on the progress of your trial will be required (see Committee explanatory notes available on Servio)*

SYDNEY WEST AREA HEALTH SERVICE (Westmead Campus)

HUMAN RESEARCH ETHICS COMMITTEE

Research Office, Clinical Sciences  
Westmead Hospital Campus  
Westmead NSW 2145

Telephone: 02 9845 8133  
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In reply please quote:

HS/pme HREC2006/8/4.20(2375)

Committee Secretariat:

Professor Stephen Leeder AO  
Chairman  
Professor of Public Health &  
Community Medicine

Dr Howard Smith  
Secretary  
Medical Graduate -  
Endocrinologist

Committee Members:

Mr Leonard Burney  
Layman

Dr Michael Cole  
Medical Graduate - Neonatal  
Paediatrician

Mrs Patricia Fa  
Clinical Trials Pharmacist

A/Prof Lorraine Ferguson AM  
Nursing Research Unit

Mr John Fisher  
Lawyer

Ms Janet Fox  
Law Graduate

Ms Jillian Gwynne Lewis  
Patient Representative

Dr Anthony Harris  
Medical Graduate -  
Psychiatrist

Dr Jim Hazel  
Medical Graduate -  
Endocrinologist

Ms Vicki Hewson  
Social Worker

Ms Jan Kang  
Diversity Health Institute

A/Prof Ian Kerridge  
Haematologist and Bioethicist

Ms Rada Kusic  
Clinical Trials Manager

Rev Sarah Plummer  
Minister of Religion

Mr John Shaw  
Layman

Dr Geoff Shead  
Medical Graduate - Surgeon

Mrs Carol Walsh  
Laywoman

Ms Shane Waterton  
Laywoman

8 October, 2006

Ms Melissa Nott  
Faculty of Health Science  
School of Occupation and Leisure Sciences  
The University of Sydney  
Building J, East Street  
LIDCOMBE NSW 2141

Dear Ms Nott

Research Proposal: An information processing approach to occupational therapy intervention with agitated patients following brain injury

Thank you for your letter received in the Research Office on 20 September 2006, forwarding your revised Participant Information and Consent Forms Version 3 dated 27/9/06 together with the signed letter of acceptance, all in accordance with the requests of the Human Research Ethics Committee letter dated 12 September 2006.

As the Committee's ethical concerns have now been satisfied, final approval of the study is confirmed and it may now commence. A copy of the approved Participant Information and Consent Forms Version No.3 dated 27/9/06 is attached for your records.

The Committee wishes you well with the study and looks forward to receiving progress reports in due course.

Yours sincerely



Dr Howard Smith  
Secretary  
Sydney West Area Health Service  
Human Research Ethics Committee



The University of Sydney

NSW 2006 Australia

Human Research Ethics Committee

[www.usyd.edu.au/ethics/human](http://www.usyd.edu.au/ethics/human)

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3 November 2006

Dr C Chapparo  
Senior Lecturer  
School of Occupation and Leisure Sciences  
Faculty of Health Sciences  
Cumberland Campus – C42  
The University of Sydney

Dear Dr Chapparo

**Title:** *An information processing approach to occupational therapy intervention with agitated patients following brain injury (Ref. No. 9654)*

PhD Student: Ms Melissa Nott

Your application was reviewed by the Executive Committee of the Human Research Ethics Committee (HREC), and in doing so have ratified your study to cover the PhD Student, Ms Melissa Nott.

The Executive Committee acknowledges your right to proceed under the authority of the Sydney West Area Health Service (Westmead Campus) Human Research Ethics Committee.

Please note, this ratification has been given only in respect of the ethical content of the study.

Any modifications to the study must be approved by the Sydney West Area Health Service (Westmead Campus) Human Research Ethics Committee before submission to the University of Sydney Human Research Ethics Committee.

Yours sincerely

**Gail Briody**  
Senior Ethics Officer  
Ethics Administration

## **APPENDIX II – CO-AUTHOR STATEMENTS**

As co-authors of the paper “*Nott, M. T., Chapparo, C., & Baguley, I. J. (2006). Agitation following traumatic brain injury: an Australian sample. Brain Injury, 20(11), 1175-1182*” we confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

Our contributions to the paper were as follows:

**Christine Chapparo**

- Critical appraisal of content
- Editing and discussion consistent with the supervisory process

Signed.....Date:.....

**Ian Baguley**

- Provision of follow-up data
- Critical appraisal of content

Signed.....Date:.....

As co-author of the paper “Nott, M. T., Chapparo, C. (2008). *Measuring information processing in a client with extreme agitation following traumatic brain injury using the Perceive, Recall, Plan and Perform System of Task Analysis. Australian Occupational Therapy Journal, 55(3), 188-198.*” I confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

My contributions to the paper were as follows:

**Christine Chapparo**

- Co-writing background section in capacity as the instrument developer
- Critical appraisal of content
- Editing and discussion consistent with the supervisory process

Signed.....Date:.....


As co-authors of the submitted manuscript “*Nott, M. T., Chapparo, C., & Linacre, J. M. Exploring the validity of an information processing assessment for measuring occupational performance in adults following brain injury. Journal of Applied Measurement (submitted December 2007, submission MS#07-39)*” we confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

**Christine Chapparo**

Signed.....Date:.....

**John Michael Linacre**

Signed..........Date: August 14, 2008

As co-authors of the paper “*Nott, M. T., Chapparo, C., & Heard, R. (2008). Reliability of the Perceive, Recall, Plan and Perform System of Task Analysis: A criterion referenced assessment. Australian Occupational Therapy Journal, Published online August 25 2008. DOI: 10.1111/j.1440-1630.2008.00763.x*” we confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

Our contribution to the paper was as follows:

**Christine Chapparo**

- Co-writing background section in capacity as the instrument developer
- Critical appraisal of content
- Editing and discussion consistent with the supervisory process

Signed.....Date:.....

**Robert Heard**

- Assistance with data analysis and interpretation
- Critical appraisal of content and discussion consistent with the supervisory process

Signed.....Date:.....



As co-authors of the paper “*Nott, M. T., Chapparo, C., & Heard, R. (2008). Effective occupational therapy intervention with adults demonstrating agitation during post-traumatic amnesia. Brain Injury, 22(9), 669-683*” we confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

Our contributions to the paper were as follows:

**Christine Chapparo**

- Assistance with data analysis and interpretation
- Critical appraisal of content, editing and discussion consistent with the supervisory process

Signed.....Date:.....

**Robert Heard**

- Assistance with data analysis and interpretation
- Critical appraisal of content and discussion consistent with the supervisory process

Signed.....Date:.....

As co-authors of the submitted manuscript “*Nott, M. T., Chapparo, C., & Heard, R. Instructing information processing strategies in clients with agitation following brain injury. Brain Injury. (Submitted 30<sup>th</sup> April 2008. ID #TBIN-2008-0089)*” we confirm that Melissa Nott has made the following contributions:

- Concept and design of the research
- Data collection, analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- Corresponding author for communication with journals

Our contributions to the paper were as follows:

**Christine Chapparo**

- Assistance with data analysis and interpretation
- Critical appraisal of content, editing and discussion consistent with the supervisory process

Signed.....Date:.....

**Robert Heard**

- Assistance with data analysis and interpretation
- Critical appraisal of content and discussion consistent with the supervisory process

Signed.....Date:.....

## **APPENDIX III – ICC WORKSHEETS**

Appendix III contains the excel worksheets used to calculate 3-way intraclass correlation coefficients (ICC) for Chapter Seven. Excel worksheets were provided by Ken McGraw based on the mathematical equations presented in Wong and McGraw (1999). ICC's were calculated based on data produced from a Type IV Sum of Squares Analysis of Variance (ANOVA), where patients were nested with tasks, and crossed by all raters. Spreadsheet cells highlighted in yellow indicate the ICC absolute value reported in all cases.

# ICC EXCEL WORKSHEET OUTPUT: PRPP Total%

## ICC raters

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>			
np	5	$n_{i\_star}$	7		
ni	7	$m_i$	1		
nj	9	$n_{j\_star}$	9		
		$m_j$	9		
<p>The mean squares and variance estimates from this design appear below</p>					
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>		
MSP	4857.915	P	70.184		
MSi:p	355.187	I:P	36.246		
MSj	1028.777	J	26.247		
MSpj	110.119	PJ	11.592		
MS_res	28.973	Res	28.973		
		Rel	76.811		
		Abs	103.059		
		P	70.184		
		I:P	5.178		
		J	26.247		
		PJ	11.592		
		Res	4.139		
		Rel	20.909		
		Abs	47.157		
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>					
		95% CI on rho		Test for Ho: rho = 0	
		Two-sided CI		One-sided CI	
<b>ICC Estimates</b>					
<b>ICC(rel)</b>		Lower	Upper		
via MS	0.7705	0.4682	0.9683	0.5272	
Via S&W	0.7705	x	x		
<b>ICC(abs)</b>					
rho_abs	0.5981	0.2472	0.9325	0.3025	
via S&W	0.5981	x	x		
				df	v
				F =	4 41 11.134 0.000
				F' =	4 41 11.134 0.000
				Enter value of rho_0 here--> 0.4682	
				df	v
				F =	4 53 2.317 0.069
				F' =	4 21 0.467 0.759

## ICC test

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>			
np	5	$n_{i\_star}$	7		
ni	7	$m_i$	1		
nj	9	$n_{j\_star}$	9		
		$m_j$	1		
<p>The mean squares and variance estimates from this design appear below</p>					
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>		
MSP	4857.915	P	70.184		
MSi:p	355.187	I:P	36.246		
MSj	1028.777	J	26.247		
MSpj	110.119	PJ	11.592		
MS_res	28.973	Res	28.973		
		Rel	76.811		
		Abs	103.059		
		P	70.184		
		I:P	5.178		
		J	2.916		
		PJ	1.288		
		Res	0.460		
		Rel	6.926		
		Abs	9.842		
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>					
		95% CI on rho		Test for Ho: rho = 0	
		Two-sided CI		One-sided CI	
<b>ICC Estimates</b>					
<b>ICC(rel)</b>		Lower	Upper		
via MS	0.9102	0.7200	0.9893	0.7665	
Via S&W	0.9102	x	x		
<b>ICC(abs)</b>					
rho_abs	0.8770	0.6441	0.9849	0.6979	
via S&W	0.8770	x	x		
				df	v
				F =	4 41 11.134 0.000
				F' =	4 41 11.134 0.000
				Enter value of rho_0 here--> 0.7200	
				df	v
				F =	4 41 3.117 0.025
				F' =	4 41 0.723 0.581

# ICC EXCEL WORKSHEET OUTPUT: PERCEIVE QUADRANT

## ICC raters

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7
ni	7	$m_i$	1
nj	9	$n_{j\_star}$	9
		$m_j$	9

<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for ni* and nj*</b></p>
MSp	5190.605	P	74.220
MSi:p	381.871	I:P	37.334
MSj	879.431	J	20.021
MSpj	178.711	PJ	18.978
MS_res	45.867	Res	45.867
		Rel	102.179
		Abs	122.199
		P	74.220
		I:P	5.333
		J	20.021
		PJ	18.978
		Res	6.552
		Rel	30.864
		Abs	50.884

<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>				
		<p>95% CI on rho</p>		<p>Test for Ho: rho = 0</p>
		<p>Two-sided CI</p>		<p>df</p>
		Lower	Upper	v
<p>ICC Estimates</p>				F =
<p>via MS</p>		<p>0.3766 0.9568</p>		45
<p>Via S&amp;W</p>		<p>x x</p>		45
<p>ICC(abs)</p>				F-value
<p>rho_abs</p>		<p>0.2551 0.9311</p>		p
<p>via S&amp;W</p>		<p>x x</p>		31
				0.3766
				0.093
				0.644

## ICC test

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7
ni	7	$m_i$	1
nj	9	$n_{j\_star}$	9
		$m_j$	1

<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for ni* and nj*</b></p>
MSp	5190.605	P	74.220
MSi:p	381.871	I:P	37.334
MSj	879.431	J	20.021
MSpj	178.711	PJ	18.978
MS_res	45.867	Res	45.867
		Rel	102.179
		Abs	122.199
		P	74.220
		I:P	5.333
		J	2.225
		PJ	2.109
		Res	0.728
		Rel	8.170
		Abs	10.395

<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>				
		<p>95% CI on rho</p>		<p>Test for Ho: rho = 0</p>
		<p>Two-sided CI</p>		<p>df</p>
		Lower	Upper	v
<p>ICC Estimates</p>				F =
<p>via MS</p>		<p>0.6940 0.9882</p>		45
<p>Via S&amp;W</p>		<p>x x</p>		45
<p>ICC(abs)</p>				F-value
<p>rho_abs</p>		<p>0.6421 0.9850</p>		p
<p>via S&amp;W</p>		<p>x x</p>		47
				0.6940
				0.025
				0.529

# ICC EXCEL WORKSHEET OUTPUT: RECALL QUADRANT

## ICC raters

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7
ni	7	$m_i$	1
nj	9	$n_{j\_star}$	9
$m_j$			
<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>
MSP	6252.013	P	88.322
MSi:p	601.614	I:P	62.784
MSj	1388.132	J	36.156
MSpj	122.657	PJ	12.300
MS_res	36.556	Res	36.556
		Rel	111.640
		Abs	147.797
		P	88.322
		I:P	8.969
		J	36.156
		PJ	12.300
		Res	5.222
		Rel	26.492
		Abs	62.648
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>			
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	

## ICC test

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7
ni	7	$m_i$	1
nj	9	$n_{j\_star}$	9
$m_j$			
<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>
MSP	6252.013	P	88.322
MSi:p	601.614	I:P	62.784
MSj	1388.132	J	36.156
MSpj	122.657	PJ	12.300
MS_res	36.556	Res	36.556
		Rel	111.640
		Abs	147.797
		P	88.322
		I:P	8.969
		J	4.017
		PJ	1.367
		Res	0.580
		Rel	10.916
		Abs	14.933
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>			
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	
		<p><b>One-sided CI</b></p>	
		<p><b>Test for Ho: rho = 0</b></p>	
		<p><b>Enter value of rho_0 here--&gt;</b></p>	

# ICC EXCEL WORKSHEET OUTPUT: PLAN QUADRANT

## ICC raters

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>			
np	5	$n_{i\_star}$	7	$m_i$	1
ni	7	$n_{j\_star}$	1	$m_j$	9
nj	9				
<p>The mean squares and variance estimates from this design appear below</p>					
		<p><b>G-study variance estimates</b></p>		<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>	
MSp	2841.479	P	38.657	P	38.657 36.925
MSi:p	301.567	I:P	29.673	I:P	4.239 50.570
MSj	573.865	J	12.424	J	12.424 11.724
MSpj	139.025	PJ	14.930	PJ	14.930 11.401
MS_res	34.512	Res	34.512	Res	4.930 64.120
		Rel	79.115	Rel	24.100 126.0918
		Abs	91.539	Abs	36.524 137.8153
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>					
		<p>95% CI on rho</p>			<p>Test for Ho: rho = 0</p>
<p>ICC Estimates</p>		<p>Two-sided CI</p>		<p>One-sided CI</p>	
	ICC(rel)	Lower	Upper	Lower	
via MS	0.6160	0.2560	0.9391	0.3166	
Via S&W	0.6160	x	x		
	ICC(abs)				
rho_abs	0.5142	0.1777	0.9109	0.2278	
via S&W	0.5142	x	x		
					<p>df v F = 4 45 6.997 0.000</p> <p>F' = 4 45 6.997 0.000</p> <p>Enter value of rho_0 here--&gt; 0.2560</p> <p>df v F-value p</p> <p>F = 4 49 1.937 0.119</p> <p>F' = 4 37 0.694 0.601</p>

## ICC test

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>			
np	5	$n_{i\_star}$	7	$m_i$	1
ni	7	$n_{j\_star}$	9	$m_j$	1
nj	9				
<p>The mean squares and variance estimates from this design appear below</p>					
		<p><b>G-study variance estimates</b></p>		<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>	
MSp	2841.479	P	38.657	P	38.657 36.925
MSi:p	301.567	I:P	29.673	I:P	4.239 50.570
MSj	573.865	J	12.424	J	1.380 11.724
MSpj	139.025	PJ	14.930	PJ	1.659 11.401
MS_res	34.512	Res	34.512	Res	0.548 64.120
		Rel	79.115	Rel	6.446 126.0918
		Abs	91.539	Abs	7.826 137.8153
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>					
		<p>95% CI on rho</p>			<p>Test for Ho: rho = 0</p>
<p>ICC Estimates</p>		<p>Two-sided CI</p>		<p>One-sided CI</p>	
	ICC(rel)	Lower	Upper	Lower	
via MS	0.8571	0.5590	0.9830	0.6315	
Via S&W	0.8571	x	x		
	ICC(abs)				
rho_abs	0.8316	0.5145	0.9794	0.5879	
via S&W	0.8316	x	x		
					<p>df v F = 4 45 6.997 0.000</p> <p>F' = 4 45 6.997 0.000</p> <p>Enter value of rho_0 here--&gt; 0.5590</p> <p>df v F-value p</p> <p>F = 4 45 3.086 0.025</p> <p>F' = 4 50 0.845 0.504</p>

# ICC EXCEL WORKSHEET OUTPUT: PERFORM QUADRANT

## ICC raters

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7 $m_i$
ni	7	$n_{j\_star}$	1 $m_j$
nj	9		

<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>
MSP	6094.766	P	91.125
MSi:p	267.615	I:P	24.066
MSj	2194.903	J	58.790
MSPj	137.270	PJ	12.322
MS_res	51.019	Res	51.019
		Rel	87.407
		Abs	146.196

<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>			
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	<p><b>One-sided CI</b></p>
		<p>Lower</p>	<p>Upper</p>
via MS	ICC(rel) 0.7981	0.5260	0.9722
Via S&W	0.7981	x	x
		<p><b>ICC(abs)</b></p>	
rho_abs	0.5268	0.1904	0.9107
via S&W	0.5268	x	x

<p><b>Test for Ho: rho = 0</b></p>			
df	v	F-value	p
F =	4	42	17.223
F' =	4	42	17.223
<p>Enter value of rho_0 here--&gt;</p>			0.5260
df	v	F-value	p
F =	4	44	2.348
F' =	4	14	0.294

## ICC test

<p>The G-study design had samples of the following sizes</p>		<p>Enter here the number of items and judges you will average across to obtain scores for persons. The default values are 1 and 1, which is appropriate if the person scores of interest are the individual item scores by individual judges.</p>	
np	5	$n_{i\_star}$	7 $m_i$
ni	7	$n_{j\_star}$	1 $m_j$
nj	9		

<p>The mean squares and variance estimates from this design appear below</p>			
		<p><b>G-study variance estimates</b></p>	<p><b>Variance estimates adjusted for <math>n_i^*</math> and <math>n_j^*</math></b></p>
MSP	6094.766	P	91.125
MSi:p	267.615	I:P	24.066
MSj	2194.903	J	58.790
MSPj	137.270	PJ	12.322
MS_res	51.019	Res	51.019
		Rel	87.407
		Abs	146.196

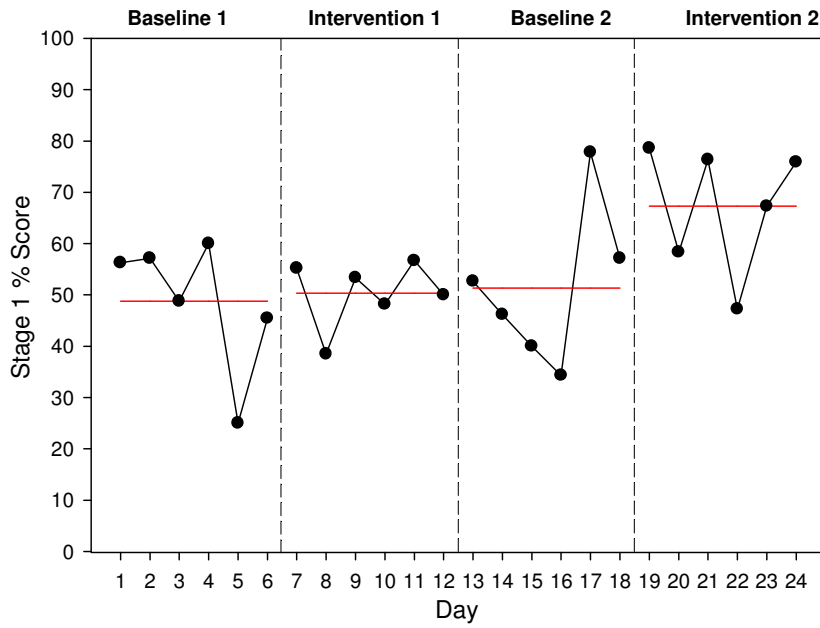
<p>The ICC estimates and F tests on rho_0 appear below. Enter values of rho_0 you wish to test.</p>			
		<p><b>95% CI on rho</b></p>	
		<p><b>Two-sided CI</b></p>	<p><b>One-sided CI</b></p>
		<p>Lower</p>	<p>Upper</p>
via MS	ICC(rel) 0.9419	0.8190	0.9931
Via S&W	0.9419	x	x
		<p><b>ICC(abs)</b></p>	
rho_abs	0.8824	0.6521	0.9854
via S&W	0.8824	x	x

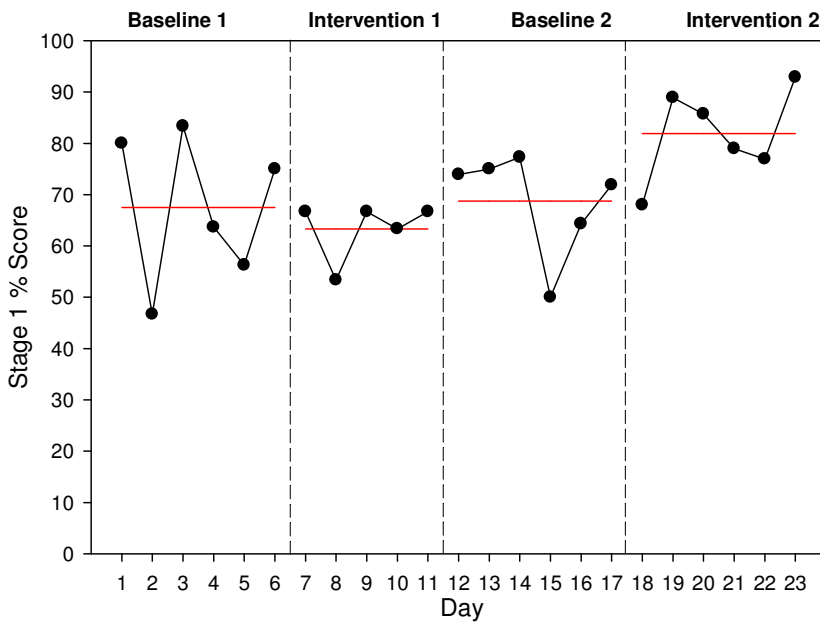
<p><b>Test for Ho: rho = 0</b></p>			
df	v	F-value	p
F =	4	42	17.223
F' =	4	42	17.223
<p>Enter value of rho_0 here--&gt;</p>			0.8190
df	v	F-value	p
F =	4	42	3.117
F' =	4	23	0.477



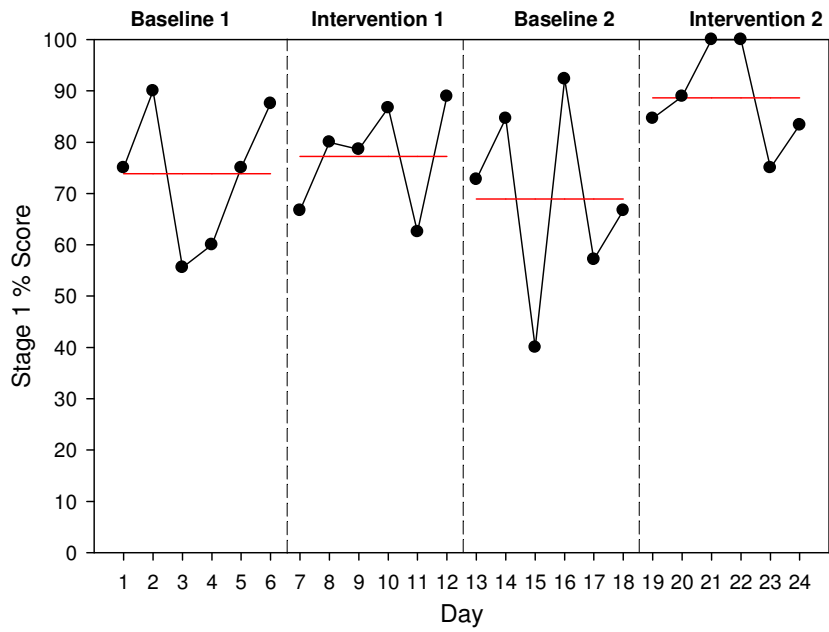
# **APPENDIX IV – PRPP SYSTEM OF TASK ANALYSIS STAGE 1 RESULTS**



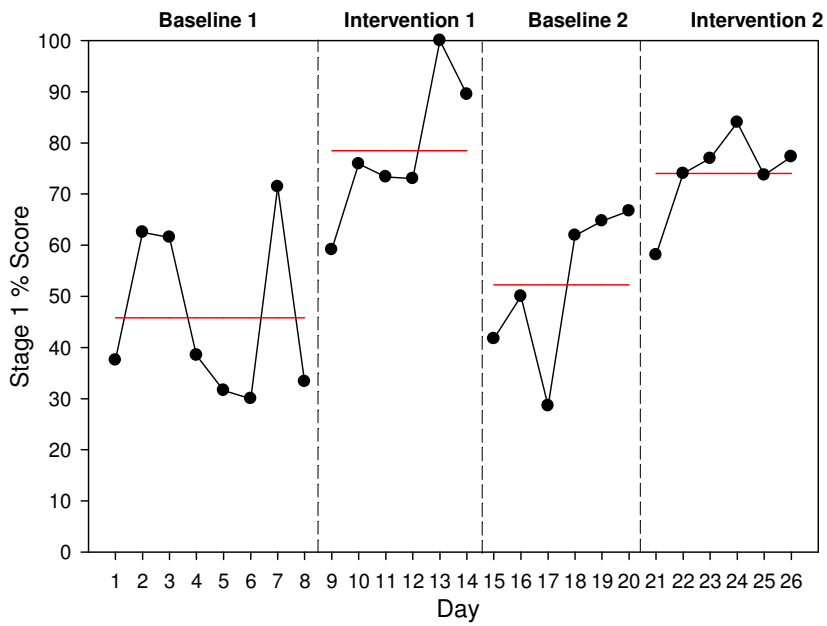
**Subject 1**



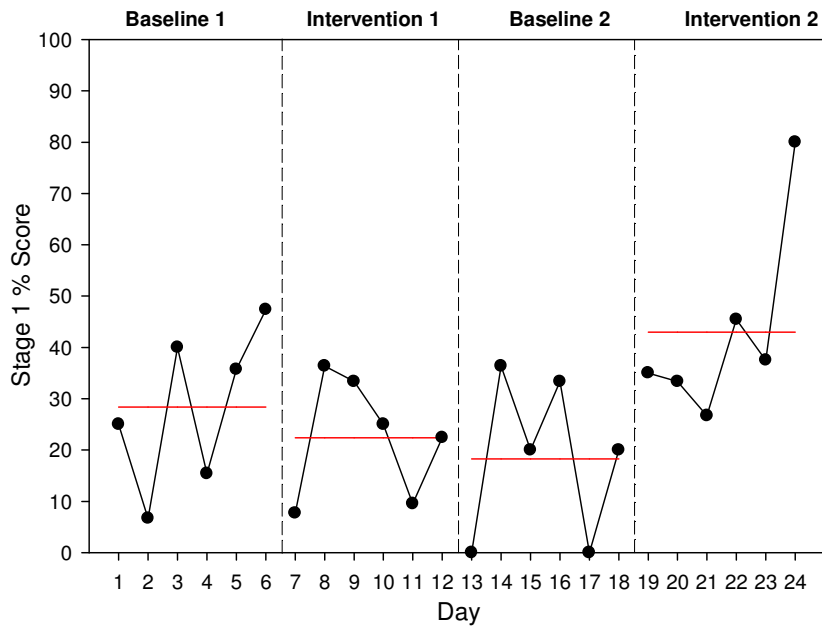
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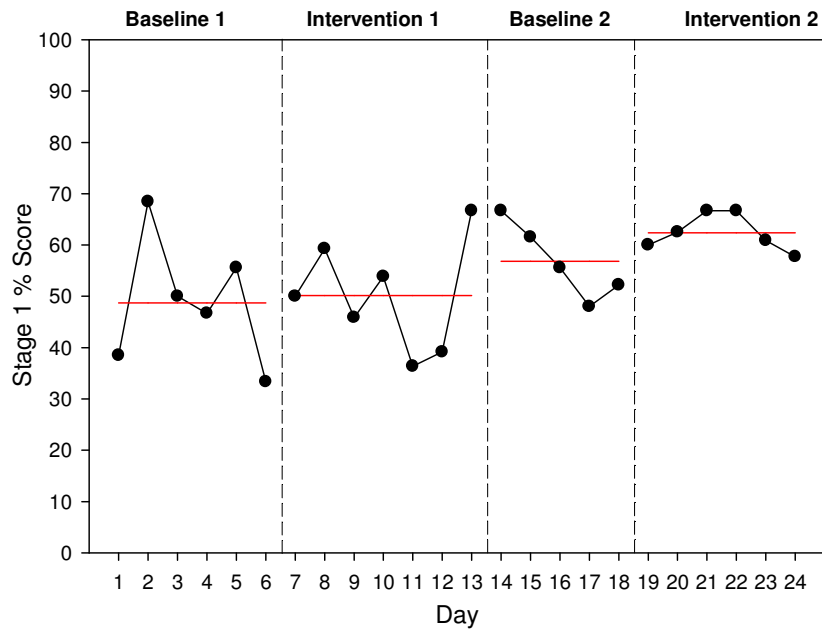
**Subject 3**



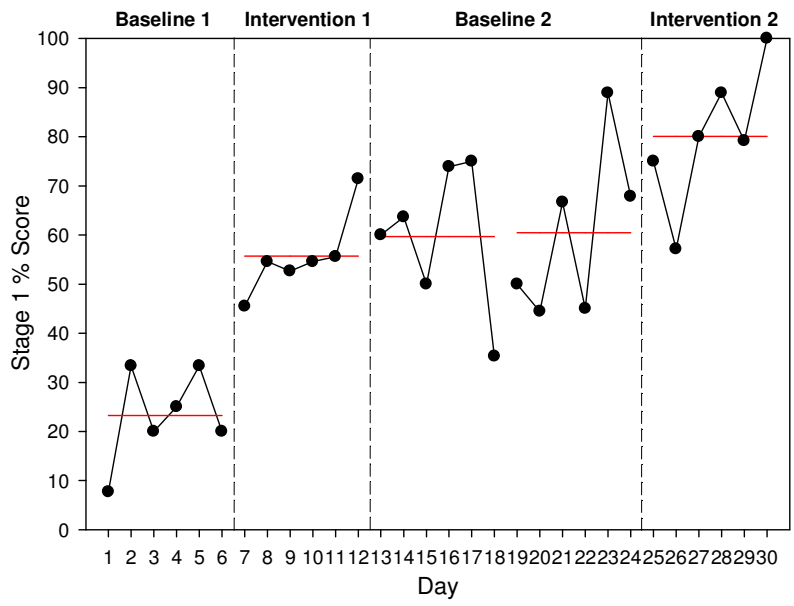
**Subject 4**



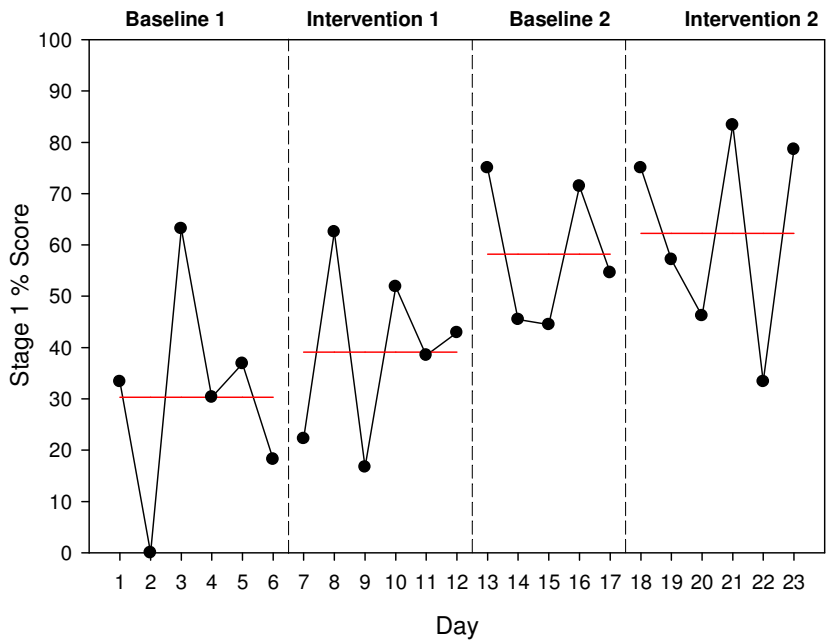
**Subject 5**



**Subject 6**



**Subject 7**



**Subject 8**