

**DEVELOPMENT OF A SIMPLIFIED VERSION OF THE MULTIPLE
ERRANDS TEST FOR USE ON A HOSPITAL WARD**

**Thesis submitted for the degree of
Doctorate in Clinical Psychology
University of Leicester**

Elisabeth Anne Pennington

**June 2006
(Minor Amendments Completed)**

UMI Number: U493032

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



UMI U493032

Published by ProQuest LLC 2013. Copyright in the Dissertation held by the Author.
Microform Edition © ProQuest LLC.

All rights reserved. This work is protected against
unauthorized copying under Title 17, United States Code.



ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346



**University of
Leicester**

**School of Psychology
Clinical Section**

104 Regent Road
Leicester LE1 7LT · UK
Tel: +44 (0) 116 223 1639
Fax: +44 (0) 116 223 1650

DECLARATION

I hereby declare that the research reported in this thesis is my own work unless otherwise stated. No part of it has been submitted for either a qualification at another institution or as a publication to a journal.

**Elisabeth Pennington
June 2006**

ABSTRACT

DEVELOPMENT OF A SIMPLIFIED VERSION OF THE MULTIPLE ERRANDS TEST FOR USE ON A HOSPITAL WARD

Elisabeth A. Pennington

Literature Review

Problems with executive functioning may have catastrophic consequences following brain injury. Assessment of these complex functions is critical in planning necessary interventions, yet they present a challenge to traditional methodologies. The review considered the issues that comprise this challenge, and the increasingly important role that ecologically valid measures play in neuropsychological assessment is highlighted.

Research Report

Shallice and Burgess (1991) described the Multiple Errands Test (MET), which successfully reflected executive impairments manifest in the context of everyday functioning. Surprisingly, the methodology has been relatively underexploited for use in clinical settings. In the present study the utility of a simplified MET designed for use on a hospital ward was explored. The measure was designed to be appropriate for patients who are unable to undergo assessment in public settings, and suitable for use with patients who are in the early stages of recovery.

Twenty four healthy participants and 21 people with acquired brain injury took part. The main findings were as follows: 1) the test discriminated well between neurological patients and controls, and the group effects remained when the difference in current general cognitive function and familiarity with the environment were considered; 2) test performance was found to be strongly associated with performance on an established ecologically valid measure of executive function; and 3) preliminary findings indicated that two patterns of error making style were associated with different dysexecutive symptoms in everyday life.

The results demonstrated the clinical utility of the ward version of the MET – with the advantage to clinicians in its brevity and sensitivity, whilst capturing aspects of everyday executive difficulties that are not readily accessible from many psychometric measures.

Critical Appraisal

Reflections on the research process including: the development of the test, conducting the study, problem resolution and a summary of the learning experiences.

Acknowledgements

I would primarily like to thank Nick Alderman for his support, commitment, and enthusiasm in supervising the work that went into this thesis. His unerring sense of humour, especially his ability to make me chuckle at my multiple prophecies of doom, is priceless. I would also like to thank my academic supervisor Mike Hopley for his advice, guidance and calming words. I am also grateful to the participants of the study for their time and interest in the research, and without whom this work could not have come to fruition.

On a personal level, I am indebted to Kara, Helen and Jo who worked tirelessly to help me gather the data, and whose regular application of coffee breaks and gossips reminded me that there was life outside the thesis. I would also like to thank the assistant psychologists at Kemsley Division for giving me their time, help and advice. Thanks also to Sharon for her regular pep talks and her ability to make even the direst situations seem amusing.

To my fiancé Jason – well it happened and the world is still spinning! Thank you so much for your care and support, and your enviable ability to bring together calmness and craziness into perfect harmony. To Sarah, well as I said before – you are a fantastic friend.

To my parents – thank you for everything. To Mum, as always, thank you for your sound advice and emotional support. To Dad, thank you for listening and sharing your views on this work. I dedicate this thesis to both of you.

Word Count

Abstract		298
Section 1:	Literature Review	8026
Section 2:	Research Report	11336
Section 3:	Critical Appraisal	3353
Total:	Excluding references and appendices	22715
	Including references and appendices	33309

Target Journal:
Neuropsychological Rehabilitation

Thesis Structure:
The Literature Review, Research Report and Critical Appraisal are self-contained sections, which have been written in accordance with the guidelines stipulated in the DClinPsy Coursework Guidelines and Assessment Regulations.

Contents

	Page
Declaration	ii
Abstract for Thesis	iii
Acknowledgements	iv
Word Count	v
Table of Contents	vi
List of Tables	ix
List of Figures	ix

Table of Contents

	Page
Section 1 Literature Review	1
Assessment of Executive Functioning Following Acquired Brain Injury: A Review	
Abstract	2
1. Introduction	3
2. Literature Search	5
3. The Nature of Executive Function	5
3.1. Aetiology of Impairments to Executive Function	5
3.2. Towards a Definition of Executive Function	6
3.3. What is “executive function”? : Classic clinical cases and recent advances	7
3.4. Formulation of Executive Function	8
3.5. Summary and Critique	14
4. Assessment of Executive Function	15
4.1. Problems with Traditional Tests of Executive Function	16
4.2. Factors Underlying the Difficulties with Traditional Tests of Executive Function	19
4.3. Summary	25
5. Ecologically Valid Measurement of Executive Function	26
5.1. Verisimilitude and Veridicality	27
5.2. Verisimilitude, Veridicality and Assessment of Executive Function	28
5.3. Future Directions: Ensuring the Reality of Ecological Validity	32
6. Summary and Conclusion	33
References	35
 Section 2 Research Report	 45
Development of a Simplified Version of the Multiple Errands Test for Use on a Hospital Ward	
Abstract	46
1. Introduction	47
1.1. Executive Dysfunction and the Challenge of Assessment	47
1.2. A Solution to the Problem?	48
1.3. Testing in the Real World	50
1.4. Application of the Multiple Errands Test to the Ward Environment	51
1.5. Research Questions	53

2.	Method	54
2.1.	Rationale and Design	54
2.2.	Participants	55
2.3.	Measures	60
2.4.	Ward Version of the Multiple Errands Test (MET-WV)	64
3.	Results	69
3.1.	Inter-Rater Reliability	69
3.2.	Comparison between brain injured and control participants' MET performance	70
3.3.	Effects of other variables on the MET-WV	74
3.4.	Validity	79
4.	Discussion	83
4.1.	Is the MET-WV sensitive to impairments in cognitive function?	84
4.2.	How does the MET-WV compare with other tests of executive function?	87
4.3.	Is the MET-WV a good predictor of behaviours that are symptomatic of impaired executive function observed in everyday life?	88
5.	Critique	89
5.1	Strengths of the Study	89
5.2.	Limitations of the Study	90
6.	Conclusion	91
	References	93
	Section 3 Critical Appraisal	101
1.	Origins	102
2.	Development of the Ward Version of the Multiple Errands Test	103
2.1.	Task Development	103
2.2.	Establishing the Rules	104
2.3.	Selecting the Measures	105
3.	Peer Review and Ethical Approval	106
4.	Conducting the Research	107
4.1.	Organisation and Competing Demands	108
4.2.	Participant Recruitment	109
4.3.	Data Collection	111
4.4.	Data Analysis	112
5.	General Reflections	112
6.	Summary	113
	References	115
	Appendices	116
Appendix 1	Research Administration	116
1.1.	Copy of notes for contributors to "Neuropsychological Rehabilitation"	117
1.2.	Copies of Letters of Ethical Approval	120
1.3.	Details of the Recruitment Process	123
1.4.	Patient Information Sheet	124
1.5.	Patient Consent Form	129
1.6.	Information Sheet (neurologically healthy control group)	130

	1.7. Consent Form (neurologically healthy control group)	132
Appendix 2	Neuropsychological and Psychometric Measures	133
	2.1 Background Measures	134
	2.2. Questionnaires	136
	2.3. Measures of Executive Function	141
Appendix 3	Pilot and Materials for the MET-WV	144
	3.1. Piloting the MET-WV	145
	3.2. MET-WV Exercise Sheet	147
	3.3. MET-WV Instructions for Participants	148
	3.4. (Cued) Recall for the MET-WV (Response Sheet)	149
	3.5. Participant Self-Rating Scales	150
Appendix 4	Raw Data (Patients Only)	151
	4.1. BADS and MET-WV Error Scores	152
	4.2. DEX-O Total Scores and DEX Symptom Cluster Scores	153

List of Tables

Table 1.	Details of Brain Injury, Age, Gender and Levels of General Ability (Pre-morbid and Current)	58
Table 2.	MET-WV Performance Among Control and Brain Injured Participants	72

List of Figures

Figure 1.	Hierarchy of brain functions (adapted from Stuss and Benson, 1986)	11
-----------	--	----

SECTION 1

LITERATURE REVIEW

ASSESSMENT OF EXECUTIVE FUNCTIONING FOLLOWING ACQUIRED BRAIN INJURY: A REVIEW

Abstract

Executive dysfunction is a frequent outcome of acquired brain injury. Disruption to this capacity is regarded as substantially contributing to the loss of independence, and interpersonal difficulties experienced by individuals living with brain injury. Appropriate assessment of these complex functions is critical in planning necessary interventions, yet they present a challenge to traditional methodologies. The review considered the issues that comprise this challenge

Numerous models have attempted to capture the mechanism of executive functioning, yet even agreement upon a definition of “executive function” has proved contentious. Conceptual issues aside, existing neuropsychological measures frequently fail to adequately reflect the executive impairments that hamper individuals’ everyday function. However, ecological validity has become an increasingly important focus in general neuropsychological assessment, and its application to measurement of executive function appears particularly fruitful in view of this capacity’s role in coordinating cognition and behaviour with real-world demands. Ecologically valid measures of executive functioning have been found to alleviate some of the difficulties inherent in traditional measures, and potentially provide a seamless link with rehabilitation.

1. Introduction

Acquired cognitive deficits can result from a variety of neurological causes, including traumatic brain injury (TBI), progressive neurological diseases, and vascular events. Whilst the occurrence of stroke is more commonly associated with middle adulthood and dementia with older age (Eslinger, 2002), TBI is a disorder frequently seen in young adults - with males at greatest risk of sustaining injuries (National Institute for Clinical Excellence, 2003). In the advent of medical advances, there is currently a growing population of individuals living with acquired functional deficits as a result of neurological disease or injury.

Cognitive, emotional and behavioural disturbance are common sequelae to brain injury (Select Committee on Health, 2001). The unravelling of intimate, social, and work relationships that follow in the wake of cognitive and “personality” changes, frequently leads to the social isolation of the individual and their family or carers (Donnelly, Donnelly, & Grohman, 2000; Oddy & Herbert, 2003). In order to convey the impact of this upheaval, clinicians have coined the term the “ripple effect” to describe the far reaching consequences of brain injury (Lapotaire, 2003). In a move to address the problem, the Department of Health has developed the *National Service Framework for Long-Term Conditions* (Department of Health, 2005), and a number of clinical guidelines and standards have emerged to compliment this framework.

Underpinning the development of the national clinical guidelines for *Rehabilitation Following Acquired Brain Injury* (Royal College of Physicians & British Society of Rehabilitation Medicine, 2003) is the recognition of the effectiveness and cost benefits of early rehabilitation, accompanied by long-term continued support for patients and their families. The principal themes of the

guidelines include the early identification of individuals who are in need of rehabilitation, and individually-tailored goal-oriented rehabilitation programs that take into account the patient's views, cultural background and pre-morbid lifestyle. Clearly, neuropsychological assessment will play a key role in accomplishing these aims. However, as will be elucidated in the current review, there is a need to develop assessment tools that are not only able to quantify deficits, but also able to predict everyday functioning in real-world settings.

Assessment of executive function is a concern for clinicians because disruption to this capacity is a frequent consequence of traumatic brain injury (Kinsella, 1998; Levine, Katz, Dade, & Black, 2002; Schnider & Gutbrod, 1999), and can be regarded as substantially contributing to the loss of independence and interpersonal difficulties experienced by individuals living with brain injury (Cripe, 1996; Gioia & Isquith, 2004; Kinsella, 1998). The conceptual and methodological issues related to the development of valid and reliable methods for assessing executive function are the basis for this review. However, the theoretical structure of executive function is a contentious issue, and this poses a significant challenge to developments in neuropsychological methodology (Burgess, 1997). The review begins by considering the types of problems encountered by individuals exhibiting “executive” difficulties, and the theoretical interpretations that have emerged to account for these deficits.

2. Literature Search

The literature search was conducted using PSYCHINFO and PUBMED¹ databases. An initial search used combinations of the terms “traumatic brain injury” “implications” and “rehabilitation”. The focus of the search was then narrowed using the terms “executive function”, “frontal lobe”, and “assessment”. The selection of models of executive function was limited to those that under-pinned the rationale and structure of the majority of clinical measures of executive functioning. Information concerning these models was derived from textbooks of clinical neuropsychology, which also provided references to seminal articles.

3. The Nature of Executive Function

3.1. Aetiology of Impairments to Executive Function

Damage to the frontal lobes of the brain is frequently found in the brain injured population; it is large region - representing more than 20% of the human neocortex (Kaufer & Lewis, 1999; Kolb & Whishaw, 1995), therefore events leading to cerebral damage have a high chance of impacting upon this area (Schnider & Gutbrod, 1999). Damage to the frontal lobes can cause massive disruption to an individual's ability to perform everyday activities, even in cases where neuropsychological assessment indicates minimal damage to motor, sensory and gross cognitive functioning (Cripe, 1996; Eslinger & Damasio, 1985).

Changes in behaviour, personality, social and emotional functioning typically follows injury to the frontal area (Kolb & Whishaw, 1995, Lezak, 1995). These changes are often regarded as the outcome of disruption to “executive functioning”,

¹ PSYCHINFO and PUBMED are two major psychological and medical databases provided by American Psychological Association and the National Library of Medicine, respectively. The databases comprise an integrated, text-based search and retrieval system, which provide access to citations in the psychological and medical literature. Access is achieved using the internet and the following web addresses: <http://www.apa.org/psycinfo/> and www.ncbi.nlm.nih.gov/entrez/query.fcgi.

and are commonly associated with: loss of employment and financial instability (Eslinger & Damasio, 1986), disrupted interpersonal relationships and loneliness (Kinsella, Ford, & Moran, 1989; Saver & Damasio, 1991), memory difficulties (Shimamura, 1995) and have been found to interfere with rehabilitation (Bajo & Fleminger, 2002).

In much of the literature concerning executive function, frontal lobe damage is implicated. However, impairment of executive function may also be associated with a variety of subcortical disorders such as Parkinson's Disease and Huntington's disease (Lezak, 1995; Sbordone, 2000). Various psychiatric disorders have also been found to affect executive function - for example, alcoholism, depression, obsessive-compulsive disorder and schizophrenia - as a result of either lesions in the frontal-subcortical circuits or alterations in the metabolic activity of the circuits (Sbordone, 2000).

3.2. Towards a Definition of Executive Function

Numerous definitions of executive function exist in the literature, with varying degrees of overlap. Indeed, the term appears to be used as a convenient shorthand for a wide set of behavioural competencies that include planning, sequencing, co-ordination of simultaneous activity, cognitive flexibility, working memory, self-monitoring and self-regulation. Due to the diversity of the executive function constructs, it is perhaps unsurprising that the term is becoming too encompassing, and could run the risk of losing utility as a concept in neuropsychological assessment (Knight, 1999).

A major problem in conceptualising executive function has been the inconsistent and interchangeable use of both psychological and anatomical

definitions of executive and frontal functions – yet the relationship between “executive” functions to “frontal lobe” functions is still not clear (Stuss & Alexander, 2000). To clarify, the behaviours that are attributed to impairment of executive function are not exclusively found following damage to the frontal lobes, although the constant association between executive and frontal functions suggests some kind of relationship (Stuss & Alexander, 2000; Stuss & Benson, 1984). To avoid the potentially misleading specification in terms of localisation, Baddeley (1986) suggested the term “dysexecutive syndrome”, which is in keeping with the *functional* definitions used for the majority of cognitive disorders, for example “perceptual deficits” rather than “occipital lobe deficits” (Baddeley & Wilson, 1988). The use of the functional terminology also prevents a restriction of executive function research purely to anatomical location, and therefore allows for a broader understanding of the cognitive phenomena.

3.3. *What is “executive function”? : Classic clinical cases and recent advances*

Certain features are highly characteristic in the breakdown of executive functioning. A classic example is the case of a railroad worker, Phineas Gage, who sustained injuries to the left frontal lobe following an accidental explosion that sent a tamping iron through his skull. Gage was described as:

“impatient of restraint when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operations, which are no sooner arranged that they are abandoned in turn for others appearing more feasible” (Harlow, 1868 cited in Macmillan, 1996 p.247).

There are clear parallels between the account of Gage and a later description of a patient with frontal lesions who displayed: “disturbed attention, increased distractibility, a difficulty in grasping the whole of a complicated state of affairs...well able to work along routine lines (but) cannot learn to master new types of task” (Rylander, 1939, p.22). More recently, a number of studies have highlighted a similar set of difficulties that include problems with initiation, inability to monitor performance, and difficulty using feedback from the environment to monitor behaviour effectively - which have become the hallmarks of executive difficulties/dysexecutive syndrome (Alderman, Burgess, Knight & Henman, 2003; Alderman & Ward, 1991; Knight, Alderman & Burgess, 2002). Overall, it has been generally agreed that executive function can be defined as a collection of related yet distinct abilities that provide for intentional, goal-directed activity (Gioia & Isquith, 2004; Lezak, 1995).

3.4. Formulation of Executive Function

The theories of executive function are too numerous and complex to review completely in this forum. For brevity, the descriptions below are limited to a selection of theoretical perspectives that provide a more operational definition of executive function and its breakdown following brain injury; these perspectives also serve as the theoretical underpinnings to the clinical measures of executive functioning described later in this review.

A number of theories have attempted to account for aspects of executive phenomena, such as planning and problem-solving (e.g. Sgaramella, Bisiacchi & Zettin, 1997), control of action (e.g. Duncan, 1986), emotional regulation (e.g. Eslinger & Damasio, 1985). Despite subtle differences, there are striking

commonalities among these theoretical perspectives; namely the regulation of behaviour through the correspondence of actions and their intended effects, and the role of error detection and utilisation in adaptive behaviour (Cicerone, 2002; Osmon, 1999). In essence, the theories pertain to a higher order system that orchestrates mental functions, where the executive functions comprise the management of the system and are pivotal in the planning, organisation, direction and control of mental resources. In this way, executive functioning can be regarded as process-oriented (involving how things get done) as well as outcome-oriented (what gets done) (Cripe, 1996).

3.4.1 Cognitive Neuropsychology: Theories of Executive Function

Based on the combination of clinical/anatomical observations and neuropsychological tests, explanations of frontal lobe function have attempted to conceptualise executive function within a cognitive neuropsychological framework. Historically, the frontal lobes have been regarded as the seat of executive activities, with early behavioural-anatomical theories proposing a basic posterior/anterior division, where the posterior portions of the cerebral hemispheres specialised in sensory reception and analysis, and the anterior parts of the brain, specifically the frontal lobes, carried out the motor executive activities (Stuss & Benson, 1986). Advances on this early view, proposed a specific role for the prefrontal cortex in the overall mental function.

Verbal Self-Regulation (Luria, 1966; 1981).

Luria (1966) proposed that damage to the prefrontal region of the cortex disrupts the conscious volitional self-regulation of behaviour, whilst leaving intact or

even enhancing the more primitive or reflexive forms of behaviour. His theory emerged from qualitative analysis of the verbal protocols of patients with prefrontal lesions attempting to solve multi-step problems. The patients' responses were frequently impulsive and lacked intentionality (characterised by failures to adjust inappropriate strategies), accompanied by deficient self monitoring and verification of behaviour (deficiencies in matching actions to original intention). According to Luria (1966; 1981), the formulation of an internalised plan of action and the subsequent regulation of behaviour, is achieved through verbal mediation of activity using self-directed "inner speech". Whilst being distinct from communicative speech, "inner speech" acquires its planning and self-regulatory role through progressive speech internalisation during development.

Behavioural/Anatomical Theory (Stuss & Benson, 1986).

Stuss and Benson (1986) proposed further subdivision of frontal lobe functions. In-line with the notion of the anterior/posterior functional systems approach, they formulated a hierarchy of brain function with the frontal brain systems associated with the highest levels (see Figure 1.).

According to Stuss and Benson (1986) executive function represents an independent level of frontal function, situated at the top of the hierarchy of frontal functions and is involved in the *conscious* direction of frontal activities.² Effectively, the executive processes enable anticipation, goal articulation and plan formation in

² Within the anterior system, the authors divided the functions into two groups, whose anatomical base lay with the caudal regions of the frontal lobes and with intimate links to the other, more posterior-based functional systems. One group of functions was concerned with sequencing behaviours, forming mental set and integration; and the other with more primitive processes - drive, motivation and will. Essentially, these functions allow the individual to interact actively and intentionally with the world through controlled action, and by handling multiple pieces of information and integrating the data with other information to form novel or meaningful interpretations.

non-routine (novel) situations. In addition, the authors proposed that executive function is subordinate to self-consciousness and self-awareness – effectively providing an anatomical basis (i.e. prefrontal cortex) for the link between the multi-integrated response mechanisms of the brain and the free-will of the “mind”.

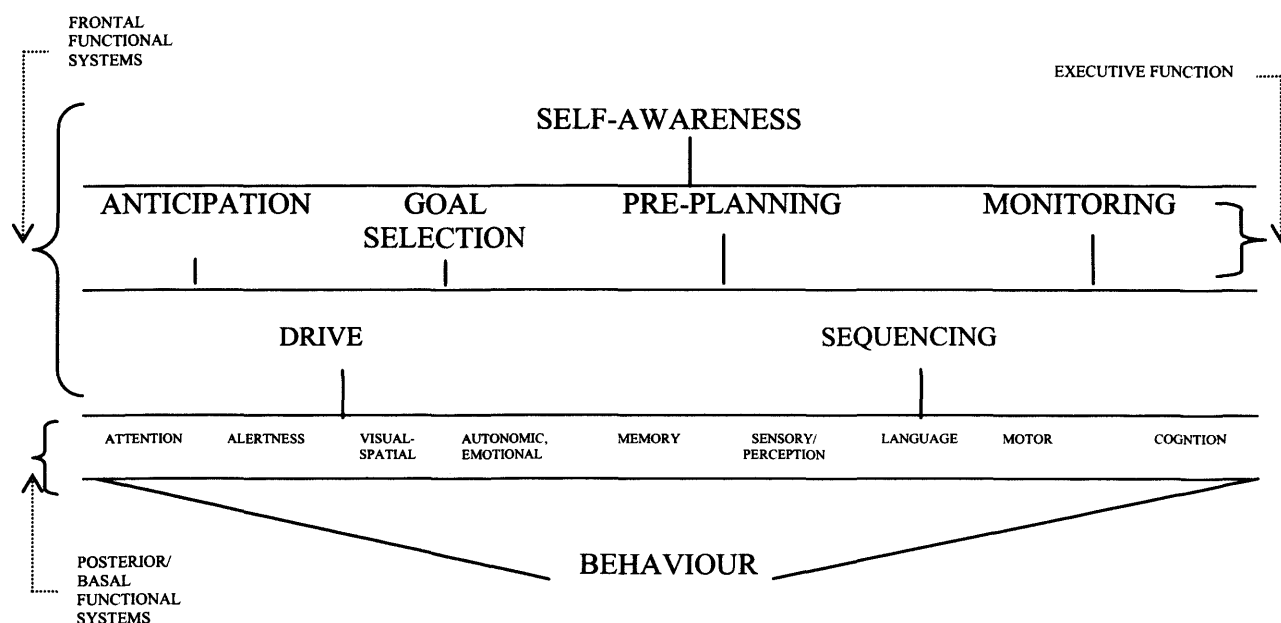


Figure 1. Hierarchy of brain functions (adapted from Stuss & Benson, 1986)

3.4.2. Cognitive Psychology: Theories of Executive Function

Whilst the neuropsychological theories capture executive function neatly at an intuitive level, the explanations fail to address how such mechanism work beyond the description of the architecture. However, purely psychological theories, such as the Working Memory model (Baddeley, 1986) and the Supervisory System (Norman & Shallice, 1986) have attempted to redress the balance.

Central Executive in the Working Memory Model (Baddeley, 1986).

Baddeley and Hitch (1974) defined working memory as a process for temporarily holding and manipulating information during the performance of other cognitive functions, such as language comprehension or problem solving. In the model, separate “slave” systems are responsible for the storage of verbal and non-verbal information, whilst attentional resources are regulated by a central executive system (CES). With increasing task complexity, increased demand is placed on the CES, which must allocate its attentional capacity so that multiple pieces of information can be managed at once. Accordingly, deficits in the CES would manifest in problems with co-ordinating multiple tasks. Indeed, experimental studies utilising this notion (i.e. Dual-task paradigm) indicated that the allocation of resources is impaired in patients with frontal pathology and/or behaviourally assessed dysexecutive syndrome (Baddeley, Logie, Bressi, Della Sala & Spinnler, 1986; Baddeley, Della Sala, Papagno, & Spinnler, 1997; McDowell, Whyte, & D’Esposito, 1997).

Supervisory System (Norman & Shallice, 1986).

Executive functioning involves a range of different process, yet the working memory model has principally focused on one process - the capacity to perform two tasks simultaneously. However, Norman and Shallice (1986) described a model that provided a richer account of the control of action and interactions with the world.

Norman and Shallice couched the processes of programming, regulation, and verification of activity in terms of the operation of a supervisory (attentional³) system. The authors proposed that two levels of control over actions are possible: (i)

³ The use of the term *attention* in this theory is broad, and refers in a general sense to the allocation of processing resources (Shallice, 1988).

where prior learning enables actions to run off automatically, and (ii) deliberate conscious control through a supervisory-executive system.

In Norman and Shallice's model, the cognitive and behavioural processes comprising simple or well-learned acts, such as typing a word, are represented by a set of schemas which are habitually activated in response to over-learned environmental contingencies. Termed "contention scheduling", this mechanism allows for routine decisions to be carried out using simple rules (built into the system), which can be operated automatically. The second component of the model, the supervisory attentional system (SAS) captures will or voluntary control of action - enabling the management of novel or complex tasks. This system allows for the interruption and modification of routine action when planning and correction of unexpected errors are required, or when the appropriate responses are novel or not well learned. Essentially, the SAS operates through the activation or inhibition of schemas to bias their selection by the contention-scheduling mechanisms, allowing for control of action during non-routine tasks.

In order to address the issue of biological plausibility, Norman and Shallice (1986) proposed that the SAS corresponds closely to the conscious volitional control of action that Luria (1966) had ascribed to the prefrontal regions of the brain. Norman and Shallice argued that impaired executive function seen in frontal patients arose from impairments in the SAS. Here, disruption to the SAS means that action is determined solely by contention scheduling, and therefore bound by triggering stimuli within the environment. As a result, the behaviour is likely to be punctuated with perseveration, impulsivity and distractibility when the individual is faced with novel or complex tasks – which are characteristic of patients with frontal lesions.

3.5. *Summary and Critique*

Numerous models have attempted to capture executive functioning, frequently under the auspices of frontal lobe function. However, the theories appear to lack specific explanations of how executive function operates. For example, little explanation is offered about the interaction of the processes that constitute planning and organisation of mental activity, or how the constant rapid automatic processing that allows tasks to be guided and organised is orchestrated. Indeed, one of the key flaws of the neuropsychological theories is the assumption that complex (i.e. non-routine/novel) and simple tasks (routine) are managed by the anterior and posterior regions of the brain respectively. Stated differently, apparently simple processes related to the frontal lobes have been identified (Stuss & Alexander, 2000). Setting aside the anatomical difficulties, even the functions of the Supervisory System (Norman & Shallice, 1986) are essentially apaphatical – i.e. negatively defined. To clarify, there is no specification of how the Supervisory System operates, other than that it carries out the processes that are not available to contention scheduling (Shallice, 2002).

Nevertheless, a number of attempts have been made to address the lack of specificity in such models. Modification of Stuss and Benson's (1986) behavioural/anatomical theory introduced the concept of feedback control systems for each of the components comprising the hierarchy of brain function (Stuss, 1991). Here, the feedback control system enables current or stored experience to determine the output response of each level, effectively creating a chain of "top-down" responses. Equally, Shallice and Burgess (1996), in a revision of the Supervisory System model, included a set of procedures that activate selective schema in a manner that captures insight, problem-solving and the use of prior intentions. In

addition, Stuss, Shallice, Alexander and Picton (1995) described a schema as a network of connected neurons that can be activated by sensory input, by other schemata, or by executive control – in essence, capturing the abstract concept of “schema” within a biologically plausible framework.

Nevertheless, the revisions although intuitively plausible, still appear ad hoc – although it has to be appreciated that effectively capturing, in many respects, the essence of “humanness” – (i.e. where interactions with the environment are determined by such abstract concepts as beliefs, desires and intentions), could never be a simple task. Whilst these models provide the beginnings of an understanding, it is clear that further research on assessment of executive functioning is needed before an adequate biopsychosocial model of executive functioning can be conceptualised.

4. Assessment of Executive Function

There are numerous ways to assess executive function clinically. The two main criteria appear to be that the tasks place non-routine demands on the participant, and the tasks are complex; this follows from the theoretical conception of executive function as a process or set of processes intimately involved in adaptation to novel situations through volitional/conscious modulation and control of routine cognitive skills.

Standardised assessments of executive function have traditionally involved tests such as the Wisconsin Card Sorting Test (WCST), Halstead Category Test, Stroop Test, Verbal Fluency, Trail Making Test, Rey Complex Figure Test, and Towers of Hanoi/London/Toronto (Boone, 1999; Lezak, 1995; Sbordone, 2000). Conventionally, the validity of these tests has been established through studies of lesions to the frontal lobes, and more recently through functional imaging

techniques. However there are considerable difficulties with the use of these measures, not least because of the problems in conceptualising executive function or the localisation of these functions within the brain.

4.1. Problems with Traditional Tests of Executive Function

4.1.1. Validity: Specificity and Sensitivity

In the literature on executive function, specificity and sensitivity of tasks have typically been defined by whether the tests indicate frontal lobe damage or activity. Specificity refers to the ability of the test to distinguish one area of damage (or illness) from another, and sensitivity refers to the ability to detect impairments in cognitive function (culminating in various hypotheses regarding the site of the lesion).

Whilst there is evidence that the traditional measures can detect damage to the frontal regions, they are quite clumsy in distinguishing between frontal lesions and those cited in other areas of the cerebral cortex. The Wisconsin Card Sorting Test, widely considered to be the “gold standard” for detecting frontal damage and executive dysfunction, has been found to be affected by damage to non-frontal regions (Anderson, Bigler, & Blatter, 1995; Anderson, Damasio, Jones, & Tranel, 1991; Bigler, 1988). Equally, other traditional measures - the Stroop Test, Trail Making Test and Halstead Category Test - have been found to be less than adequate in distinguishing specific frontal lobe dysfunction (e.g. Anderson et al., 1995; Reitan & Wolfson, 1995; Wildgruber, Kischka, Fassbender, & Ettlin, 2000).

With respect to sensitivity, many of the frontal tests have been found to be unreliable in detecting subtle impairments in cognitive function. There have been a number of cases reported where patients with damage to the frontal regions have

performed within normal limits on frontal measures (e.g. Eslinger & Damasio, 1985; Saver & Damasio, 1991; Shallice & Burgess, 1991). However, several measures appear more sensitive than specific to frontal damage, such as Verbal fluency and the Porteus Maze test, although patients will not typically show deficits on all of them (Stuss & Benson, 1984).

4.1.2 Poor Prediction of Everyday Functioning

In terms of construct validity, standardised assessments have been found to be unreliable predictors of the everyday difficulties arising from disruption to executive function (Cripe, 1996; Gioia & Isquith, 2004; Wilson, 1993). There have been a number of clinical cases reported where there is an obvious disparity between gross disturbance in the performance of everyday activities and test scores that are suggestive of only minor cognitive impairments (e.g. Cripe, 1996; Eslinger & Damasio, 1985; Shallice & Burgess, 1991).

Eslinger and Damasio (1985) reported the case of patient EVR, who despite massive frontal orbital and mesial lesions, performed well on a range of neuropsychological measures, including traditional frontal tests. Nevertheless, EVR was grossly impaired in his ability to organise his life. He was unable to meet professional and personal responsibilities – being dismissed from a series of jobs for tardiness and disorganisation, and two marriages disintegrated for similar reasons. He prevaricated over simple decisions, such as deciding which restaurant to dine in – deriving multiple (tangential) plans to assist in the process, but failing to exact a choice. Given such a classic set of characteristics of executive dysfunction, it is rather problematic that measures of executive function, used so widely in neuropsychological assessments, failed to indicate such impairments.

The mismatch between test performance and real-life difficulties appears to be rooted in the implicit assumption that performance on the tests is representative of the function of specific executive processes necessary for the individual to manage real-life situations, such as the ability to shift response set gauged by the WCST. However, the empirical validity of this assumption has been rarely examined, and where it has, the relationship between test performance and real-life is not so clearly defined (Burgess, Alderman, Evans, Emslie, & Wilson, 1998).

4.1.3 Reliability and Validity

The quality of the tests of frontal function has also been questioned by the scientific literature. A study of a non-patient sample indicated that the WCST and Verbal Fluency test have poor and moderate re-test reliability, respectively (Bird, Papadopoulou, Ricciardelli, Rossor, & Cipolotti, 2004), although others are more optimistic about the temporal stability of the WCST (Ingram, Greve, Ingram, & Soukup, 1999). Nevertheless, Stuss and Alexander (2000) noted that at an individual level, variation in performance of TBI patients on repeated administrations of the same task could be an artefact of dysfunction to the frontal lobes, i.e. the ability to complete the task is intact, but the ability to sustain the top-down effort required to complete the task is impaired. Whilst this is a reflection of the impact of the brain damage rather than the structure of the tests per se, it still remains that such variability could confound experimental studies of frontal lobe function, and of more concern to neuropsychological assessment, lead to inaccuracies in the conclusions drawn about an individual's strengths and weaknesses.

Whilst some tests are reported to have face validity in tapping executive skills, such as planning and organisation, there have been consistent failures in

replicating the findings (Baddeley et al., 1997; Tranel, Anderson, & Benton, 1994). Indeed, there is evidence that the tests are tapping into different processes from those that they purport to measure – put another way, tests of frontal lobe function have been found to show poor correlation amongst themselves (Knight, 1999).

Overall, there are a number of concerns surrounding the use of traditional tests to assess executive function. Clearly, from the perspective of neuropsychological rehabilitation, the most problematic issue is the finding that such measures are unreliable in their prediction of every-day functioning. Nevertheless, a number of explanations have been offered to account for these problems, and these will be elucidated in the next section. The explanations fall roughly into two categories: (i) conceptual and methodological issues associated with the design of the measures; and (ii) less prosaic issues rooted in the need to understand the impairment in the context of the *individual*. Arguably by addressing these issues, then valid and reliable assessment of executive function could be achieved.

4.2. Factors Underlying the Difficulties with Traditional Executive Tests

4.2.1 Localisation

Historically, the frontal lobes have been regarded as the seat of executive functions, therefore measures of executive function have been traditionally validated on patient populations with frontal lesions. However, the relationship between “executive” and “frontal” functions is unclear; moreover the studies of the effects of frontal lobe damage have frequently failed to clearly define the anatomical limits of pathology (Stuss & Alexander, 2000).

The frontal lobes comprise several functionally distinct regions (motor, premotor and prefrontal cortices) each of which can be sub-divided into further

functionally distinct areas. The frontal lobes are also rich in connections with other cortical and subcortical regions, including the posterior parietal cortex, limbic system, basal ganglia and hypothalamus (Kaufer & Lewis, 1999; Kolb & Whishaw, 1995; Stuss & Benson, 1986). Given such structural complexity, Stuss and Alexander (2000) observed that researchers interested in localising executive functions are presented with a phenomenal task. Indeed, given the possibility that a single task may require processes related to different areas of the entire brain (as well as different regions within the frontal lobes), then relating different tasks to the frontal lobes will be an inherently highly complex and difficult process.

For brevity, data relating to examination of the anatomical localisation of executive function are not elucidated here. However, a particular concern for neuropsychological rehabilitation is the vulnerability of the frontal lobes to traumatic brain injury (TBI) and the resultant long-term cognitive and behavioural impairments that may emerge from such damage (Levine, Katz, Dade, & Black, 2002). TBI generally produces both diffuse and focal injuries to the brain⁴ (Levine et al., 2002), which means that circumscribed frontal lesions are relatively infrequent – indeed with the exception of the early stages of frontal lobe dementia, there are few clinical conditions with limited relation to the frontal lobes (Stuss & Alexander, 2000). In view of the association between executive impairments and damage to non-frontal regions, it seems illogical to assess executive function in individuals with acquired brain injury using tests that have been solely validated on populations with frontal lesions.

In summary, the search for anatomical localisation of executive function is

⁴ The diffuse injury emerges from acceleratory/deceleratory forces upon the brain within the skull causing shearing and axonal injuries in the cerebral hemispheres and brain stem, haemorrhage and diffuse swelling; whilst focal injury occurs through contact of the brain against the skull creating contusions on the surface of the frontal and temporal lobes (Kinsella, 1998; Levine et al., 2002).

still inconclusive. The historical location of the executive functions with the frontal lobes has been questioned, and there is a growing consensus that executive impairments can emerge as a consequence of nonfrontal damage. Researchers are attempting to deal with these issues by locating patients with focal frontal lesions (e.g. Stuss & Alexander, 2000), and using functional neuroimaging techniques with both neurologically intact individuals and patients with frontal damage (Jagust, 1999; Owen, 1997). However, in view of such a level of uncertainty, it is perhaps unsurprising that traditional frontal tests have been found to be unreliable indicators of executive function.

4.2.2. Fractionation of the Executive System

Recent evidence suggests that the executive system can be fractionated (Baddeley, 2002; Burgess, 1997; Burgess, Alderman, Evans, Emslie, & Wilson, 1998). Here, the system is thought to comprise a number of cognitive processes (or modules), where impairment of a particular module will give rise to specific behavioural and cognitive sequelae. For example, a factor analysis of patients' dysexecutive symptoms, conducted by Burgess et al. (1998), revealed three underlying cognitive factors: inhibition, intentionality, and executive memory - each tapped by different neuropsychological measures of executive function. Given these findings, it is perhaps unsurprising that low correlations have been found between various frontal tests purporting to measure executive function.

Whilst there have been attempts to localise the different cognitive processes within the frontal lobes (e.g. Stuss et al., 2002), this research is fundamentally problematic given the size and complexity of the frontal regions, as well as the finding that executive failure can occur in the absence of frontal pathology

(Baddeley, 2002). For these reasons, it has been suggested that analysis of the array of cognitive symptoms of executive dysfunction and the neuropsychology of the frontal lobes should be studied as virtually separate entities. In this way, operational definitions of the functions of the frontal and executive functions could be developed, which may eventually become integrated (Baddeley & Wilson, 1988; Stuss & Alexander, 2000).

From a practical perspective, Burgess et al. (1998) reasoned that if different tasks measure different aspects of dysexecutive syndrome, then assessment would be best served by the use of a variety of tests of executive function. The authors suggested that a range of tasks covering the three cognitive factors that emerged from their factor analysis of dysexecutive syndrome, should become a standard means of assessing executive function.

4.2.3. Test Structure

Some accounts report that measures of executive functions are relatively insensitive to everyday difficulties because the design of the test provides a range of clues to structure behaviour, i.e., the design imposes a controlled external structure that places less demand on self-regulated executive abilities (Channon, 2004; Cripe, 1996; Shallice & Burgess, 1991; Stuss & Alexander, 2000). Here, task initiation and completion are strongly prompted by the examiner, the tests frequently require the patient to deal with a single explicit problem in isolation, and the trials tend to be short (commonly one minute in duration or even less).

In contrast, many everyday activities - such as preparing a meal for a number of dinner guests - requires the organisation and planning of behaviour over longer time periods; making successful performance dependent on the ability to create,

maintain, activate delayed intentions as well as prioritise competing demands (Norman & Shallice, 1986). Furthermore, real-life problem-solving often requires the individual to deal with problems that are: open-ended in nature, frequently lack a superior solution, and where the relevant pieces of information are seldom available simultaneously – which are rarely considered in traditional measures of executive function (Channon, 2004). Overall, it is hardly surprising that traditional measures are a poor gauge of executive functioning if the structure of the tests prevents the implementation of those cognitive processes that they are designed to measure.

4.2.4. *Impairment versus Disability*

Put simply, the origins of the traditional measures of executive functioning are in the academic arena; they were designed and used purely to understand the processes comprising executive function (through lesion studies) rather than to predict adaptive difficulties (Cripe, 1996). For this reason, Ponsford, Sloan and Snow (1995) stressed that such measures should be used to provide information about specific cognitive impairments following TBI, rather than the assessment of disability or handicap.⁵

There are merits in determining which particular skills are impaired and intact, and how the individual compares to others of the same age (i.e. standardised measures); essentially, whilst not being direct information about the individual's life, this knowledge can be used to build-up a picture of an individual's cognitive strengths and weaknesses so that impossible demands are not placed upon them when planning treatment or rehabilitation (Wilson, 1993). However, given that a

⁵ The authors were referring to the World Health Organisation's concepts of impairment, disability and handicap. According to this definition impairment is the loss or abnormality of a body part, structure or function; disability as the resulting restriction on activity; and handicap the consequent social disadvantages for the individual (World Health Organisation, 1980).

person is much more than the sum of his scores on neuropsychological tests – factors such as motivation, personality, individual style and family support cannot be ignored (Wilson, 1993). Indeed, the *International classification of functioning, disability and health* (World Health Organisation, 2001) now refers to “participant restriction” rather than “handicap”, a revision that is intended to reflect the environmental and personal factors that create disadvantages for the individual within a range of domains, such as occupation, social relationships and personal maintenance. It is therefore unsurprising that neuropsychological tests are unreliable in predicting the real-life performance of individual patients, if their remit is purely to gauge “impairment”.

4.2.5. *The Mind-Data Problem (Cripe, 1996)*

Cripe (1996) stated that measures of executive function are fundamentally flawed because of an epistemological problem that the author refers to as the mind-data problem. His thesis is that test scores are over simplified symbolic representations of real events, where the more complex, interactive or dynamic an event is – the poorer the symbolic representation of reality. Since the human mind and its resultant actions constitutes a very complex system, then measurement of the mind is extremely difficult and will inevitably result in oversimplification of phenomena - making description and prediction impossible.

Cripe argued that because executive functions are very complex (metacognitive) dynamic processes, their observation would be particularly limited by symbolic reductions, which is why measures of executive functions are unreliable. Put simply, too much data is excluded from the evaluation process. To combat this issue, the author maintained that the executive functions can be best

understood by a complex evaluation process that incorporates objective quantitative and qualitative methods of observation.

In essence, Cripe's (1996) argument was for ecological validity in measurement of executive functions – that is the use of test procedures that enable a predictive relationship between behaviour in the neuropsychological assessment and real-world settings. Only through observation of behaviour in different settings (e.g. at home, work, or school) alongside accounts of people who live with the individual, can valuable insights be obtained about the demands placed upon the patient's functional and cognitive strengths, their premorbid skills and abilities, and the impact of biological systems (e.g. medical conditions) (Sbordone, 1996).

4.3 *Summary*

The design of reliable and valid tests of executive function has proven particularly difficult for neuropsychological research. Key to the difficulties is the anatomical-localisation debate over what brain regions house the executive functions. Clearly, many of the methodological problems so far have stemmed from the premature localisation of function within the frontal regions of the brain.

A separate issue pertains to the disparity between the structure of the tests and the real-life situations engaging the executive processes that the tests purport to measure. Arguably “real-life” is neglected not only by the design of the tests, but also by the examiners who neglect to look beyond the test scores, and in doing so negate the complex dynamic relationship between the internal mental life of the individual and the external world.

Removed from this philosophical debate, the clinician is left with a predicament. Assessment is a necessary part of the process in providing support for

people who have suffered brain damage, and who are potentially subject to the debilitating problems associated with disruption to executive function – yet such problems may be missed if only gross general cognitive functioning is examined, which may well be measured as within normal limits (Kinsella, 1998). Clearly, traditional tests alone appear insufficient in enabling the clinician to deal with such issues.

However, this dilemma has been broached by the tests that pertain to being “ecologically valid” – assessment tools that have characteristics similar to naturally occurring behaviour and have value in predicting everyday function. The issue of ecological validity has led to the relatively recent development of neuropsychological tests that use formalised versions of real-world activities, such as the Behavioural Assessment of the Dysexecutive Syndrome (BADS) (Wilson, Evans, Emslie, Alderman, & Burgess, 1996). Importantly, the reasoning behind the development of these measures also underpins the principal themes in the current development of the national clinical guidelines, which pertain to understanding (and assisting with) the difficulties that an *individual* experiences in the context of their daily life.

5. Ecologically Valid Measurement of Executive Function

Ecological validity may be narrowly defined as the “functional and predictive relation between the patient’s behaviour on a set of neuropsychological tests and the patient’s behaviour in a variety of real-world settings” (Sbordone, 1996, p.16). The questionable ecological validity of traditional tests of executive function means that inferences regarding *disability* could be unreliable, and rehabilitation strategies could be compromised. Furthermore, within the medical-legal arena, where accurate

assessment of a patient's present and future function play a key role in compensation claims, claimants may suffer financially.

It is only relatively recently that ecological validity became a concern for neuropsychological research; this is perhaps a reflection of an awareness of the consequences of brain injury, as well as recognition of the effectiveness and cost benefits of rehabilitation (Turner-Stokes & Wade, 2004). A literature search using the PSYCHINFO database (1967 to present) with the search terms "executive functions" and "ecological validity" yielded only sixteen studies; whilst the same search using "frontal lobes" instead of "executive functions" yielded one study. These findings are somewhat surprising given the widely accepted view that impairments to executive function play a large part in the myriad of difficulties that individuals face in the wake of brain injury. However, the results represent an improvement on the situation compared to that of a decade ago, when a literature search using the same search terms failed to yield a single study (see Cripe, 1996).

5.1. *Verisimilitude and Veridicality*

Implicit in the definitions of ecological validity are two requirements: first, *verisimilitude* where the demands of the test and testing conditions resemble the demands of the individual's everyday world; and second, *veridicality* where test performance predicts some aspect of the individual's functioning on a day-to-day basis (Gioia & Isquith, 2004).

In many testing situations verisimilitude is compromised because the examiner provides the structure, organisation, guidance, plan, cueing and monitoring necessary for successful performance - effectively serving as an external executive control and relieving the patient of the need to be strategic and goal-directed (Stuss

& Benson, 1986). For this reason, impaired executive function can easily be overlooked, and this is particularly troublesome given that disruption to these skills can have far-reaching implications, particularly in the successful management of complex tasks such as home management and handling finances (Sbordone & Guilmette, 1999). However, there are now a number of assessment devices that have been designed with verisimilitude in mind.

5.2. *Verisimilitude, Veridicality and Assessment of Executive Function*

5.2.1. *The Six Elements Test (SET) and Multiple Errands Test (MET)*

Shallice and Burgess (1991) demonstrated that patients with executive deficits may be specifically impaired on tasks that require planning and multi-tasking, despite normal performance on measures of language, perception, memory and executive function. On these grounds the rationale for their methodology emerged from the types of real-life situations that presented problems for individuals with executive impairments. Typically these situations necessitate the individual to organise and plan their behaviour over long periods of time, pursue several open-ended tasks concurrently, and without feedback.

Shallice and Burgess (1991) devised two tasks: (i) The Six Elements test (SET), which was conducted in a hospital office and required the participant to organise their activities in order to carry out six tasks in a limited time period without breaking certain rules; and (ii) the Multiple Errands test (MET), which was carried out in a shopping centre and required the participants to buy certain objects, find out certain information, and to be in a particular place at a particular time, whilst abiding by an arbitrary set of rules. The patients' performance on both tests revealed a tendency to break rules and leave items unfinished, whilst failure to carry out

delayed intentions and departures from social convention were specific to the MET.

With respect to veridicality, given the close relationship between the requirements of the tests and real-life situations, Shallice and Burgess (ibid) argued that the patients' difficulties in managing everyday life could be readily mapped onto those difficulties manifesting in the testing situation.⁶ However, this veridicality was not empirically assessed. Nevertheless, the subsequent development of the Dysexecutive Questionnaire (DEX), which forms part of the Behavioural Assessment of the Dysexecutive Syndrome (BADS) test battery (Wilson, Alderman, Burgess, Emslie, and Evans, 1996), has provided a means of empirically assessing the ecological validity of measures of executive function.

Importantly, whilst the SET and MET were originally designed as experimental measures (to investigate disorders in strategy application), rather than routine use with clinical populations, they have subsequently been modified for the latter purpose as discussed below.

5.2.2. Behavioural Assessment of the Dysexecutive Syndrome (BADS)

The BADS has become widely accepted by clinicians as the most reliable and valid method of assessing executive function currently available. The BADS comprises six tests (including a simplified version of the SET) and the DEX. The DEX, which was originally devised to validate the tasks within the battery, samples a range of behavioural, cognitive and emotional problems commonly associated with dysexecutive syndrome. As with the SET and MET, Norman and Shallice's (1986) Supervisory System strongly influenced the development of the actual task structures

⁶ Shallice and Burgess couched the patients' difficulties on the SET and MET in terms of disruption to the Supervisory System (Norman and Shallice, 1986), where failures in processes such as goal articulation, provisional plan formulation, marker creation and triggering, and evaluation were hypothesised to be the source of errors.

– the authors also acknowledge the influence of Baddeley's (1986) Central Executive in test construction (Wilson, Evans, Emslie, Alderman, & Burgess, 1998).

The BADS profile score (derived from scores on six subtests) was found to correlate highly with the DEX ratings made by a relative or carer; moreover multiple regression analyses indicated that the profile score was the only predictor of each of the component factors of the DEX when considered alongside frontal lobe tests, intelligence measures and age (Wilson et al., 1998). Thus with respect to veridicality, the BADS has been empirically demonstrated to be a good indicator of the presence of every day difficulties attributable to executive dysfunction.

5.2.3. Executive Route-Finding Task (ERFT) and the Test of Functional Everyday Abilities (TOFEA)

There are a number of other measures of executive function that purport ecological validity, these include the Executive Route-Finding Task (Boyd & Sautter, 1993) and a derivative, the Test of Functional Everyday Abilities (TOFEA) (Bamdad, Ryan, & Warden, 2003). In principle, these two tests focus on the abilities of participants to manage unstructured problems - yet their relation to real-life is questionable, this is because the solutions for successfully completing the “unstructured” tasks may be cued. Moreover, it appears that both the Executive Route-Finding Task and the TOFEA have yet to be empirically tested for ecological validity (e.g. using the DEX); indeed, the clinical usefulness of the former has been questioned (Bamdad et al., 2003)

The TOFEA requires participants to gather information using a variety of sources to complete a task, which includes finding an address of a hotel and directions to its location; they are also provided with the sources to obtain this

information: a telephone, phone books, and a map. Realistically, part of the solution for finding an address is surely the realisation of a means to do this, i.e. to use a telephone directory. Arguably the availability of a limited number of sources in a test situation actually provides the types of cues that would not be readily available in real-life.

Covert task structuring is a criticism of many other new “paper and pencil” measures of executive function (Knight, 1999). Thus, even these new measures, which purport to be ecologically valid, face the same problems that have dogged the traditional measures of executive function. Moreover, tasks such as the ERFT and TOFEA “sanitise” real-life because the participant is responding to hypothetical situations, i.e., the participant never deals with unforeseen events that necessitate the management of unexpected outcomes. This is particularly problematic given that most theories of executive functions regard the ability to make non-routine decisions, or manage the unexpected - a key executive skill.

In summary, the structure of the SET and MET has come to represent the principles underpinning most of the current approaches to examining executive function, particularly human multi-tasking (Burgess, 2000; Burgess, Veitch, de Lacy Costello, & Shallice, 2000). The participant is presented with an “ill-structured” problem with multiple approaches to proceeding with the task, requiring subtle planning and prioritisation of competing demands as well as the realisation of delayed intentions. However, it seems that even with measures that abide by these strictures, ecological validity does not automatically follow due to the inevitable falsity of the testing situation.

5.3. *Future Directions: Ensuring the Reality of Ecological Validity*

In many respects it appears that the only truly ecologically valid measures are those that are “real-life” tasks, i.e., where the testing is conducted in the everyday environment. Indeed, this notion underlies the work of a group of researchers who have sought to modify Shallice and Burgess’ (1991) original Multiple Errands Test. Here, a simplified version of the MET (the MET-SV) was devised for use in a shopping centre in Northampton (Alderman et al., 2003) and in a hospital setting (MET-HV) (Knight, Alderman, & Burgess, 2002).

Both studies demonstrated the clinical utility of the MET methodology. The measures (based on analyses of types of error, e.g. rule breaks) clearly discriminated between patients with acquired brain injury and neurologically healthy controls, significantly correlated with other ecologically sensitive executive tests (e.g. BADS), and were predictive of behavioural indicators of dysexecutive syndrome (gauged by the DEX). Furthermore, the methodology offers more than diagnostic power – it can provide a seamless link with rehabilitation (Knight et al., 2002). Different rehabilitation techniques could be used depending upon an individual’s pattern of errors; for example, people who make task failures may be helped with the use of external aids or compensatory strategies such as checklists (Alderman et al., 2003).

In light of these findings, MET methodology seems a very promising approach to assessing executive function. Different versions of the MET have been found to comply with the strictures of traditional validity and reliability (see Knight, 1999), but unlike many other measures of executive function, the methodology also shows ecological validity. Furthermore, the methodology is versatile; it has potential to be applied to a range of situations, and it also offers a means of directly mapping an individual’s difficulties onto appropriate rehabilitation strategies.

6. Summary and Conclusion

The difficulties in assessing executive function are both frustrating and socially costly as patients' rehabilitation needs may be discounted or misinterpreted (Lezak, 1993). Even at the level of description, the complex nature of executive function defies simple definition. Numerous theories have attempted to capture the mechanics of the executive processes. Whilst succeeding to provide explanation at an intuitive level, they fail to provide convincing evidence about how such complex mental activity is orchestrated. However, effectively capturing the very essence of “humanness” or put somewhat crudely, devising a cognitive model of consciousness complete with such abstract concepts as beliefs, desires, and intentions, could never be a simple task.

In view of the difficulties with conceptualising executive function, it is unsurprising that measurement has proved equally problematic. Perhaps key to the difficulties to date is the drive to locate the executive functions anatomically – many of the methodological problems in assessing executive function seem to stem from the premature localisation of the function with the frontal lobes. Notwithstanding, the desire to reduce such complex dynamic processes to a series of single numbers, without recourse to considering the interactions of the individual within the real-world, renders such measurements at best limited, at worst inaccurate (Cripe, 1996).

Given the nature of executive functions with their inherent focus on managing and coordinating cognitive and behavioural activities in response to real-world demands, the ecological validity of measures has become important in their assessment. Above all, the key to providing support for those individuals living with dysexecutive syndrome, appears to lie with the development of tasks that are as close to “real-life” as possible – as this not only provides tangible clues to the nature of the

executive deficits, but also provides a source of information as to how such difficulties can be managed through rehabilitation strategies. Indeed, the importance of this position is reinforced by the clinical guidelines for *Rehabilitation Following Acquired Brain Injury* (Royal College of Physicians & British Society of Rehabilitation Medicine, 2003), which place considerable emphasis on early identification of individuals who are in need of rehabilitation, and the need to tailor rehabilitation programs to the individual. Currently, the most promising approach appears to be the Multiple Errands test (MET) methodology, not least because it has been found to satisfy the strictures of validity, reliability and ecological validity, but also because it is so readily adaptable to the real world. Indeed, a particular strength of this methodology is the potential to create a seamless link with rehabilitation, which in tandem with the MET's reality-based structure offers a means of providing rehabilitation programs that can viably take into account the *patient's views, cultural background and pre-morbid lifestyle* – a principal theme in the clinical guidelines.

References

- Alderman, N., Burgess, P. W., Knight, C., & Henman, C. (2003). Ecological validity of a simplified version of the multiple errands shopping test. *Journal of the International Neuropsychological Society*, 9, 31 - 44.
- Alderman, N., & Ward, A. (1991). Behavioural treatment of dysexecutive syndrome: Reduction of repetitive speech using response cost and cognitive overlearning. *Neuropsychological Rehabilitation*, 1(65 - 80).
- Anderson, C. V., Bigler, E. D., & Blatter, D. (1995). Frontal lobe lesions, diffuse damage, and neuropsychological functioning in traumatic brain-injured patients. *Journal of Clinical and Experimental Neuropsychology*, 17, 900 - 908.
- Anderson, S. W., Damasio, H., Jones, R. D., & Tranel, D. (1991). Wisconsin Card Sorting Test performance as a measure of frontal lobe damage. *Journal of Clinical and Experimental Neuropsychology*, 13, 909 - 922.
- Baddeley, A.D. & Hitch, G. (1974). Working memory. In G.A. Bower (Ed.), *Recent advances in learning and motivation*, Vol. 8. New York: Academic Press.
- Baddeley, A. (1986). *Working memory*. Oxford, England: Oxford University Press.
- Baddeley, A. (2002). Fractionating the central executive. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 246 - 260). New York: Oxford University Press.
- Baddeley, A., Bressi, S., Della Sala, S., Logie, R., & Spinnler, H. (1991). The decline of working memory in Alzheimer's disease. *Brain*, 114, 2521 - 2542.
- Baddeley, A., Della Sala, S., Papagno, C., & Spinnler, H. (1997). Dual-task performance in dysexecutive and nodysexecutive patients with a frontal lesion. *Neuropsychology*, 11, 187 - 194.

- Baddeley, A.D., Logie, R., Bressi, S., Della Sala, S., & Spinnler, H. (1986). Dementia and working memory. *Quarterly Journal of Experimental Psychology*, 38A, 603 – 618.
- Baddeley, A., & Wilson, B. A. (1988). Frontal amnesia and the dysexecutive syndrome. *Brain and Cognition*, 7, 212 - 230.
- Bajo, A., & Fleminger, S. (2002). Brain injury rehabilitation: What works for whom and when? *Brain Injury*, 16, 385 - 395.
- Bamdad, M. J., Ryan, L. M., & Warden, D. L. (2003). Functional assessment of executive abilities following traumatic brain injury. *Brain Injury*, 17, 1011 - 1020.
- Bigler, E. D. (1988). Frontal lobe damage and neuropsychological assessment. *Archives of Clinical Neuropsychology*, 3, 279 -297.
- Bird, C. M., Papadopoulou, K., Ricciardelli, P., Rossor, M. N., & Cipolotti, L. (2004). Monitoring cognitive changes: Psychometric properties of six cognitive tests. *British Journal of Clinical Psychology*, 43, 197 - 210.
- Boone, K. B. (1999). Neuropsychological assessment of executive functions. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (pp. 247 - 260). New York: Guildford Press.
- Boyd, T. M., & Sautter, S. W. (1993). Route-finding: A measure of everyday executive functioning in the head injured adults. *Applied Cognitive Psychology*, 7, 171 - 181.
- Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 81 -116). Hove, England.: Psychology Press Ltd.

- Burgess, P. W. (2000). Strategy application disorder: the role of the frontal lobes in human multitasking. *Psychological Research*, 63, 279 - 288.
- Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, 4, 547 - 558.
- Burgess, P. W., Veitch, E., de Lacy Costello, A., & Shallice, T. (2000). The cognitive and neuroanatomical correlates of multitasking. *Neuropsychologia*, 38, 848 - 863.
- Channon, S. (2004). Frontal lobe dysfunction and everyday problem-solving: Social and non-social contributions. *Acta Psychologica*, 115, 235 - 254.
- Cicerone, K. D. (2002). The enigma of executive functioning: Theoretical contributions of therapeutic interventions. In P. J. Eslinger (Ed.), *Neuropsychological Interventions: Clinical practice and research* (pp. 246 - 265). New York: Guildford Press.
- Colantonio, A., Ratcliff, G., Chase, S., Kelsey, S., Escobar, M., & Vernich, L. (2004). Long term outcomes after moderate to severe traumatic brain injury. *Disability and Rehabilitation*, 26(5), 253 - 261.
- Crawford, J. R. (1998). Introduction to the assessment of attention and executive functioning. *Neuropsychological Rehabilitation*, 8, 209 - 211.
- Cripe, L. I. (1996). The ecological validity of executive function testing. In R. J. Sbordone & C. J. Long (Eds.), *Ecological validity of neuropsychological testing* (pp. 171 - 202). Delray Beach, FL: St. Lucie Press.
- Department of Health. (2005). *The National Service Framework for Long-term Conditions*. London: Department of Health.

- Donnelly, K. Z., Donnelly, J. P., & Grohman, K. J. (2000). Cognitive, emotional, and behavioural problems associated with traumatic brain injury: A concept map of patient, family, and provider perspectives. *Brain and Cognition*, 44(21 - 25).
- Duncan, J. (1986). Disorganization of behaviour after frontal lobe damage. *Cognitive Neuropsychology*, 3, 271 - 290.
- Eslinger, P. J. (2002). *Neuropsychological Interventions: Clinical practice and research*. New York: Guildford Press.
- Eslinger, P. J., & Damasio, A. R. (1985). Severe disturbance of higher cognition after bilateral frontal ablation: Patient EVR. *Neurology*, 35, 1731 - 1741.
- Gioia, G. A., & Isquith, P. K. (2004). Ecological assessment of executive function in traumatic brain injury. *Developmental Neuropsychology*, 25, 135 - 158.
- Ingram, F., Greve, K. W., Ingram, P.T., & Soukup, V. M. (1999). Temporal stability of the Wisconsin Card Sorting Test in an untreated patient sample. *British Journal of Clinical Psychology*, 38, 209 - 211.
- Jagust, W. (1999). Neuroimaging and the frontal lobes: Insights from the study of neurodegenerative diseases. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (pp. 107 - 122). New York: The Guildford Press.
- Kaufer, D. I., & Lewis, D. A. (1999). Frontal lobe anatomy and cortical connectivity. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (pp. 27 - 44). New York: The Guildford Press.
- Keil, K., & Kazniak, A. W. (2002). Examining executive functions in individuals with brain injury: A review. *Aphasiology*, 16, 305 - 335.

- Kinsella, G. (1998). Assessment of attention following traumatic brain injury: A review. *Neuropsychological Rehabilitation*, 8, 351 - 375.
- Kinsella, G., Ford, B., & Moran, C. (1989). Survivors of social relationships following head injury. *International Journal of Disability*, 11, 9 -14.
- Knight, C. (1999). *The development of a hospital version of the multiple errands test to assess executive functioning following severe acquired brain injury*. Unpublished doctoral dissertation, University of Birmingham, England.
- Knight, C., Alderman, N., & Burgess, P. W. (2002). Development of a simplified version of the multiple errands test for use in hospital settings. *Neuropsychological Rehabilitation*, 12, 231 - 255.
- Kolb, B., & Whishaw, I. Q. (1995). *Fundamentals of Human Neuropsychology* (4th ed.). New York: W H. Freeman & Company.
- Lapotaire, J. (2003). *Time out of mind*. London: Virago Press.
- Levine, B., Katz, D. I., Dade, L., & Black, S. E. (2002). Novel approaches to the assessment of frontal damage and executive deficits in traumatic brain injury. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 448 - 465). New York: Oxford University Press.
- Lezak, M. D. (1993). Newer contributions to the assessment of executive functions. *Journal of Head Trauma Rehabilitation*, 8, 24 - 31.
- Lezak, M. D. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford University Press.
- Luria, A. R. (1966). *Higher cortical functions in man*. London: Tavistock.
- Luria, A. R. (1981). *Language and cognition*. Washington, DC: Winston.

- Macmillan, M. (1996). Phineas Gage: A case for all reasons. In C. Code, C. W. Wallesch, Y. Joannette & A. Lecours (Eds.), *Classic cases in neuropsychology* (pp. 243 - 262). Hove, England: Psychology Press.
- McDowell, S., Whyte, J., & D'Esposito, M. (1997). Working memory impairments in traumatic brain injury: evidence from a dual-task paradigm. *Neuropsychologia*, 35, 1341 - 1353.
- National Institute for Clinical Excellence. (2003). *Head injury: Triage, assessment, investigation and early management of head injury in infants, children and adults*. London: National Institute for Clinical Excellence.
- Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behaviour. *Consciousness and Self-regulation: Advances in Research and Theory*, 4, 1 - 18.
- Oddy, M., & Herbert, C. (2003). Intervention with families following brain injury: Evidence-based practice. *Neuropsychological Rehabilitation*, 13, 259 - 273.
- Osmon, D. C. (1999). Complexities in the evaluation of executive functions. In J. J. Sweet (Ed.), *Forensic neuropsychology: Fundamentals and practice*. Lisse, Netherlands: Swets & Zeitlinger.
- Owen, A. M. (1997). Cognitive planning in humans: Neuropsychological, neuroanatomical and neuropharmacological perspectives. *Progress in Neurobiology*, 53, 431 - 450.
- Ownsworth, T. L., McFarland, K., & Young, R. M. (2000). Self-awareness and psychosocial functioning following acquired brain injury: An evaluation of a group support programme. *Neuropsychological Rehabilitation*, 10, 465 - 484.

- Ponsford, J., Sloan, S., & Snow, P. (1995). *Traumatic brain injury: Rehabilitation for everyday adaptive living*. Hove, England: Lawrence Erlbaum & Associates.
- Reitan, R. M., & Wolfson, D. (1995). Category test and trail naming test as measures of frontal lobe functions. *Clinical Neuropsychologist*, 9, 50 - 56.
- Royal College of Physicians & British Society of Rehabilitation Medicine. (2003). *Rehabilitation following acquired brain injury: National clinical guidelines*. London, England: RCP, BSRM.
- Rylander, G. (1939). Personality changes after operation on the frontal lobes. *Acta Psychiatrica Neurologica, Supplement No. 30*.
- Saver, J., & Damasio, A. R. (1991). Preserved access and processing of social knowledge in a patient with acquired sociopathy due to ventromedial frontal damage. *Neuropsychologia*, 29, 1241 - 1249.
- Sbordone, R. J. (1996). Ecological validity: Some critical issues for the neuropsychologist. In R. J. Sbordone & C. J. Long (Eds.), *Ecological validity of neuropsychological testing*. Delray Beach, FL: St Lucie Press.
- Sbordone, R. J. (2000). The executive functions of the brain. In G. Groth-Marnat (Ed.), *Neuropsychological assessment in clinical practice*. New York: John Wiley & Sons.
- Sbordone, R. J. (2001). Limitations of neuropsychological testing to predict the cognitive and behavioral functioning of persons with brain injury in real-world settings. *NeuroRehabilitation*, 16, 199 - 201.
- Sbordone, R. J., & Guilmette, T. J. (1999). Ecological validity: Prediction of everyday and vocational functioning from neuropsychological test data. In J.

- J. Sweet (Ed.), *Forensic neuropsychology: Fundamentals and practice* (pp. 227 - 254). Lisse, Netherlands: Swets & Zeitlinger.
- Sbordone, R. J., & Long, C. J. (1996). *Ecological validity of neuropsychological testing*. Delray Beach, FL: St. Lucie Press.
- Schnider, A., & Gutbrod, K. (1999). Traumatic Brain Injury. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (pp. 487 - 506). New York: Guildford Press.
- Select Committee on Health. (2001). *Third Report - Head Injury: Rehabilitation*. Retrieved on 17 May, 2006, from www.publications.parliament.uk
- Sgaramella, T. M., Bisiacchi, P. S., & Zettin, M. (1997). From a component analysis to a cognitive rehabilitation of everyday planning. In J. Leon-Carrion (Ed.), *Neuropsychological rehabilitation: Fundamentals, innovations and directions*. Delray Beach, FL: GR/St Lucie Press.
- Shallice, T. (1988). *From neuropsychology to mental structure*. New York: Cambridge University Press.
- Shallice, T. (2002). Fractionation of the supervisory system. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function*. New York: Oxford University Press.
- Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain*, 114, 727 - 741.
- Shallice, T., & Burgess, P. W. (1996). Domains of supervisory control and the temporal organisation of behaviour. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 351, 1405 - 1412.

- Shimamura, A. P. (1995). Memory and frontal lobe function. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 803 - 813). Cambridge, MA: MIT Press.
- 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.
- Stuss, D. T., & Alexander, M. P. (2000). Executive functions and the frontal lobes: a conceptual view. *Psychological Research*, 63, 289 - 298.
- Stuss, D. T., Alexander, M. P., Floden, D., Binns, M. A., Levine, B., McIntosh, A. R., et al. (2002). Fractionation and localization of distinct frontal lobe processes: Evidence from focal lesions in humans. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 392 - 407). New York: Oxford University Press.
- Stuss, D. T., & Benson, D. F. (1984). Neuropsychological studies of the frontal lobes. *Psychological Bulletin*, 95, 3 - 28.
- Stuss, D. T., & Benson, D. F. (1986). *The frontal lobes*. New York: Raven Press.
- Stuss, D. T., Shallice, T., Alexander, M. P., & Picton, T. W. (1995). A multidisciplinary approach to anterior attentional functions. *Annals of the New York Academy of Sciences*, 769, 191 - 211.
- Tranel, D., Anderson, S. W., & Benton, A. (1994). Development of the concept of "executive function" and its relationship to the frontal lobes. In F. Boller & J. Grafman (Eds.), *Handbook of Neuropsychology* (Vol. 9, pp. 125 - 148). Amsterdam: Elsevier.
- Turner-Stokes, L., & Wade, D. (2004). Rehabilitation following acquired brain injury: concise guidance. *Clinical Medicine*, 4, 61 - 65.

- Wildgruber, D., Kischka, U., Fassbender, K., & Ettlin, T. M. (2000). The Frontal Lobe Score: Part II: Evaluation of its clinical validity. *Clinical Rehabilitation*, 14, 272 - 278.
- Wilson, B. A. (1993). Ecological validity of neuropsychological assessment: Do neuropsychological indexes predict performance in everyday activities? *Applied and Preventative Psychology*, 2, 209 - 215.
- Wilson, B. A., Alderman, N., Burgess, N., Emslie, H., & Evans, J. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmonds, England: Thames Valley Test Company.
- Wilson, B. A., Evans, J. J., Emslie, H., Alderman, N., & Burgess, P. W. (1998). The development of an ecologically valid test for assessing patients with a dysexecutive syndrome. *Neuropsychological Rehabilitation*, 8, 213 - 228.
- World Health Organisation (1980). *International classification of impairments, disabilities and handicaps. A manual of classification relating to the consequences of disease*. Geneva: WHO.
- World Health Organisation (2001). International classification of functioning, disability and health. Retrieved on 17 May 2006, from <http://www3.who.int/icf/>

SECTION 2

RESEARCH REPORT

DEVELOPMENT OF A SIMPLIFIED VERSION OF THE MULTIPLE ERRANDS TEST FOR USE ON A HOSPITAL WARD

Abstract

Disruption to executive functioning may have catastrophic consequences following brain injury. Appropriate assessment is critical in planning necessary interventions, yet many existing neuropsychological measures do not adequately reflect the executive impairments manifest in the context of everyday functioning. Shallice and Burgess (1991) described one procedure, the Multiple Errands Test (MET), which did attain this goal. Surprisingly, the methodology has been relatively under exploited for use in clinical settings. Nonetheless, the existing research confirms a high degree of potential for use in this arena. In the present study the utility of a simplified MET designed for use on a hospital ward is explored. The measure was designed to be appropriate for patients who are unable to undergo assessment in public settings, and suitable for use with patients who are in the early stages of recovery.

Twenty four healthy participants and 21 people with acquired brain injury took part. The main findings were as follows: 1) the test discriminated well between neurological patients and controls, and the groups effects remained when the difference in current general cognitive function and familiarity with the environment were considered; 2) test performance was found to be strongly associated with performance on an established ecologically valid measure of executive function (BADS); and 3) preliminary findings indicated that two patterns of error making style were associated with different dysexecutive symptoms in everyday life. The results demonstrate the clinical utility of the ward version of the MET – with the advantage to clinicians in its brevity and sensitivity, whilst capturing aspects of everyday executive difficulties that are not readily accessible from many psychometric measures.

1. Introduction

1.1. Executive Dysfunction and the Challenge of Assessment

Disruption to executive function is a frequent consequence of acquired brain injury (Kinsella, 1998; Levine, Katz, Dade, & Black, 2002; Schnider & Gutbrod, 1999), and is commonly associated with: loss of employment and financial instability (Eslinger & Damasio, 1985), disrupted interpersonal relationships and loneliness (Kinsella, Ford, & Moran, 1989; Saver & Damasio, 1991), memory difficulties (Shimamura, 1995) and has been found to interfere with rehabilitation (Bajo & Fleminger, 2002).

Individuals with executive dysfunction frequently have difficulties with planning and organisation, show impaired attention and cognitive inflexibility, display impulsive and socially inappropriate behaviour (or conversely diminished responsiveness and apathy), and have a lack of self-awareness and self-monitoring. Put simply, executive function can be defined as the control, supervisory, or self-regulatory function that directs all cognitive activity, emotional responses, and overt behaviour (Gioia & Isquith, 2004).

Appropriate assessment of these complex functions is critical in planning necessary interventions, *yet* they present a challenge to many neuropsychological tests, as these measures frequently fail to adequately reflect the executive impairments that can hamper individuals' everyday function (Cripe, 1996). There are well-cited examples of obvious disparities between gross disturbance in the performance of everyday activities and test scores that are suggestive of only minor cognitive impairments (e.g. Cripe, 1996; Eslinger & Damasio, 1985, 1994; Shallice & Burgess, 1991). Lack of substantive relationships between tests of frontal lobe functioning (traditionally used to gauge executive impairments) and difficulties

encountered in “real-life” has led some investigators to express the belief that such measures are not reliable predictors of everyday problems imputed to executive impairment (Acimovic, Keatley, & Lemmon, 1993; Lezak, 1993; Wilson, 1993). However, there is evidence for the fractionation of executive functions at the behavioural level, with different neuropsychological tests predicting separate factors (Burgess, Alderman, Evans, Emslie, & Wilson, 1998). Consequently, different executive tests may measure *different aspects* of the dysexecutive syndrome.

Nonetheless, the clinician is left with a predicament. Assessment is a potentially useful part of the process in providing support for people who have suffered brain damage, and who may be subject to the debilitating problems associated with disruption to executive function. Yet such disabilities may be missed if only gross general cognitive functioning is examined, which may well be measured as within normal limits (Kinsella, 1998). Equally, whilst tests of executive function may be useful in explaining aspects of everyday behaviour, their ability to *predict* the difficulties an individual may encounter in daily life is limited (Manchester, Priestly, & Jackson, 2004). Naturally, the latter has considerable implications for submission of neuropsychological reports for use in the medical-legal arena.

1.2. *A Solution to the Problem?*

The necessity for neuropsychological tests to predict the degree of disability or handicap arising from brain disorder (rather than just quantify impairment) has generated an interest in the development of *ecologically valid* assessment instruments. Ecological validity is defined as the functional and predictive relationship between an individual’s performance on neuropsychological tests and

their behaviour in a variety of real world settings, such as home, work or in the community (Sbordone, 1996).

Typically, ecological validity is assessed by determining correlations between test scores and measures of behavioural disability (Burgess et al., 1998), or more global measures of functioning such as employment status or activities of daily living (see Chaytor & Schmitter-Edgecombe, 2003). Some attempts have been made to enhance the ecological validity of traditional measures of executive function⁷ by considering extra-test variables, such as compensatory strategies and environmental cognitive demands, and relating these to real world performance (Chaytor, Schmitter-Edgecombe, & Burr, 2006). Naturally, a multitude of factors may underlie performance on neuropsychological tests; therefore empirically investigating these complex relationships is likely to be a long and exhaustive process.

An alternative approach has been to devise tasks that are *analogous* to those required in everyday life activities involving executive functioning. One of the more routinely used tests is the Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson, Burgess, Emslie, & Evans, 1996). Here, ecological validity was determined by comparison of test scores on the BADS with the responses of relatives or carers on the Dysexecutive Questionnaire (DEX; Burgess, Alderman, Wilson, Evans, & Emslie, 1996), which measures behaviours that are symptomatic of impaired executive function. Relative to traditional measures of frontal lobe functioning, the BADS proved the best single indicator of the presence of everyday problems attributable to executive dysfunction. A subsequent study confirmed this

⁷ Here, the term “traditional” refers to the measures that have been conventionally used to assess executive function, and where the validity of the tests has typically been established through studies of lesions to the frontal lobes - these measures are frequently referred to as tests of “frontal lobe function” in the literature.

superiority, and significant relationships between several BADS subtests and a measure of social role functioning were also found (Norris & Tate, 2000).

1.3. Testing in the Real World

In order to enhance the ecological validity of tests of executive function, attempts have been made to make assessment more life-like and to use behavioural observations of tasks carried out in real world setting. Indeed, given the nature of executive functions with their inherent focus on managing and coordinating cognitive and behavioural activities in response to real-world demands, then *logically* these skills would be best measured using formalised versions of real-world activities.

One such measure, the Multiple Errands Test (MET) (Shallice & Burgess, 1991) has been found to be particularly sensitive to patients' everyday dysexecutive problems. The MET is conducted in a shopping precinct and requires patients to buy specific items, find out certain information (for example, the price of a pound of tomatoes), to be in a particular place at a particular time, and to follow some arbitrary rules whilst doing these things (for example, to only enter a shop to buy something). Accordingly, the MET taps into abilities that play an important role in decision making and behavioural control in everyday life - yet are frequently omitted in formal testing - which include noticing whether a task needs to be done, selecting between competing possibilities, adhering to rules over a substantial period of time, and prospective memory (remembering to do something in the future) (Manchester et al., 2004).

Surprisingly, MET methodology has been relatively under exploited for use in clinical settings. Nonetheless, the existing research confirms a high degree of

potential for its use in this arena. Simplified versions⁸ of the MET administered to a broad range of patients with acquired brain injury, including one designed for use within the grounds of a hospital, have been found to comply with the strictures of traditional validity and reliability, as well as proving highly predictive of executive difficulties in the context of everyday living (Alderman, Burgess, Knight, & Henman, 2003; Knight, Alderman, & Burgess, 2002).

Unlike many existing measures of executive function, the MET methodology also offers a means of *directly* mapping individual's difficulties onto appropriate rehabilitation strategies (Knight et al., 2002). For example, participant's interactions and social behaviour are readily observable, as are difficulties with planning or strategy use. Here, rehabilitation can be focused on specific areas of difficulty, and progress measured by repeating the MET (Alderman, Knight, Rutterford, & Swan, 2000). Indeed, this is particularly pertinent for clinicians, given that the recent clinical guidelines for *Rehabilitation Following Acquired Brain Injury* place considerable emphasis on the need to tailor rehabilitation programs to the individual (Royal College of Physicians & British Society of Rehabilitation Medicine, 2003).

1.4. Application of the Multiple Errands Test to the Ward Environment

Clinicians are frequently constrained by time and resources, therefore a measure of executive function that is “neat” and easy to administer, as well as being ecologically valid (i.e. reflecting patient's everyday difficulties) is highly desirable. Equally, whilst there is a high degree of utility in testing patients in everyday situations, some patients are unable to undergo assessment in public settings due to mobility problems or severe behavioural problems. However, for these patients the

⁸ Shallice and Burgess' (1991) methodology was originally tested on three frontal lobe patients with higher than average IQ, which is atypical for patients seen in routine clinical practice. Accordingly, simplification of the original methodology was required to make it more suitable for general use.

hospital ward is a viable testing arena – as the ward *is* the patient's (and clinician's) environment.

In terms of clinical practice, adapting the MET to a ward environment also renders assessment a more viable proposition for patients who are in the earlier stages of rehabilitation/recovery. Such patients are more likely to be susceptible to confusion and disorientation (see Lippert-Grüner, Kuchta, Hellmich, & Klug, 2006; Royal College of Physicians & British Society of Rehabilitation Medicine, 2003), therefore testing in a familiar environment (i.e. the ward) should minimise the impact of confusion upon test results.

Consequently, the aim of the present study was to develop and evaluate a ward-based version of the MET (subsequently referred to as the MET-WV). The test was designed to be used specifically within a hospital ward environment, with the intention of facilitating the assessment of those patients who cannot be readily observed in public, or those patients who are still in the early stages of recovery. Moreover, given the constraints of traditional neuropsychological measures of executive function, the study considered the functional and predictive relation between the patient's behaviour on the MET-WV and their everyday functioning.

1.5. Research Questions

(i) Is the MET-WV sensitive to impairments in cognitive function?

Many existing measures of frontal lobe and executive function have been found to be unreliable in detecting subtle impairments in cognitive function. In contrast, there is evidence to suggest that MET methodology is sensitive to executive impairments (Alderman et al., 2003; Knight et al., 2002). Accordingly, it was hypothesised that the performance of brain injured participants on the MET-WV would be significantly impaired compared with neurologically healthy controls.

The study also considered the role of a number of other variables upon task performance, which included: chronological age, general level of cognitive functioning (IQ), memory, mood and familiarity with environment. Whilst some of these variables may predict performance on the MET-WV, it was anticipated that statistical control of their effects would not impact upon the ability of the MET-WV to discriminate between the brain injured and control participants.

(ii) How does the MET-WV compare with other tests of executive function?

It was anticipated that an association would be found between the MET-WV and the BADS – a test of executive functioning that has been found to have good ecological validity. In contrast, a weaker relationship between traditional frontal lobe tests and the MET-WV was anticipated, this is because the traditional measures have been found to be variable in their ability to predict everyday problems imputed to executive impairment.

(iii) *Is the MET-WV a good predictor of behaviours that are symptomatic of impaired executive function observed in everyday life?*

It was anticipated that there would be significant relationship between the scores of people with acquired brain injury (ABI) on the MET-WV and informants' ratings on the DEX - a questionnaire that samples many of the everyday symptoms associated with executive impairment.

2. Method

Ethical issues as defined by the British Psychological Society (2000) were adhered to in designing and implementing the research. Ethical review was sought and obtained through St. Andrew's Group of Hospitals Research Group and the Leicestershire, Northamptonshire and Rutland NHS Research Ethics Committee (see Appendix 1). The details of the recruitment process, and copies of the information and consent forms can be found in Appendix 1.

2.1. Rationale and Design

The study closely followed the methodology adopted by Knight et al. (2002). Two groups of participants were considered: a neurologically healthy control group and a patient group comprising individuals with acquired brain injury. The degree to which the MET-WV is sensitive to cognitive impairment was assessed by a between groups comparison of the performance of participants with ABI and a neurologically healthy control group. The dependent variables were the error scores on the MET-WV.

The relationship between the MET-HV and existing measures of frontal lobe and executive function were examined by correlating brain injured participants' error

scores with: (i) traditional tests of executive function (frontal lobe functioning); and (ii) a contemporary measure with demonstrated ecological validity (BADS; Wilson et al., 1996). Correlations were also used to examine the relationship between the MET-WV and everyday function by correlating the brain injured participant's error scores with ratings on the DEX questionnaire (Burgess et al., 1996).

2.2. *Participants*

Sample size was determined by computing a power calculation based on previous research by Knight et al., (2002) examining the utility of a simplified MET for use in hospital grounds. Here, comparison of two groups of 20 participants (brain injured and neurologically healthy control) yielded a power of 0.99 ($\alpha = 0.05$)⁹. According to Cohen (as cited in Howell, 1997) this power value is likely to yield a large experimental effect thus reducing the probability of any effects being subject to type two errors (i.e. not finding a difference that is there).

In the present study, slightly more participants volunteered than had originally been anticipated. Accordingly, the opportunity to include these individuals in the sample was taken. The acquired brain injured group comprised 21 people, all of whom were patients admitted to Kemsley Division (a neurorehabilitation service), St. Andrew's Hospital, Northampton. The neurologically healthy group comprised 24 people who had no history of neurological disease, and were recruited from amongst members of staff employed by St. Andrew's hospital.

⁹ The power value was calculated using "Power Calculator" software devised by the University College of Los Angeles Department of Statistics. The programme is available on the internet from <http://calculators.stat.ucla.edu/powercalc/>.

2.2.1. *Brain injured participants*

Participants were invited to participate in the study if they fulfilled the following criteria: aged 18 years or over, no gross perceptual problems, no impairment of dominant hand function, and intact functional language skills. The criteria served to reduce the potential confounding effects of variables such as perception, motor and language skills upon the results of the study. Individuals without English as their first language were excluded from the study (including neurologically healthy controls), as it was anticipated that lack of exposure to English language may confound the interpretation of neuropsychological tests (where test validation and norms had been derived from English speaking populations).

The brain injured participants comprised 14 males and 7 females, which reflects the larger number of males with acquired brain injury in the general population (National Institute for Clinical Excellence, 2003). The age of the participants ranged from 21 to 59 years (mean = 38.04 years, $SD = 9.75$). Details of the type of injury, pre-morbid levels of general ability, and current levels of ability are presented in Table 1.

The majority of the brain injured group had sustained a traumatic brain injury (15), as a result of a road traffic accident (9), fall (5) or assault (1). Hypoxic brain injuries had been sustained by 4 participants, where overdose of illicit drugs or alcohol had been involved. Of the remaining participants, one had acquired the brain injury as the consequence of a tumour (and surgical excision), and the other participant's brain injury occurred as a result of cerebral oedema following diabetic ketoacidosis (caused by no or low levels of insulin leading to hyperglycaemia). Severity of the brain injury was determined with reference to duration of post-

traumatic amnesia, duration of coma, or depth of coma on admission to hospital (see Richardson, 2000). Most were classified as “very severe” (10), with six classified as “severe”, and one “moderate”. It was not possible to determine severity brain injury for four participants.

The average time since injury was 9.25 years ($SD = 7.22$, minimum = 0.75, maximum = 27). Estimates of optimal pre-morbid levels of general cognitive ability were obtained using the Wechsler Test of Adult Reading (WTAR: Wechsler, 2001), which estimated the Wechsler Adult Intelligence Scale – 3rd Edition (WAIS-III: Wechsler, 1999) full scale IQ (FSIQ) for the brain injured group lay between 80 and 114 (mean = 98.38, $SD = 10.02$; described as *average*). Current levels of ability as assessed with the WAIS-III were somewhat lower, with the FSIQ for the group falling between 65 and 117 (mean = 85.71, $SD = 13.92$; described as *low average*).

Table 1. Details of Brain Injury, Age, Gender and Levels of General Ability (Pre-morbid and Current)

Participant	Description of Brain Injury	Age (at test)	Gender	WTAR FSIQ (Pre-morbid)	WAIS-III FSIQ (Current)
1	Hypoxic BI as a consequence of cardiac arrest following alcohol intoxication. CT and MRI scans showed no definite abnormality. Presumptive diagnosis of Wernicke's (Korsakoff's) syndrome.	35	M	109	91
2	Hypoxic BI following cardiac arrest, secondary to methadone & heroine overdose with alcohol intake.	44	M	86	65
3	Fell down flight of stairs under influence of alcohol. Scans revealed fronto-temporal subdural haematoma which was surgically evacuated. Further operation to remove residual haematomas. PTA = 6 weeks.	30	M	102	72
4	Underwent a right fronto-temporal craniotomy & total macroscopic excision of a craniopharyngioma (pituitary region tumour). Post-op surgery complicated by hypopituitarism & meningitis.	31	F	103	98
5	Fell, hit head on wall & pavement. Struck right fronto-temporal region, sedated but not ventilated. PTA = 2 weeks.	42	F	95	80
6	Developed diabetic ketoacidoses. Severe BI secondary to cerebral oedema.	21	F	100	90
7	RTA - hit by a car when crossing the road. CT scan showed mild widespread cerebral contusion. PTA = 6 months.	55	F	95	78
8	Severe hypoxic BI following cardiac arrest, secondary to overdose of illicit drugs. MRI scans showed generalised atrophy. GCS = 3.	29	F	103	83
9	RTA - struck by bus. Severe BI with bilateral subdural haematoma. Left temporal lobectomy with raised intracranial pressure. Coma for 3 weeks. PTA = 12 weeks.	30	F	106	117
10	Single vehicle RTA, may have been intoxicated. Coma for 14 days, speech & mobility difficulties, epilepsy.	48	M	95	87
11	Fell from 13ft ladder. Sustained frontal brain contusions and subarachnoid haemorrhage.	46	M	97	97

Table 1. (continued)

Participant	Description of Brain Injury	Age (at test)	Gender	WTAR FSIQ (Pre-morbid)	WAIS-III FSIQ (Current)
12	RTA – driving a car that was hit by a lorry. Cerebral CT scan showed multiple cerebral contusions. Suffered dense left hemiplegia. Epilepsy. GCS = 5.	40	M	105	95
13	Hit by a train. Open right occipital fracture, right frontal injury (subdural). GCS = 8	46	M	114	96
14	Assault. Coma for 3.5wks. Pneumonia, pulmonary embolism, deep vein thrombosis, craniotomy, right leg weakness.	23	M	100	84
15	Hit by a lorry. Scan indicated right frontal & temporal lobe contusions. Coma for 3 wks & sustained damage to base of skull. PTA = 2 months.	59	M	113	106
16	Drug induced psychosis. BI resulted from electrocution and a 100ft fall. MRI showed contusion and haemorrhages. Atypical epilepsy secondary to BI. PTA = 8 weeks.	33	M	85	70
17	Epilepsy prior to injury. Fell from balcony. Intraventricular & subdural haemorrhage.	35	M	110	100
18	RTA - passenger in car involved in a collision. Large periorbital haematoma of right eye. EEG revealed bilateral abnormalities. Scan showed gross cerebral atrophy confirming diffuse & severe damage to brain tissue.	39	F	100	82
19	Overdose of drugs & alcohol. Hypoxic BI & aspiration pneumonia. GCS = 3.	38	M	81	69
20	RTA – riding motor bike and head on collision with a car - thrown through window screen. Coma for 6 weeks (drug-induced to promote healing). BI to frontal and temporal regions. PTA = 4 months.	39	M	87	72
21	Acquired BI in early adolescence. RTA - hit by a car. Frontal lobe contusions noted on scans. Later scans revealed lateral ventricles cerebral spinal fluid space widening and white matter loss. Overt seizure activity over left hemisphere	28	M	80	68

WTAR = Wechsler Test of Adult Reading (Wechsler, 2001) WAIS-III = Wechsler Adult Intelligence Scale – 3rd Edition (Wechsler, 1999)
 FSIQ = Full scale intelligence quotient, BI = Brain injury, RTA = Road traffic accident, PTA = Post-traumatic amnesic, GCS = Glasgow Coma Scale

2.2.2. Neurologically healthy participants (controls)

The 24 control participants were staff who volunteered to take part in the study in response to posters advertising the research placed around the hospital site. Following a brief screening interview, participants were invited to join the study if they did not have a history of neurocognitive risk factors (for example, traumatic brain injury or stroke) or developmental difficulties (for example, dyslexia). Given time constraints, large numbers of participants could not be tested to provide “exact” matches with the brain injured participants (with respect to age, gender and IQ bands). However, the sample was found to provide a reasonable match (see below).

The control participants comprised 5 males and 19 females, who were aged between 21 and 56 years (mean = 39.67, $SD = 12.35$). An indicator of general cognitive ability was obtained through performance on the WTAR, which estimated the WAIS-III FSIQ for the control group lay between 85 and 113 (mean = 105.92, $SD = 6.84$; described as *average*). There was no significant difference between the control and brain injured group with respect to age: $t(43) = .487, p > .05$. However, there was a significant difference between the groups with respect to WTAR estimated WAIS-III FSIQ, with the control group scoring higher than the brain injured group: $t(43) = 2.98, p < .01$. Nonetheless, both groups’ performances were still classified as within the average range.

2.3. Measures

In addition to completing the MET-WV (described below), participants completed a number of neuropsychological and psychometric measures. For the brain injured participants, the majority of this information was obtained from existing cognitive assessments (conducted as part of their routine clinical

examination). For the neurologically healthy control group, the measures were administered just prior to testing with the MET-WV. Details of the tests, including reliability and validity, are provided in Appendix 2.

2.3.1. Measures completed by brain injured participants and control group

Dysexecutive Questionnaire (DEX; Burgess et al., 1996). The DEX provided a measure of *everyday* executive ability, where ratings are made of observable behaviours that are symptomatic of underlying impairments of executive function. Ratings are made on a Likert-Type scale of twenty of the most commonly reported dysexecutive symptoms (e.g. disinhibition, confabulation). Control participants rated themselves using the self-completion version of the DEX (DEX-S; Burgess et al., 1996). The brain injured participants were rated on the second version of the questionnaire (DEX-O, Burgess et al., 1996) by a member of staff who knew the patient well. Informant report was used because lack of awareness and reduced insight are characteristic of patients with acquired brain injury (see Port, Willmott, & Charlton, 2002). Indeed, self-report of cognitive ability has been found to be only weakly (if at all) related to test performance in neurological populations (Burgess, et al., 1998; Goldstein & McCue, 1995).

Hospital Anxiety and Depression Scale (HADS: Zigmond & Snaith, 1983).

Participants rated aspects of their mood using the HADS – a self-report measure that yields a separate anxiety and depression score. In order to obtain an accurate reflection of the individual's emotional status at test, the HADS was administered just prior to testing on the MET-WV. The measure was included because increased anxiety and depression are associated with traumatic brain injury and may further

impair cognitive functions (Bowen, Neuman, Conner, Tennant, & Chamberlain, 1998; Ponsford, Sloan, & Snow, 1995) and thus may act as potentially confounding variables.

2.3.2. Measures completed by the brain injured participants

Four measures of frontal lobe and executive function were completed by the brain injured participants, one of which has proven ecological validity. In order to reduce Type one error (i.e. erroneously rejecting the null hypothesis, see Howell, 1997), only one variable from each measure was selected. Here, selection of the variables was based on previous research and relevance to clinical practice.

Traditional tests of frontal lobe function. The Controlled Oral Word Association Test (COWAT; Miller, 1984), the Cognitive Estimates Test (CET; Shallice & Evans, 1978), and the Modified Card Sorting Test (MCST; Nelson, 1976) were selected because they are well established and frequently administered tests (see Groth-Marnat, 2000; Lezak, 1995). Further, these measures have been included in previous ecological validity research (Burgess et al., 1998; Chaytor et al., 2006) and in the validation of simplified versions of the MET (Alderman, et al., 2003; Knight et al., 2002). A summary of each test is provided below - see Appendix 2 for more detail.

- (i) COWAT (Miller, 1984): Participants are required to produce as many words as they can that begin with the letters F, A, and S, respectively. Participants are required to adhere to two rules: not to use proper names and to not use the same word again with a different ending (e.g. “eat” and “eating”). The

variable selected for use in the analysis was the total number of admissible words produced across the three trials; this is because performance is believed to reflect behavioural spontaneity, and strategy formation for retrieval (see Obonsawin, Crawford, Page, Chalmers, Cochrane, & Low, 2002).

- (ii) Cognitive Estimates Test (Shallice & Evans, 1978): Participants are required to answer ten questions to which they are unlikely to know the exact answer (e.g., “what is the length of an average man’s spine?”) - requiring a reasonable estimate. The resulting error score is believed to measure strategy planning (Shallice & Evans, 1978), and represents the degree to which the participant’s scores deviate from the norm.
- (iii) MCST (Nelson, 1976): Participants are required to match cards that vary by colour, shape and number to four “key cards”. Participants are not told how to sort the cards, but must determine the correct category from feedback provided by the examiner, which changes periodically during the test. The variable selected for analysis was the percentage of perseverative errors committed during the test, this is because it is considered more purely executive than other variables (i.e. categories or non-perseverative errors) (Lezak, 1995).

Contemporary measure of executive function. The brain injured participants completed the Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson et al., 1996). The BADS was selected because it has been used in previous validation studies of the MET (Alderman et al., 2003; Knight et al., 2002), it is also rich in ecological validity, and is also widely used in clinical practice. The BADS comprises

six subtests whose successful completion loads heavily on the executive functions. The variable chosen for analysis was the profile score, which reflects performance on the BADS as a whole. The test authors reported that the profile scores for their brain injured sample was highly correlated with the DEX-O ratings, which suggests that the performance on the BADS is predictive of executive impairments.

2.4. Ward Version of the Multiple Errands Test (MET-WV)

2.4.1. The test environment

The MET-WV was carried out on an inpatient ward within the Kemsley Division at St. Andrew's Hospital, Northampton. Selection of the ward was based on a number of factors. Firstly, it contained features typical of most hospital wards, such as a nursing office, lounge and smoking room. Secondly, the patient group living on the ward were less susceptible to engaging in behaviours that could either disrupt, or at worst present a danger, to individuals participating in the study. Thirdly, the ward manager agreed for the research to be conducted on the ward, and briefed the staff accordingly.

2.4.2. Description of the MET-WV

The MET-WV comprised a simplified version of the procedure described by Shallice and Burgess (1991). Three modifications were made which mirrored those described in previous simplified versions of the MET (Alderman et al., 2003; Knight et al., 2002), that is: (i) provision of more concrete rules to enhance task clarity and reduce the likelihood of interpretation failures; (ii) simplification of task demands; and (iii) the provision of an instruction/exercise sheet which explicitly directed participants to record designated information. Here, the modifications served to

simplify the MET sufficiently to enable a broader range of participants to be tested – relative to the participants with superior IQ described by Shallice and Burgess (1991). Following the construction of an initial version of the MET-WV, a pilot study ($N = 3$) was carried out to establish the feasibility of the measure, and aspects of the test were modified as required (see Appendix 3.)

The sheet containing a summary of the test that was given to participants (referred to as the Exercise Sheet) is shown Appendix 3. The instructions that were read to participants by the assessor can also be found in Appendix 3.

Tasks. Participants were required to achieve four sets of simple tasks, totalling 12 separate subtasks. The first set of tasks required participants to attain six specific goals, which included asking for an A4 brown envelope from the Nursing Office, finding a magazine, and sliding a pad of lined paper under the door of the training kitchen. The second set of tasks required participants to obtain and write down four items of designated information, which included the number of fire exits on the ward and the name of the nurse in charge. In the third task, participants were required to meet the assessor outside the laundry 10 minutes after the test has begun and state the time. The final task was for the participant to inform the assessor when they have finished the test.

Rules. In order to reduce ambiguity and simplify task demands, the rules were made more explicit than those contained in the original MET. The rules were also clearly stated on the exercise sheet, which was carried throughout the test by the participants (cf. Alderman et al., 2003).

2.4.3. Measures specific to the MET-WV

Rule Recall. In order to obtain a measure of memory that could be specifically related to performance on the MET-WV, participants were asked to recall the task rules as soon as they had completed the test. For rules that were not recalled, prompts were then provided and the correct responses to the cues noted – a copy of the response sheet with prompts is provided in Appendix 3. The total number of rules recalled (including cued responses) was treated as a measure of memory for the purpose of analysis.¹⁰

Participant Ratings. Prior to commencing the MET-WV, separate ratings were obtained from the participant regarding their perceived ability to carry out the types of task undertaken in the test (efficiency), and their familiarity with the ward (cf. Alderman et al., 2003). The efficiency item was rated using a 10-point Likert type scale with weighted end points (1 = hopeless, 10 = excellent); familiarity was measured using a four-point scale (0 = not at all, 1 = somewhat, 2 = fairly well, 3 = very well). Following administration of the MET-WV participants were asked to rate the ease of completing the exercise (task ease) and how well they performed (competence). Task ease was rated using a 5-point scale (1 = very difficult, 2 = difficult, 3 = moderate, 4 = easy, 5 = very easy), and competency was rated using a 10-point scale as before (1 = hopeless, 10 = excellent). All four rating scales were presented on a single sheet of paper, see Appendix 3.

¹⁰ The total number of rules contains responses that were prompted as well as those retrieved without such assistance. Accordingly, this measure provided information about the amount of information stored in memory. Here, inability to recall (without prompts) may stem from problems with retrieval rather than the information simply not being consolidated and retained – thus, the prompting procedure effectively by-passes this issue (for a review, see Baddeley, 1995).

2.4.4. Procedure

Participants were accompanied to the ward by one assessor¹¹. For safety reasons, all the brain injured participants were also accompanied by an escort who was requested to keep the participant in line of sight at all times. Testing began outside the nursing office on the ward where patients were briefed by the assessor regarding what would be required of them.

First, as described above, the participant was asked to provide separate ratings concerning their efficiency and their familiarity with the ward. Participants were then given a clipboard that held a copy of the exercise sheet (see Appendix 3), a pen, a pad of lined paper, a pad of plain paper and a small paper bag. A wrist watch was also given to any participant who did not have one. The assessor then read aloud the instructions (see Appendix 3), and explained the rules with reference to the exercise sheet. It was emphasised that the assessor would follow and observe the participant at a distance and should not be spoken to unless it was a specific requirement of the exercise. Participants were invited to ask any questions that they had and then to summarise what they were expected to do. If necessary, the assessor repeated the instructions until he/she were satisfied that the participant was familiar with the demands of the test. Finally, the start of the test was signalled by the statement “Begin the exercise”.

The assessor made written notes for the purpose of recording behaviour and performance. The assessor did not initiate interaction with the participant unless this was necessary on the grounds of safety (e.g. if a participant attempted to leave the ward).

¹¹ The role of assessor was undertaken by the Principal Investigator for the majority of testing, although on several occasions the role was undertaken by an Assistant Psychologist (AP) who had been trained for this purpose. Nonetheless, the recordings of behaviour completed during testing were always scored by the Principal Investigator (with the AP present to clarify issues as necessary).

At the end of the test, the participant was asked to recall as many of the task rules as they could remember, and prompts were provided for those rules not recalled – their responses were noted on a score sheet (see Appendix 3). Care was taken to ensure that none of the test items were in the participant's view, as these could facilitate responses. Next, the participant was asked to provide ratings regarding task ease and their competency in carrying out the test – as previously described.

2.4.5. *Analysis of individual participant performance*

After the test, the assessor reviewed the observation notes to determine error scores regarding MET-WV performance. Errors were categorised using Shallice and Burgess (1991) definitions, that is: 1) *inefficiencies* – where a more effective strategy could have been applied; 2) *rule breaks* – where a specific rule (social, or one of the eight explicitly defined within the test) was broken; 3) *interpretation failure* – where the requirements of a task had been misunderstood; 4) *task failures* – where any one of the 12 tasks had not been completed satisfactorily. In addition, the number of times help was asked for (other than from the assessor conducting the test, as this comprised a rule breaking error) was also recorded and included in the analysis.

A concern was that as the MET-WV was a less structured test than most psychometric measures inter-rater reliability may be low (Crawford, 1998). In accordance with the procedure described by Knight et al. (2002), the observation scripts for the control group¹² were reviewed and the errors scored by an independent rater (the Consultant Neuropsychologist) – enabling inter-rater reliability to be examined. Nevertheless, in all cases the error scores generated by the Principal Investigator were used for the purpose of analysis.

¹² The original intention was for the two raters to review the scripts for brain injured participants and the control group. However, this proved too unwieldy in the time frame available to collect the data.

3. Results

3.1. *Inter-Rater Reliability*

Assessment of inter-rater reliability was conducted for the control group data only. Absolute agreement between raters across all error categories¹³ was reached for 14/24 participants (58.4%). The method proposed by Shrout and Fleiss (1979) was used to calculate the intraclass correlation coefficient (ICC) for total rule breaks, task failures, total errors and requests for help.¹⁴ The ICCs were: .97, .90, .92 and .99, respectively. According to the conventions described by Spitzer, Fleiss, and Endicott (1978), inter-rater reliability was considered to be good (all values were greater than .75).

Statistical analysis was not appropriate for inefficiencies and interpretation failures because very few of the behaviours were evident (see Table 2.). Most participants did not make any errors of this type. However, absolute agreement between raters was reached for 21/24 (87.5%) of cases concerning inefficiencies, and 21/24 (87.5%) of cases concerning interpretation failures. Overall, inter-rater reliability can be considered to be good across the error categories and requests for help.

¹³ For the purposes of inter-rater reliability the rule breaks were not separated into actual and social rule breaks – the scores included in the analysis corresponded to total rule breaks.

¹⁴ The single measure intraclass correlation was employed as this provides an index of the reliability of the ratings for a single judge – where one judge (the trainee) went on to provide ratings for the whole data set (brain injured and control group).

3.2. Comparison between brain injured and control participants' MET-WV performance

Summary statistics regarding the different error categories and requests for help are shown in Table 2. Where appropriate, possible differences between group means were investigated through application of independent samples t-tests. Separate variance estimates were used for those comparisons where Levene's test indicated that this was appropriate (see Howell, 1997).

The brain injured participants made significantly more rule breaks (actual and total) and achieved fewer tasks than controls, and overall made a greater number of errors. Statistical comparison of social rule breaks, inefficiencies and interpretation failure was not possible because there was little variance in the data (with most participants not making these errors). Nonetheless, there were more incidences of errors in these categories in the brain injured group. There was no significant difference between the groups in the number of requests for help.

3.2.1. Examination of the patterns of errors

Overall, the groups made very different numbers of errors: a typical brain injured participant made approximately twice the number of total errors as an average control. However, the relative proportions of the numbers of errors in each category were similar across groups. Actual rule breaks were the most common (48.6% and 52% of total errors for controls and brain injured participants, respectively). Task failures were the next most frequent (controls 47.1%, brain injured participants 42%). Rank order for the remaining error types (inefficiencies, interpretation errors and social rule breaks) were also similar, and comprised a very small proportion of the total errors - when the three categories were combined the

errors accounted for 4.3% of the control data, 6.1% for brain injured participants.

Given the small number of errors classed in the latter three categories, the data were amalgamated so that further quantitative analyses focused on total rule breaks, task failures and total errors – this was to avoid violating the assumptions of statistical tests.

Table 2. MET-WV Performance Amongst Control ($N = 24$) and Brain Injured Participants ($N = 21$)

Minimum and maximum refer to the scores the highest and lowest error scores within the data set, and total refers to the sum of the errors made across all participants comprising the group.

Error Category	Control					Brain injured					<i>t</i>	<i>p</i> *
	Mean	<i>SD</i>	Min	Max	Total	Mean	<i>SD</i>	Min	Max	Total		
Inefficiencies	.13	.34	0	1	3	.24	.54	0	2	5	N/A	-
Interpretation Failures	.00	.00	0	0	0	.24	.54	0	2	5	N/A	-
Total Rule Breaks	2.96	2.18	0	9	71	6.76	3.77	2	17	142	4.07	<.001 ^v
- actual	2.83	1.95	0	8	68	6.48	3.74	2	17	136	4.01	<.001 ^v
- social	.13	.34	0	1	3	.26	.72	0	3	6	N/A	-
Task Failures	2.75	1.54	0	6	66	5.24	2.76	1	11	110	3.67	=.001 ^v
Total Errors	5.83	3.10	2	14	140	12.48	5.05	3	22	262	5.23	<.001 ^v
Requests for help	2.21	1.50	0	5	53	2.43	2.29	0	7	51	.375	.710 ^v

* Two-tailed tests were used in the event that the reverse of the predicted hypotheses was true

^v Separate variance estimates used

N/A Data were unsuitable for statistical analysis

3.2.2. *Sensitivity of the MET-WV to neurological damage*

The sensitivity of the measure to neurological damage is demonstrated in the degree to which it can discriminate between the control and the brain injured groups. A cut-off score of 11 or more errors (total errors) was determined using the top 5th percentile of that of controls (cf. Alderman, 2003; Knight et al., 2002). Using this cut-off, 62% of the brain injured participants were correctly identified through their MET-WV performance (only one control would have been misclassified using this criteria).

Data were also explored using a qualitative approach, where the individual error types (as contrasted with categories) were examined. Here, the actual items comprising the categories of error were considered. For example, a frequently observed rule break was when a participant re-entered a room; an example of a frequent task failure was when a participant neglected to put the completed exercise sheet into the A4 brown envelope.

Overall, there appeared to be a qualitative difference in performance of the two groups. Twenty eight individual error types were demonstrated by controls, but considerably more were observed in the brain injured group (44). Twenty three error types were common across groups, with five additional types observed in the controls' performance. Critically, the brain injured participants demonstrated 21 error types unique to them. For example, 24% failed to write down the number of fire exits on the ward (a task failure), while no control did this. Others were less numerous: for example 14% repeated tasks (inefficiency), and one patient blocked the passage of people despite a request to move out of the way (social rule break).

3.3. *Effects of other variables on the MET-WV*

The number of category specific errors made (comprising total rule breaks and task failures) and total errors were correlated with: age, general cognitive ability, recall of rules, familiarity with the ward, and mood. The relationship between task performance and self-ratings of efficiency, task ease and competence were also considered – these were addressed last because the ratings were conceived as a reflection of personal experience rather than potentially affecting scores on the test. The correlations were conducted separately for each group. Two-tailed tests were used for all analyses because specific predictions regarding the direction of relationships between variables had not been made.

It is acknowledged that a general convention for multiple comparisons is the use of the Bonferroni correction to reduce the possibility of Type one errors. However, this correction is very conservative, and may increase the possibility that of rejecting an effect that does actually exist (Type two error) (see Field, 2005). Equally, this procedure is not generally adopted in the neuropsychological literature and in the majority of the studies reported in this volume. Accordingly, the Bonferroni correction has not been implemented in the present study. Finally, where *t* tests have been implemented, separate variance estimates were used for those comparisons where Levene's test indicated that this was appropriate.

3.3.1. *Age*

There were no significant correlations between age and MET-WV errors for either the control or brain injured participants (all p 's > .05). Here, the absence of a significant relationship between task performance and age is possibly a reflection of the relative youth of the two groups of participants – all participants were younger

than sixty. It is likely that the participants had not yet been subject to the age-related neurological processes associated with a decline in cognitive performance (for a review see Salthouse, 1991; Woodruff-Pak, 1997).

3.3.2. *FSIQ*

The WTAR predicted WAIS-III FSIQ was used as a measure of general cognitive ability for the control group, whilst scores from the WAIS-III were used for the brain injured participants. No significant relationships between MET-WV task performance and IQ emerged for the control group. However, higher IQ scores were found to be associated with a lower number of total errors in the brain injured group, $r = -.49, p < .05$. Nonetheless, significant differences in the performance of the control and brain injured participants was preserved when intelligence was treated as a covariate in a one-way independent analysis of variance (with total errors as the dependent variable): $F(1, 42) = 5.04, p < .05$.¹⁵ In essence, the difference between the brain injured and control groups' performance on the MET-WV cannot be simply accounted for in terms of intelligence.

3.3.3. *Memory*

The measure of memory implemented was the total number of MET-WV rules recalled immediately after test completion (maximum score of 8). As anticipated, the control group recalled a significantly greater number of rules than the brain injured participants: $t(27.45) = 6.85, p < .001$ (control mean = 6.75, $SD = .99$; brain injured mean = 3.29, $SD = 2.12$). A significant correlation was found between rule recall and total errors on the MET-WV for the control group ($r = -.44$,

¹⁵ As expected, intelligence was found to significantly related to task performance, $F(1, 42) = 7.87, p < .01$.

$p < .05$). The same relationship also emerged for the brain injured group ($r = -.45$, $p < .05$), and an even stronger association was found between the measure of memory and task failures ($r = -.59$, $p < .01$). Thus, poorer performance on the MET-WV (i.e. high error scores) was associated with fewer rules being recalled after completing the test.

Differences between groups were examined using one-way independent analysis of variance with the number of rules recalled as a covariate and total errors as the dependent variable. As expected, the covariate was significantly related to MET-WV task performance, $F(1, 42) = 10.19$, $p < .01$. Interestingly, the significant difference between the groups disappeared when variance attributed to rule recall was controlled ($F(1, 42) = 2.75$, $p = 0.10$).

3.3.4. *Familiarity*

Pearson Chi-Square indicated that there were no significant differences between the groups in the proportion of participants rating themselves on the categories of familiarity ($\chi^2 = 1.49$, $df = 3$, $p > .05$).¹⁶ Correlations using Kendall's tau-b were conducted for the ratings of familiarity and the two categories of errors and total errors – this statistic was used because the data set was quite small and contained a number of tied ranks (see Field, 2005). The only significant association found was between tasks failures and familiarity for the brain injured participants, *Kendall tau-b* = $-.398$, $p < .05$, which indicates that within this group there was a tendency for more task failures to be associated with less familiarity with the ward.

¹⁶ Due to the sample size, the contingency table contained three cells where the expected frequency was below five (the lowest was 4.2, highest 4.7) – therefore the test may have lost statistical power (Field, 2005). Nonetheless, given $p = .69$ it seems unlikely that a genuine difference would have been missed.

A one-way independent samples analysis of variance with familiarity as a covariate¹⁷ and task failures as the dependent variable was conducted. Here, significant differences in the performance of the brain injured and control group remained, $F(1, 42) = 17.52, p < .001$.¹⁸ Thus, the differences in performance with respect to tasks failures cannot be attributable solely to degree of familiarity with the ward.

3.3.5. *Mood*

Comparison of the two groups' scores on the Hospital Anxiety and Depression Scale (HADS) indicated that the brain injured group rated themselves as more anxious and depressed than controls. For anxiety $t(30.31) = 2.304, p < .05$ (control mean = 5.75, $SD = 3.00$; brain injured mean = 8.81, $SD = 5.40$); for depression $t(23.07) = 5.60, p < .001$ (control mean = 1.08, $SD = 1.32$; brain injured mean = 6.71, $SD = 4.44$). (With the exception of the brain injured mean anxiety score which was classified as "borderline", all other scores fell within the "normal" range.) Despite these differences, no significant correlations were found between the HADS and errors on the MET-WV for either group. Therefore, task performance does not appear to be significantly related to affect.

3.3.6. *Summary*

Examination of a series of variables that could potentially affect performance on the MET-WV revealed that both intelligence and familiarity with the ward were related to task performance, but only in the brain injured group. Nonetheless,

¹⁷ Whilst a non-parametric procedure was used in the previous correlation analysis, familiarity was treated as a covariate in the analysis of variance since inspection of the skewness and kurtosis scores indicated that the distribution was *not* too far away from normal to subject the data to this parametric procedure (Field, 2005).

¹⁸ As expected, familiarity was found to significantly related to task performance, $F(1, 42) = 7.01, p < .05$.

differences between the control and brain injured group remained when these factors were controlled for – thus, intelligence and familiarity could not solely account for differences between the groups' performance. However, recall of rules after the test was found to be significantly related to task performance in both groups, and differences between the groups disappeared when the variance attributable to memory was removed.

3.3.7. Exploring the relationship between self-ratings and performance on the MET-WV

Finally, the reflections of the participants upon their ability to manage tasks in everyday life and their experience of the MET-WV were considered. The self-rating scales used were: efficiency, task ease, and competency. The only significant differences between the groups emerged with regard to self-ratings of efficiency, with the control group rating themselves as more efficient at carrying out tasks like the MET-WV – although mean ratings for both groups were towards the “excellent” pole, $t(26.88) = 2.35, p < .05$ (control mean = 8.54, $SD = .93$; brain injured mean = 7.38, $SD = 2.09$).

With respect to task ease, mean ratings for both groups indicated that they experienced the MET-WV as an “easy” to “moderate” task (control mean = 3.25, $SD = .85$; brain injured mean = 3.66, $SD = 1.15$). In terms of competency, which was a reflection of how well participants thought they had done, most participants rated themselves just above the midpoint of the scale - towards the “excellent” pole (control mean = 6.92, $SD = 1.64$; brain injured mean = 7.05, $SD = 2.44$).

Despite the optimism of both groups, the only significant correlation that emerged was between competency and total errors for the control group, $r = -.413, p$

< .05. Here, lower ratings of competency were associated with greater errors, this is possibly a reflection of the difference in the degree of insight into task performance – brain injury is commonly associated with poorer insight into cognitive abilities (e.g. Port, Willmott, & Charlton, 2002).

3.4. *Validity*

While MET-WV performance differed between brain injured participants and controls, an anticipated function of the test is to reflect and confirm the presence and severity of everyday difficulties attributable to executive dysfunction. Accordingly, the relationship with existing measures of executive functioning was examined. Here, the majority of the analyses focused on the brain injured participants' data only.

3.4.1. *Relationship with traditional measures of executive function (frontal lobe tests)*

Association between the MET-WV (total rule breaks, task failures and total errors) and three traditional measures of executive functioning were considered (COWAT, MCST and Cognitive Estimates Test). The only significant correlation was between the COWAT (total number of words produced) and task failures, $r = -.53, p < .05$. The greater production of words on the COWAT was associated with fewer task failures.

3.4.2. *Relationship with an ecologically sensitive test – BADS*

In contrast to traditional measures of executive function, several significant correlations emerged between the MET-WV error scores and the BADS profile

score. Total errors were significantly related to the profile score, $r = -.55, p < .05$. An even stronger relationship emerged between tasks failures and the profile score, $r = -.65, p = .001$. Lower profile scores (indicative of executive dysfunction) were associated with greater task failures and overall errors on the MET-WV.

Interestingly, examination of the relationships between the four established measures of executive function revealed few significant correlations. Indeed, only the COWAT was found to significantly correlate with both the MCST (% of perseverative errors) and the profile score on the BADS – $r = -.61, p < .01$, and $r = .68, p = .001$, respectively. Here, the lower production of words on the COWAT was associated with greater perseverations on the MCST, and lower profile scores on the BADS (indicative of executive dysfunction).

3.4.3. *Relationship with the DEX questionnaire*

Finally, the relationship between the MET-WV and ratings regarding behavioural indicators of the dysexecutive syndrome was examined. As expected, comparison of the ratings made by rehabilitation staff concerning the brain injured participants' presentation (using the DEX-O) and the self-ratings of the control group (DEX-S) were significantly different, $t(30.64) = 8.22, p < .001$ (brain injured mean = 34.24, $SD = 10.40$; control mean = 13.13, $SD = 5.88$) – indicating that the brain injured participants had significantly greater dysexecutive difficulties.

Burgess et al. (1998)¹⁹ suggest that the DEX measures five principle symptom clusters: (i) *inhibition* – behavioural manifestations of disinhibition or inability to inhibit a habitual response; (ii) *intentionality* – difficulties in formulating goal-oriented plans and executing these satisfactorily; (iii) *executive memory* –

¹⁹ The authors proposed that the dysexecutive syndrome *fractionates* into five separate factors, and that different tests of executive function load differentially onto the factors.

disturbances of memory associated with executive dysfunction, especially those of confabulation and perseveration; (iv) *positive affect* – positive emotional and personality changes associated with dysexecutive function, including aggression and variable motivation; and (v) *negative affect* – negative emotional and personality changes, including apathy and shallow affect.

Total DEX-O scores and the sums of ratings pertaining to each of the five symptom clusters were correlated with the total rule breaks, task failures and total errors scores on the MET-WV. Surprisingly, no significant correlations emerged. (Indeed, the same absence of significant relationships between the DEX-S and MET-WV were found for the control group.)

Nonetheless, Alderman et al. (2003) suggested that the neurological patients may show different profiles with regards to their error style on the MET, which can be characterised by two patterns: individuals who show higher (relatively) task failures than rule breaks vs. those who show the opposite pattern. In the simplified shopping version of the MET, the brain injured participants were divided into subgroups according to error style and then comparisons of the severity of the five symptom clusters on the DEX were examined. The analyses revealed that different neuropsychological profiles emerged for each error style. Thus, in the present study significant relationships between performance on the MET-WV and the DEX *may* have been masked due to the different error styles of the brain injured participants (due to fractionation of the dysexecutive syndrome – see Burgess et al., 1998).

Accordingly, preliminary analyses were conducted to explore the relationship between error style and the five factors of the DEX. Naturally, any conclusions drawn from the statistical analyses will be tentative given that subgroups will be formed from a sample of 21 participants. The brain injured participants were

allocated into groups dependent upon their pattern of errors: 9 participants comprised the group where the number of task failures were greater than rule breaks (referred to as Task Failers), and 12 participants comprised the group where rule breaks were greater than task failures (referred to as Rule Breakers). Group comparisons examined the severity of the five symptom clusters on the DEX. For two symptom clusters, the differences were significant. Task Failers showed more severe “intentionality” symptoms, where the principal difficulty comprises formulating and executing plans, $t(19) = 2.98, p < .01$ (Task Failers mean “intentionality” score = 12.56, $SD = 3.95$; Rule Breakers = 8.00, $SD = 3.07$). Task Failers also showed more symptoms of “negative affect” comprising apathy and asponaneity, $t(19) = 2.061, p = .05$ (Task Failers negative affect mean score = 4.56, $SD = 2.70$; Rule Breakers mean = 2.50, $SD = 1.88$).

Separate correlations for each subgroup were then used to explore possible relationships between errors on the MET-WV and the total score and five symptom clusters of the DEX. Spearman’s rho was used as a conservative measure in light of the small sample sizes. Note, the correlation statistic is the item of interest rather than p values, this is because with small samples the correlation statistic has to be higher (closer to ± 1) to achieve significance. Here, correlation statistics of $\pm .30$ and above were of interest as these represent a medium size of effect (Field, 2005). For the Task Failers, reasonably strong correlations were found between executive memory and MET-WV total rule breaks and total errors (r_s ’s = .55 and .43, respectively). For the Rule Breakers, reasonable correlations were found between inhibition and MET-WV task failures and total errors (r_s ’s = -.35 and -.39, respectively), and between intentionality and MET-WV total rule breaks and task failures (r_s ’s = -.33 and -.32, respectively). Interpretation of these results will not

advanced here - any explanations would need to be speculative given the small sample size.

In summary, initial analyses indicated that there were no significant simple, linear relationships between the performance of brain injured participants on the MET-WV and the DEX. Nonetheless, two different error styles (“Rule breakers” and “Task Failers”) were found to map onto different neuropsychological profiles on the DEX. Indeed, exploring the relationships between the performance on the MET-WV and the DEX for each subgroup indicated that MET-WV may reflect aspects of everyday executive difficulties.

4. Discussion

In this study a hospital ward-version of the Multiple Errands Test was described, and its psychometric properties examined with reference to its role in clinical assessment. Firstly, the findings allayed Crawford’s (1998) concern that less structured tests such as the MET could lead to low inter-rater reliability. Agreement between the two raters regarding (control) performance errors was found to be good. Scoring was straightforward and highly reliable - with the majority of the errors falling under the auspices of rule breaks or task failures (for both groups of participants). Indeed, this pattern was anticipated given the modifications to Shallice and Burgess’ (1991) original methodology (cf. Alderman et al., 2003; Knight et al., 2002). Here, the rules were made more explicit and accessible to the participant, which in turn reduced ambiguity and simplified task demands - leading to fewer inefficiencies and interpretation failures.

In the following sections the research questions defined in the Introduction will be considered, and the findings discussed with reference to neuropsychological

theory and clinical practice. The final section reflects on the strengths and limitations of the study, which will be accompanied by recommendations for the direction of further research.

4.1 *Is the MET-WV sensitive to impairments in cognitive function?*

4.1.1 *Quantitative differences in performance between brain injured participants and controls*

Individuals with acquired brain injury were found to make significantly more errors than neurologically healthy controls. The mean performance within the brain injured group was over two standard deviations below the control mean. However, there was greater variability on the performance of brain injured participants, with not all the patients making errors outside the expected range – that is, brain injury does not automatically equate to executive dysfunction (at least, as measured by the MET-WV). Nonetheless, when this hypothesis was examined, the test was found to discriminate between brain injured and neurologically healthy controls with a fairly high degree of accuracy. Using a cut-off of 11 or more errors (i.e., 5th percentile of controls) 62% of the brain injured group were correctly classified, while only one control would have been incorrectly assigned. Such a degree of sensitivity is notable given that the actual test duration was in the order of 30 minutes. Furthermore, this finding compares very favourably to existing tests of frontal lobe and executive functioning, a number of which appear to lack test-sensitivity in discriminating controls from brain injured patients (see Alderman et al., 2003; Burgess et al., 1998). To clarify, using the 5th percentile of control performance as a cut-off, these authors found that a maximum of 39% of the patients were correctly identified using a range

of tests of frontal lobe function - indeed sensitivity was found to be as low as 4% for the Cognitive Estimates Test.

4.1.2. Qualitative differences in performance between brain injured participants and controls

Qualitatively, there were differences in performance between the two groups. When the types of error committed were examined (as opposed to error categories), there were a number that were unique to the brain injured participants. For example, no neurologically healthy participant failed to write down the number of fire exits on the ward: in contrast this error was demonstrated by nearly a quarter of the patients (24%). Other brain injured participant errors were much more idiosyncratic. For example, one participant shouted at a member of staff (social rule break), while another gave a magazine to a member of staff rather than the assessor (task failure). Indeed, this provides support for Shallice and Burgess' (1991) proposition that some forms of error are characteristic of acquired brain damage. In their simplified MET, Alderman et al, (2003) utilised this notion by weighting participants' error scores to reflect the important qualitative difference in the performance of individuals with brain injury. ("Normal" or acceptable errors seen observed in up to 95% of the controls were assigned a score of "1", errors only demonstrated by five percent or less of controls were assigned a score of "2", and errors unique to the brain injured group were assigned a weighted score of "3".) The authors found this to be a more sensitive scoring method – with 82% of the brain injured correctly identified. Unfortunately, the smaller number of participants in the present study²⁰ cautioned

²⁰ Compared with the present piece of research, there were twice as many participants in each group in Alderman et al.'s (2003) study.

against devising a system of weighted scores – although this does suggest a potentially useful area for further research.

4.1.3. The effect of other variables on task performance

A further result of importance for the clinical utility of the test was the finding that the MET-WV appears to be independent of the potentially biasing effects of general intellectual ability and familiarity with the environment. Neither of these variables was associated with the controls' performance. With regards to the brain injured participants, there were modest correlations between current level of intellectual ability (WAIS-III FSIQ) and total errors, and between familiarity with the ward and task failures. Nonetheless, the significant differences in brain injured participants' and controls' task performance remained when variability ascribed to FSIQ and familiarity was statistically controlled. Clearly this finding is counter to the suggestion that MET-WV failures in patients are principally due to non-executive problems.

Critically, the measure of memory used in the present study (total number of rules recalled) was found to correlate with total errors for both groups of participants (and also with task failures in the brain injured group). Moreover, the differences between the groups disappeared after statistically controlling for the variability attributed to "memory". Naturally, it is tempting to see this finding as suggesting that the difference between the brain injured and control groups' performance was simply due to memory disorder. However, it would have been very surprising if memory effects had not been discovered. Aspects of memory, particularly working and prospective memory, have been found to be closely related to executive function – where previously formed intentions depend on intact function of the supervisory

attentional system or central executive, i.e. multi-tasking (Baddeley, 1986; Kinsella, 1998). Equally, failure to use strategies, to manipulate and organise information, will also limit *recall* on memory tests (Howieson & Lezak, 1995). Accordingly, it seems highly likely that the measure of memory used in the present study drew on executive processes – thus, statistically controlling for memory may have unfairly eliminated “executive” variance from the analysis. In the light of the evidence, the strong hypothesis that memory ability was the source of difference in the performance of the two group cannot be entirely substantiated.

4.2. *How does the MET-WV compare with other tests of executive function?*

The findings support the hypothesis that stronger associations would be found between the MET-WV and an ecologically valid measure of executive function (BADS) compared with traditional measures of frontal lobe function. Here, strong relationships were found between MET-WV task failures, total errors and the BADS profile score – that is, poorer performance on the MET-WV was associated with lower scores on the BADS.

The only other significant relationship was found between task failures and the number of words produced on the COWAT. Equally, this test of verbal fluency was the only traditional measure found to correlate with the BADS. Furthermore, the absence of significant relationships between the traditional measures themselves (with the exception of the COWAT and MCST) lends support to the notion that these measures are unlikely to be tapping the same aspects of executive functioning (Burgess et al., 1998). To clarify, the dysexecutive syndrome has been found to fractionate - with different tests measuring different aspects of executive functioning (Burgess et al., 1998).

In light of the evidence, it seems reasonable to conclude the MET-WV and BADS are drawing on similar cognitive processes. Indeed, this strengthens the case that the MET-WV was measuring everyday executive function since the BADS has been rigorously validated in this regard (Wilson et al., 1996).

4.3. *Is the MET-WV a good predictor of behaviours that are symptomatic of impaired executive function observed in everyday life?*

Initial examination of the relationship between the MET-WV and the informant observations of the brain injured participants' everyday executive difficulties (DEX-O) suggested that the test was not reflecting these symptoms. Nonetheless, when the brain injured group were divided according to their error-making style: either Task Failers or Rule-Breakers (cf. Alderman et al., 2003) – different profiles on the DEX emerged. Here, people who tended to fail tasks (relative to those who broke rules) were noted by carers to show more problems with formulating and executing plans, appear more apathetic and lack spontaneity. Indeed, a similar pattern of impairments was noted by Alderman et al. (2003).

Arguably, relationships between the MET-WV and the DEX may have been masked by the presence of two different neuropsychological profiles (with respect to specific executive difficulties) within the brain injured group. Indeed, relatively strong relationships between the DEX and MET-WV emerged when the data were analysed separately for each profile. Naturally, given the size of the sample any interpretation would be highly speculative. Nonetheless, the findings suggest that acceptance of the null hypothesis cannot be entirely substantiated. Here, performance on the MET-WV *does* appear to capture (some) aspects of everyday executive

difficulties – but the relationship is not simple, and the *strength* of this prediction needs further exploration.

5. Critique

5.1. *Strengths of the Study*

A new test of executive functioning has been described, and examined with respect to reliability, sensitivity, and validity of the measure. The test appeared to withstand this examination on all counts. Furthermore, the MET-WV also caters to the needs of the clinician – testing is relatively brief, requires few resources, and can be conducted in an environment which is both safe (for the patient) but also yields clinical information that is not obvious through performance on other psychometric tests. For example, it involves free interactions and opportunity to observe social behaviour; equally, potential difficulties that a patient may encounter in responding to the demands of the ward environment can be readily identified. In this regard, performance could provide a clearer and more seamless link to rehabilitation. For instance, people who tend to fail tasks could be helped through the use of external aids or checklists (e.g. Burke, Zenicus, Weslowski, & Doubleday, 1991) or strategies designed to enhance planning/ problem solving and goal management (e.g. Manly, Hawkins, Evans, Woldt, & Robertson, 2002; McDonald, Flashman & Saykin, 2002). For people who tend to break rules, methods designed to remediate or circumvent monitoring problems could be implemented (e.g. Alderman, Fry, & Youngson, 1995; Alderman & Knight, 1997).

5.2. *Limitations of the Study*

A potential weakness of the present study is that the exact contribution of memory to performance on the MET-WV is not known. Moreover, recall of the MET-WV rules as a means of gauging memory ability is likely to be an “impure” memory measure. To clarify, the measure was opportune (although specific to the MET-WV) rather than derived from validated memory tests, such as the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1991) or Wechsler Memory Scale (Wechsler, 1997).²¹ Importantly, the *duration* or *frequency* of exposure of a participant to the rules on the MET-WV could not be controlled – that is, there was likely to be substantial variation in the number and length of the occasions that individuals referred to this information (on the exercise sheet). Clearly, executive processes are likely to play a role in this activity. Arguably, the memory measure used in the present study *may* actually reflect the ability to multi-task, since monitoring actions during testing and reference to the rules are key to successful task performance (cf. Baddeley, 1986; Norman & Shallice, 1986).

Notwithstanding, executive processes are implicated in validated measures of memory (e.g. Lowieson & Lezak, 1995). Future research could examine the relationship between the MET-WV and a validated measure of memory, with a view to conducting a multiple regression analysis to examine the contribution of executive (and non-executive) variation to MET performance.

A second issue that has been found to limit the study was the number of participants. Sample sizes were adequate to accommodate comparisons between brain injured and control participants, but finer grained analyses were hampered.

²¹ The decision to implement an opportune measure was made because a single consistent memory test had not been administered across the patients as part of their routine clinical examination – with different clinicians favouring different tests. Further testing was unfeasible due to time constraints, and may also have led to participant attrition.

Whilst examination of the types of error committed was made at the descriptive level, it was not viable to implement the system of weighted scores implemented by Alderman et al. (2003) - which was found to heighten the sensitivity of the MET to brain injury. Equally, exploration of the two types of error-making style in the brain injured participants and relationship to everyday executive dysfunction was limited – although the preliminary findings indicate there would be value in pursuing this matter.

Finally, the present study focused on the application of the MET methodology to a single ward – the applicability of the method to other wards or hospital settings is unknown. Clearly, this is an important consideration to clinicians who wish to implement the measure in everyday practice. Nonetheless, there is evidence to suggest that it would not be unreasonable to suppose generalisability – a version of the MET devised for use in the hospital grounds has been found to yield comparable results from two test sites (Knight, 1999; Knight et al., 2002).

6. Conclusion

In conclusion, this preliminary investigation regarding the utility of a ward-version of the Multiple Errands Test, which is simple and robust enough to use in clinical practice and with a range of brain injured patients is encouraging.

The findings contribute to the body of evidence confirming that test procedures with demonstrated ecological validity have much to offer the clinician. It would appear that MET methodology can offer a quick and sensitive measure of executive dysfunction, whilst providing insight into the everyday problems that a person with brain injury may encounter. Clearly, there is much to be gained by continuing to invest in the exploration of MET methodology – both in the context of

the ward and other environments – and its contribution to rehabilitation. Indeed, this remit is implicit in the recent clinical guidelines for *Rehabilitation following acquired brain injury*, which place considerable emphasis on the need to tailor rehabilitation programs to the individual (Royal College of Physicians & British Society of Rehabilitation Medicine, 2003). Further research into such a flexible and robust methodology fits well with clinical need outlined by such guidance.

References

- Acmonovic, M. L., Keatley, M. A., & Lemmon, J. (1993). The importance of qualitative indicators in the assessment of mild brain injury. *Journal of Cognitive Rehabilitation*, 11, 8 - 14.
- Alderman, N., Burgess, P., Knight, C., & Henman, C. (2003). Ecological validity of a simplified version of the multiple errands shopping test. *Journal of the International Neuropsychological Society*, 9, 31 - 44.
- Alderman, N., Fry, R. K., & Youngson, H. A. (1995). Improvement of self-monitoring skills, reduction of behaviour disturbance and the dysexecutive syndrome: Comparison of response cost and a new programme of self-monitoring training. *Neuropsychological Rehabilitation*, 5, 193 - 221.
- Alderman, N., & Knight, C. (1997). The effectiveness of DRL in the management and treatment of severe behaviour disorders following brain injury. *Brain Injury*, 11, 79 - 101.
- Alderman, N., Knight, C., Rutterford, N., & Swan, L. (2000). *Ecological validity of a simplified version of the Multiple Errands Test: Can it be used to drive treatment options and measure outcome in the rehabilitation of executive disorders?* Paper presented at the Impact 2000: An international conference on brain injury, Nottingham, England.
- Baddeley, A. (1986). *Working memory*. Oxford, England: Oxford University Press.
- Baddeley, A. (1995). The psychology of memory. In A. Baddeley, B. A. Wilson & F. N. Watts (Eds.), *Handbook of memory disorders* (pp. 3 - 25). Chichester, England: John Wiley & Sons, Ltd.
- Bajo, A., & Fleminger, S. (2002). Brain injury rehabilitation: What works for whom and when? *Brain Injury*, 16, 385 - 395.

- Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated review. *Journal of Psychosomatic Research*, 52, 69 - 77.
- Bowen, A., Neumann, V. A., Conner, M., Tennant, A., & Chamberlain, M. A. (1998). Mood disorders following traumatic brain injury: identifying the extent of the problem and the people at risk. *Brain Injury*, 12, 177 - 190.
- British Psychological Society. (2000). *Code of conduct, ethical principles and guidelines*. Leicester, England: British Psychological Society.
- Burgess, P., Alderman, N., Wilson, B. A., Evans, J., & Emslie, H. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmunds, England: Thames Valley Test Company.
- Burgess, P., Alderman, N., Wilson, B. A., Evans, J. J., & Emslie, H. (1996). The Dysexecutive Questionnaire. In B. A. Wilson, N. Alderman, P. Burgess, H. Emslie & J. J. Evans (Eds.), *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmunds, England: Thames Valley Test Company.
- Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, 4, 547 - 558.
- Burke, W. H., Zenicus, A. H., Weslowski, M. D., & Doubleday, F. (1991). Improving executive function disorders in brain injured clients. *Brain Injury*, 5, 241 - 252.
- Channon, S. (2004). Frontal lobe dysfunction and everyday problem-solving: Social and non-social contributions. *Acta Psychologica*, 115, 235 - 254.

- Chaytor, N., & Schmitter-Edgecombe, M. (2003). The ecological validity of neuropsychological tests: A review of the literature in everyday cognitive skills. *Neuropsychology Review*, 13, 181 - 196.
- Chaytor, N., Schmitter-Edgecombe, M., & Burr, R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology*, 21, 217 - 227.
- Crawford, J. R. (1998). Introduction to the assessment of attention and executive functioning. *Neuropsychological Rehabilitation*, 8, 209 - 211.
- Cripe, L. I. (1996). The ecological validity of executive function testing. In R. J. Sbordone & C. J. Long (Eds.), *Ecological validity of neuropsychological testing* (pp. 171 - 202). Delray Beach, FL: GR Oress, St. Lucie Press.
- Damasio, A. R. (1994). *Descartes' error. Emotion, reason and the human brain*. London: Papermac.
- Della Sala, S., MacPherson, S.E., Phillips, L.H., Sacco, L., & Spinnler, H. (2003). How many camels are there in Italy? Cognitive estimates standardised on the Italian population. *Neurological Science*, 24, 10 – 15.
- Eslinger, P. J., & Damasio, A. R. (1985). Severe disturbance of higher cognition after bilateral frontal ablation: Patient EVR. *Neurology*, 35, 1731 - 1741.
- Field, A. (2005). *Discovering statistics using SPSS* (2nd ed.). London: Sage.
- Gioia, G. A., & Isquith, P. K. (2004). Ecological assessment of executive function in traumatic brain injury. *Developmental Neuropsychology*, 25, 135 - 158.
- Goldstein, G., & McCue, M. (1995). Differences between patient and informant functional outcome ratings in head-injured individuals. *International Journal of Rehabilitation and Health*, 1, 25 - 35.

- Grant, D.A. & Berg, E.A. (1948). A behavioural analysis of degree of reinforcement and ease of shifting to new responses in a Wiegl-type card sorting problem, *Journal of Experimental Psychology*, 38, 404 – 411.
- Groth-Marnat, G. (2000). *Neuropsychological assessment in clinical practice*. New York: John Wiley & Sons.
- Howell, D. C. (1997). *Statistical methods for psychology* (4th ed.). Belmont, CA: Duxbury Press.
- Howieson, D. B., & Lezak, M. D. (1995). Separating memory from other cognitive problems. In A. D. Baddeley, B. A. Wilson & F. N. Watts (Eds.), *Handbook of memory disorders* (pp. 411 - 426). Chichester, England: John Wiley & Sons Ltd.
- Kinsella, G. (1998). Assessment of attention following traumatic brain injury: A review. *Neuropsychological Rehabilitation*, 8, 351 - 375.
- Knight, C. (1999). *The development of a hospital version of the multiple errands test to assess executive functioning following severe acquired brain injury*. Unpublished doctoral dissertation, University of Birmingham, England.
- Knight, C., Alderman, N., & Burgess, P. (2002). Development of a simplified version of the multiple errands test for use in hospital settings. *Neuropsychological Rehabilitation*, 12, 231 - 255.
- Levine, B., Katz, D. I., Dade, L., & Black, S. E. (2002). Novel approaches to the assessment of frontal damage and executive deficits in traumatic brain injury. In D. T. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 448 - 465). New York: Oxford University Press.
- Lezak, M. D. (1993). Newer contributions to the assessment of executive functions. *Journal of Head Trauma Rehabilitation*, 8, 24 - 31.

- Lezak, M. D. (1995). *Neuropsychological assessment* (3rd edition ed.). New York: Oxford University Press.
- Lippert-Grüner, M., Kuchta, J., Hellmich, M., & Klug, N. (2006). Neurobehavioural deficits after severe traumatic brain injury. *Brain Injury*, 20, 569 - 574.
- Manchester, D., Priestly, N., & Jackson, H. (2004). The assessment of executive functions: Coming out of the office. *Brain Injury*, 18, 1067 - 1081.
- Manly, T., Hawkins, K., Evans, J., Woldt, K., & Robertson, I. H. (2002). Rehabilitation of executive function: Facilitation of effective goal management of complex tasks using periodic auditory alerts. *Neuropsychologia*, 40, 271 - 281.
- McDonald, B. C., Flashman, L. A., & Saykin, A. J. (2002). Executive dysfunction following traumatic brain injury: Neural substrates and treatment strategies. *Neurorehabilitation*, 17, 333 - 344.
- Miller, E. (1984). Verbal fluency as a function of a measure of a measure of verbal intelligence and in relation to different types of cerebral pathology. *British Journal of Clinical Psychology*, 23, 53 - 57.
- National Institute for Clinical Excellence. (2003). *Head injury: Triage, assessment, investigation and early management of head injury in infants, children and adults*: National Institute for Clinical Excellence.
- Nelson, H. E. (1976). A modified card sorting test sensitive to frontal lobe defects. *Cortex*, 12, 313 - 324.
- Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behaviour. *Consciousness and Self-regulation: Advances in Research and Theory*, 4, 1 - 18.

- Norris, G., & Tate, R. I. (2000). The behavioural assessment of dysexecutive syndrome (BADS): Ecological, concurrent and construct validity. *Neuropsychological Rehabilitation, 10*, 33 - 45.
- Obonsawin, M. C., Crawford, J. R., Page, J., Chalmers, P., Cochrane, R., & Low, G. (2002). Performance on tests of frontal function reflects general intellectual ability. *Neuropsychologia, 40*, 970 - 977.
- O'Carroll, R.E., Egan, V., & MacKenzie, D.M. (1994). Assessing cognitive estimation. *British Journal of Clinical Psychology, 33*, 193 – 197.
- Ponsford, J., Sloan, S., & Snow, P. (1995). *Traumatic brain injury: Rehabilitation for everyday adaptive living*. Hove, England: Lawrence Erlbaum and Associates.
- Port, A., Willmott, C., & Charlton, J. (2002). Self-awareness following traumatic brain injury and implications for rehabilitation. *Brain Injury, 16*, 277 - 289.
- Reynolds, E., & Leung, S.N.M. (2003, February). Test review: The Wechsler Test of Adult Reading (WTAR), *Division of Neuropsychology Newsletter, 2*, p 3 - 5.
- Richardson, J. T. E. (2000). *Clinical and neuropsychological aspects of closed head injury* (2nd ed.). Hove, England: Psychology Press.
- Royal College of Physicians & British Society of Rehabilitation Medicine. (2003). *Rehabilitation following acquired brain injury: National clinical guidelines*. London: RCP, BSRM.
- Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Saver, J., & Damasio, A. R. (1991). Preserved access and processing of social knowledge in a patient with acquired sociopathy due to ventromedial frontal damage. *Neuropsychologia, 29*, 1241 - 1249.

- Sbordone, R. J. (1996). Ecological validity: Some critical for the neuropsychologist. In R. J. Sbordone & C. J. Long (Eds.), *Ecological validity of neuropsychological testing* (pp. 15 - 42). New York: St Lucie Press.
- Schnider, A., & Gutbrod, K. (1999). Traumatic Brain Injury. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (pp. 487 - 506). New York: Guildford Press.
- Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain*, 114, 727 - 741.
- Shallice, T., & Evans, M. E. (1978). The involvement of the frontal lobes in cognitive estimation. *Cortex*, 14, 294 - 303.
- Shimamura, A. P. (1995). Memory and frontal lobe function. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 803 - 813). Cambridge, MA: MIT Press.
- Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*, 86, 420 - 428.
- Spitzer, R. L., Fleiss, J. L., & Endicott, J. (1978). Problems of classification: Reliability and validity. In M. A. Lipton, A. DiMascio & K. F. Killam (Eds.), *Psychopharmacology: A generation of progress*. New York: Raven.
- Spreen, O., & Strauss, E. (1998). *A compendium of neuropsychological tests: Administration, norms and commentary (2nd Edition)*. New York: Oxford University Press.
- Wechsler, D. (1997). *Wechsler Memory Scale (3rd Edition)*. San Antonio, TX: Psychological Corporation.
- Wechsler, D. (1999). *The Wechsler Adult Intelligence Scale - Third Edition*. Oxford, England: Harcourt Assessment.

- Wechsler, D. (2001). *The Wechsler Test of Adult Reading* (UK ed.). Oxford, England: Harcourt Assessment.
- Wilson, B. A. (1993). Ecological validity of neuropsychological assessment: Do neuropsychological indexes predict performance in everyday activities? *Applied and Preventative Psychology*, 2, 209 - 215.
- Wilson, B. A., Alderman, N., Burgess, P., Emslie, H., & Evans, J. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmunds, England: Thames Valley Test Company.
- Wilson, B. A., Cockburn, J., & Baddeley, A. (1991). *The Rivermead Behavioural Memory Test*. Bury St Edmunds, England: Thames Valley Test Company.
- Woodruff-Pak, D. S. (1997). *The neuropsychology of aging*. Malden, MA: Blackwell Publishers, Inc.
- Zigmond, A., & Snaith, P. (1993). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, 67, 361 - 370.

SECTION 3

CRITICAL APPRAISAL

DEVELOPMENT OF A SIMPLIFIED VERSION OF THE MULTIPLE ERRANDS TEST FOR USE ON A HOSPITAL WARD

1. Origins

The study evolved as a consequence of my interest in neuropsychology and a fortunate meeting with Dr. Nick Alderman, Consultant Clinical Neuropsychologist, at a research fair held in the Department of Clinical Psychology at the University of Leicester.

Without doubt, my interest in neuropsychology has been coloured by my father's head injury, which he sustained three years ago. The first-hand experience of the impact of a brain injury, aptly referred to as "the ripple effect" (Lapotaire, 2003), has made me acutely aware of the importance of assessment with respect to the structure and aims of rehabilitation. Accordingly, when Dr. Nick Alderman described his involvement in a series of studies that sought to develop a means of assessing executive functioning with a *direct* link to rehabilitation – my interest was captured. Indeed, in reviewing the literature, it became apparent that many existing measures of executive function failed to reflect the everyday difficulties experienced by individuals who had sustained a brain injury. Clearly, this potentially presents a problem for the implementation of appropriate rehabilitation programmes, whilst also having ramifications for the medical-legal arena.

In contrast, the studies using the Multiple Errands methodology, which employs behavioural observation of tasks undertaken in "real-life" settings, indicated that this approach was a *valuable* and highly *viable* means of assessing executive dysfunction (Alderman, Burgess, Knight, & Henman, 2003; Knight, Alderman, & Burgess, 2002). Following a series of meetings with Dr. Nick Alderman, we decided to investigate whether the Multiple Errands methodology could be applied to a hospital ward, and importantly, whether this would have utility for clinical use. In essence, the drive was to develop a tool that was capable of reflecting everyday

executive problems, yet has the desirable characteristic of being easy to administer (in terms of time taken and resources employed), as well as being suitable for patients with mobility and/or behavioural problems.

2. Development of the Ward Version of the Multiple Errands Test

The initial stage of the development process was to consider how to adapt the MET methodology to the ward environment, and then to establish the appropriate means of assessing the test's utility for clinical use. The key to the translation of the methodology was the maintenance of characteristics of the MET that were known to present difficulties for patients with dysexecutive syndrome. In other words, the remit was to devise a test that required participants to use subtle planning and prospective memory, whilst being "ill structured" - in that there were multiple ways to approach the task and participants need to decide for themselves how to proceed (Burgess, 2000; Burgess, Veitch, Costello, & Shallice, 2000; Shallice & Burgess, 1991).

2.1. Task Development

As a starting point, the possible tasks that a patient could undertake on the ward were considered. In addition, these tasks needed to be generalisable to other wards for the test to be potentially viable for clinical use outside of St. Andrew's hospital. Drawing on personal experience of other hospital wards, there were a number of characteristics that they shared - such as a staff, nursing office, lounge and smoking room. Accordingly, a short list of potential tasks was drawn up and discussed with my supervisor and staff who worked on the wards.

2.2. *Establishing the Rules*

Perhaps the most time consuming stage of development was establishing the MET rules. Here, a careful balance needed to be drawn up so that the rules were not too “alien” to the demands of real-life, yet would place relative high demand on planning and problem-solving skills – ensuring that the controls would not perform at ceiling.

To facilitate the process, a number of rules were taken directly from the previous MET studies to create a basic framework. Examples include: not speaking to the examiner and the instruction to carry out *all* the tasks (but in any order). Several rules were then adapted; for example, the instruction to stay within specific limits of the shopping precinct – which in the present study became a rule specifying that the participant was to stay within the limits of the ward. Equally, the requirement for participants to not return to a shop that already been visited, became the instruction to not go back into any room that (the participant) had already been in.

Finally, a number of *new* rules were devised. Here, a rule analogous to the instruction not to spend more than a certain amount of money (used in both the hospital and shopping versions of the MET) was to “not carry more than one item at a time”. Similarly, the rule to not buy more than two items from a predefined shop became “you should ask no more than two questions to the same member of staff”.

Subsequent piloting of the MET-WV confirmed the adequacy of the rules – both in terms of clarity and demands on executive skills. Indeed, the only amendments required were related to the tasks – these included revising one task so that the information to solve the problem was *always* guaranteed to be available, and shortening the time to meet the examiner from twenty to ten minutes.

2.3. *Selecting the Measures*

In order to explore the relationship of the MET-WV with existing measures of executive function, a number of neuropsychological tests were selected for comparison. In accordance with previous MET studies, the measures comprised a number of frontal lobe tests, which were widely used in clinical settings. A further measure of executive function was the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996), which has demonstrated ecological validity. Here, it was anticipated that the MET-WV would have a stronger relationship with the BADS, due to the shared focus on *everyday* executive difficulties, as opposed to the traditional measures which captured *aspects* of the dysexecutive syndrome but with little relation to reality. To enable exploration of the influence of *other* factors on MET-WV performance, a number of additional measures were also selected, which included tests of general cognitive functioning, memory and mood.

Naturally, the selection of measures was governed strongly by whether they were routinely administered to the patients. Clearly, requiring the patients to undertake a large battery of tests would be unfeasible in the time constraints, and could have led to participant attrition due to fatigue (and possibly anxiety). Accordingly, care was taken to ensure that the measures were frequently used by psychologists within Kemsley Division.

Surprisingly, the only measure that did present a problem was memory. Here, different psychologists appeared to favour different assessment tools, with the range comprising: Wechsler Memory Scales—third edition (WMS-III, Wechsler, 1997), Adult Memory and Information Processing Battery (AMIPB; Coughlan & Hollows, 1985), and the Rivermead Behavioural Memory Test (RBMT; Wilson, Cockburn &

Baddeley, 1985). A solution to the problem was the application of a simple and quick measure of memory that could be administered at test, which avoided the need to engage patients with further assessment. Here, all the participants were asked to recall the rules that they had been asked to follow during the MET-WV. There were several benefits of this approach: firstly, it provided a measure of memory that was *specific* to the test, and secondly the measure was administered to *both* the control and patient group – thus providing information about the influence of memory in both groups' performance (this had been an area of interest highlighted by previous MET studies).

In summary, the process of developing the test required quite a long period of deliberation. A careful balance had to be drawn up between placing too great or too little demands on participants – risking floor and ceiling effects. Supervision proved pivotal in the exposition of ideas - facilitating the development and construction of the test and the optimal selection of psychometric measures (given the time constraints and available patient data).

3. Peer Review and Ethical Approval

A research proposal was prepared, subjected to an internal university review, submitted to St. Andrew's Group of Hospitals Research Group for approval of the study, and finally ethical approval was sought from the Leicestershire, Northamptonshire and Rutland research ethics committee. The whole process took approximately 7 months – running from May to December 2005 (when a favourable ethical opinion was received).

Whilst the process was time consuming and occasionally frustrating (due to delays and changes to meetings), it was a useful experience. My prior experience of research had been on studies where grants had already been obtained and ethical approval was not required. Accordingly, I needed to take time to review the relevant documentation (which was substantial with respect to the NHS ethics application) and examine the contents of successful applications to ensure that the requirements of the reviewers were addressed.

In the region where the study was to be conducted applicants were invited to attend the ethics committee where their proposal was discussed. Whilst anxiety provoking, attending the meeting did facilitate the application process. Here, clarification on issues could be sought with both parties present and without substantial paper work. In light of this experience, I would elect to attend ethics committee meetings for future research proposals, where possible.

The only modification to the proposed study was a series of amendments to the patient information sheet – the NHS ethics panel expressed concerns that the language was too technical for individuals with brain injury. The amendments were made in consultation with a Speech and Language therapist, and the patient information sheet was then sent to be reviewed by a Service Users Group at Kemsley Division – no concerns were raised.

4. Conducting the Research

One of the key learning experiences that I have drawn from undertaking the research project has been recognition of the need to build flexibility into projections of the time scale for the study. Previous projects have taught me to build in extra-time into estimations of when a deadline can be accomplished. Nonetheless, there

were a number of external factors accompanying the present study that led to quite substantial amendments to the timetabling of project-oriented tasks – these issues will be described below.

4.1. Organisation and Competing Demands

By the time that the ethical approval for the study had been granted, I had already begun my year-long specialist placement at Kemsley Division. The original intention had been to commence data collection in October 2005 with projected completion by February 2006. However, the delays inherent in passing through three review panels meant that initiation of data collection was already two months behind schedule. Nonetheless, my presence at the hospital facilitated the ground work to enable a smooth transition into data collection – the processes included becoming acquainted with key members of staff, familiarising myself with hospital policy and procedures, undertaking a pilot with Assistant Psychologists, and preparing a number of test materials.

Ethical approval was received just prior to the Christmas Break, which meant that there was a frustrating lull in research activity until January. However, the recruitment of staff members for the neurologically healthy control group proved smoother than originally anticipated, which enabled some time to be gained. Nonetheless, the desire to accrue as much data in as short a time-scale as possible took its toll. Here, undertaking two parallel placements (the second in a Child and Adolescent Mental Health Team in a different county) demanded a high degree of mental and emotional energy – thus depleting resources. Equally, the time taken as research days meant that there were frequent short periods where I was absent from placement, which in turn impacted both on the scheduling and preparation of client-

work. In sum, fatigue and anxiety (regarding clinical and research issues) became uncomfortable bed fellows.

Fortunately, in February 2006 the opportunity arose to develop a small research team, which lessened the burden of recruitment and data collection. I was joined by two MSc students who were keen to obtain experience of involvement in a research project – one to fulfil part of her course requirements, the other student with a view to comparing the results of the present study with data collected from a shopping version of the MET. Whilst there was a degree of pressure in organising and coordinating the small team – the experience was positive. Possibly the hardest aspect was reliance upon others to undertake activities that I normally undertook myself – such as collection of basic background data, locating case files, and organising appointments with participants. To a degree this was a reflection of my own need to relinquish absolute control over every aspect of the project. Nonetheless, observing others' interest in the study and the discussions that emerged over the course of data collection were very valuable with regards to both maintaining motivation and facilitating decision-making.

4.2. Participant Recruitment

The recruitment of control participants was easier than I had originally foreseen. Posters were placed around the grounds of the hospital, and interested parties invited to use an office contact number or email. With the rapid influx of interest, it was necessary to devise a timetable so that I could easily keep track of bookings and available appointments. Equally, I needed to be sure that I had enough time was allocated per appointment to enable accommodate delays, such as late

arrival or unexpected eventualities such as the disturbances on the ward – and to allow time to type up the test observations and prepare experimental materials.

In contrast, the recruitment of brain injured participants was more complicated and subject to delays. Whilst the selection of patients to approach was straightforward, achieved through discussion with clinicians and assistant psychologists – the route to testing was not so direct. Firstly, the Responsible Medical Officers (RMOs) for the wards were asked for their opinions regarding all the patients' capacity to consent to take part in the research. Naturally, due to work commitments the response was not always as swift as desired. Secondly, letters of invitation to the study and information sheets were forwarded to the patients via their care coordinators. Frustratingly, a number of letters were lost in transit, and requests for staff to broach the topic of the research with the patients were sometimes slow to come to fruition. Finally, the organisation of appointments with patients was often fraught with difficulty. In part, most of the problems stemmed from insurmountable staff commitments – here, escorting a patient took one member of staff away from ward duties for up to an hour. However, despite the frustrations and anxiety entailed by the delays, the brain injured participants' test data was eventually collected over a period of two months (March – April 2006).

In hindsight, these issues are a reflection of the difficulties inherent in testing inpatient populations. Realistically, the only approach to managing the situation is to allow flexibility in the time-schedule and to be prepared to reorganise activities to make optimal use of the time available. Nonetheless, I also learnt that persistence is a necessary requirement in such a hectic environment. To clarify, a research project is not necessarily upper most in priorities for staff, although gentle reminders and becoming a familiar face on the wards did appear to assist with the process.

4.3. *Data Collection*

The experience of administering a newly developed test, especially when it felt such a high personal investment, was in the same breath: exciting and anxiety-provoking, but also without doubt - rewarding. In particular, I was struck by the interest that the participants showed in the study. Equally, I was aware that for some of the staff the process was quite stressful – since they were effectively subjecting themselves to assessment by a colleague. In some respects, the patients were less anxious - perhaps due to their experience of regular psychological assessment. A number of the patients expressed appreciation of the time and interest that they received from me, with many individuals stating that they enjoyed doing the test - and several expressed keenness to participate in further research. Overall, whilst testing drew heavily on my observation skills, I was aware that I relied strongly on my clinical skills for managing the more interpersonal aspects of testing – such as building rapport, allaying concerns and being sensitive to participants' cognitions regarding their performance.

A large proportion of the data was collected from patient files. Initially this appeared to be a straightforward process, yet it soon became apparent that the content and structure of the files were affected by a number of variables: such as the ward on which patients were resident, how long they had been a patient at the hospital, as well as the professionals involved in their care (with separate filing systems for certain notes). Fortunately, members of “my” research team and the assistant psychologists were on hand to locate much of the information, although many hours were spent rummaging through mounds of paper work in filing cabinets and holed up in storage rooms amongst the archive files.

4.4. Data Analysis

In many respects data analysis proved the most fraught period of the research process. On reflection, much of the pressure stemmed from the impending deadline for thesis submission. Nonetheless, I was aware that a fair proportion of anxiety could be attributed to *me* for wanting to prove that I could offer something of value. The notion that the project could amount to accepting a series of null hypotheses was unpleasant, but a potential reality. Equally, there was the nagging doubt as to whether the findings would cover all the issues pertinent to assessing the clinical utility of the measure.

In order to find a means of containing these concerns, I drew up a list of research questions based on those that had been addressed by previous studies using the MET methodology. Naturally, for the purpose of a thesis it would be unfeasible to pose and address all possible questions of interest, therefore a short-list of the imperative issues was devised and analyses conducted. Meetings with my academic and clinical supervisors also served to allay some of the concerns. Indeed, the conversations enabled me “to take a step back” and relieve the self-imposed need to produce the “perfect” piece of work.

5. General Reflections

The experience of developing a neuropsychological measure for use in a clinical setting has been both demanding and rewarding. The practical application of the study contrasts with much of my previous experience of research, where the studies tended to focus on a singular psychological (cognitive) phenomenon - often within the isolation of a university laboratory.

The process of implementing and conducting the research has made me acutely aware of the practical difficulties in putting ideal research methodology into practice. Compromise and flexibility became key activities, in terms of: (i) the need to utilise and optimise the *available* resources rather than pursue the ideal (re: neuropsychological measures); (ii) to accept that research processes are dynamic and subject to external factors – requiring careful re-scheduling of project-oriented tasks; and (iii) that a piece of research conducted on a relatively short-time scale cannot address every question that could be asked.

6. Summary

Reflecting on the process of research, I have learnt the following:-

- a) Practical difficulties are inherent in research in the “real-world” – flexibility and compromise are key.
- b) Supervision is an invaluable resource – both in terms of working through ideas and finding solutions to problems, but also with respect to managing the anxiety of undertaking a research project.
- c) Subjecting a research proposal to review panels is a long and exhaustive exercise, but the time and effort invested *facilitate* the process of drawing the research ideas together into a feasible format.
- d) The balance of clinical work and conducting research is difficult to achieve, since both place competing demands on time and energy.
- e) Managing a small research team is demanding but rewarding. Working with others maintains motivation and provides a forum for ideas to be explored, whilst easing the burden of data collection.

- f) Gentle persistence and persuasion are often required with staff in the ward environment - where there are many priorities surpassing a research project.
- g) There are substantial rewards in working with participants who are genuinely interested in the research.
- h) Despite the levels of anxiety, there is a high degree of satisfaction in conducting research in clinical settings – especially when the product has the potential to be implemented in clinical practice.

References

- Alderman, N., Burgess, P., Knight, C., & Henman, C. (2003). Ecological validity of a simplified version of the multiple errands shopping test. *Journal of the International Neuropsychological Society*, 9, 31 - 44.
- Burgess, P. W. (2000). Strategy application disorder: the role of the frontal lobes in human multitasking. *Psychological Research*, 63, 279 - 288.
- Burgess, P. W., Veitch, E., de Lacy Costello, A., & Shallice, T. (2000). The cognitive and neuroanatomical correlates of multitasking. *Neuropsychologia*, 38, 848 - 863.
- Coughlan, A., & Hollows, S. E. (1985). *Adult Memory and Information Processing Battery*. Leeds, England: St. James' University Hospital.
- Knight, C., Alderman, N., & Burgess, P. (2002). Development of a simplified version of the multiple errands test for use in hospital settings. *Neuropsychological Rehabilitation*, 12, 231 - 255.
- Lapotaire, J. (2003). *Time out of mind*. London: Virago Press.
- Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain*, 114, 727 - 741.
- Wechsler, D. (1997). *Wechsler Memory Scale (3rd Edition)*. San Antonio, TX: Psychological Corporation.
- Wilson, B. A., Alderman, N., Burgess, N., Emslie, H., & Evans, J. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmunds, England: Thames Valley Test Company.
- Wilson, B. A., Cockburn, J., & Baddeley, A. (1985). *The Rivermead Behavioural Memory Test*. Bury St Edmunds, England: Thames Valley Test Company.

Appendix 1 Research Administration

- 1.1. Copy of notes for contributors to “Neuropsychological Rehabilitation”
- 1.2. Copies of Letters of Ethical Approval
- 1.3. Details of the Recruitment Process
- 1.4. Patient Information Sheet
- 1.5. Patient Consent Form
- 1.6. Information Sheet (for neurologically healthy control group)
- 1.7. Consent Form (for neurologically healthy control group)

1.1. Copy of Notes for Contributors to “Neuropsychological Rehabilitation”

Instructions for Authors - Neuropsychological Rehabilitation

*****Note to Authors:** please make sure your contact address information is clearly visible on the **outside** of all packages you are sending to Editors.***

Manuscripts are invited for submission. Please note that authors are encouraged to submit papers electronically to expedite the peer review process. Please email your paper, saved in a standard document format type such as Word, Rich Text Format, or PDF, to eleonor.wood@informa.com. Alternatively, if you wish to submit a hard copy, please send one copy of the manuscript AND a disk version to: Journals Editorial Assistant, Psychology Press Ltd, 27 Church Road, Hove, East Sussex, BN3 2FA, UK. Tel: (0)20 7017 7730, Fax: (0)20 7017 6717.

Your covering email/letter must include full contact details (including email), the title of the journal to which you are submitting, and the title of your article.

All manuscripts should be submitted in American Psychological Association (APA) format following the latest edition of *Publication Manual of the APA* (currently 5th edition).

Authors will normally receive a decision on their papers within three months of receipt, and if accepted they will normally be published six to nine months later. The date of receipt of the manuscript will be printed. Where minor revision of a paper is requested the original date of receipt will appear, provided that a satisfactory revision is received within one month of the request. Otherwise it will bear the revised version date.

Copyright. It is a condition of publication that authors vest or license copyright in their articles, including abstracts, in Psychology Press, an imprint of the Taylor & Francis Group, an Informa business. This enables us to ensure full copyright protection and to disseminate the article, and the journal, to the widest possible readership in print and electronic formats as appropriate. Authors may, of course, use the material elsewhere after publication providing that prior permission is obtained from Taylor & Francis. Authors are themselves responsible for obtaining permission to reproduce copyright material from other sources. To view the 'Copyright Transfer Frequently Asked Questions please visit www.tandf.co.uk/journals/copyright.asp.

Journal Production Editor: web.queries@tandf.co.uk

FORMAT

Typescripts. The style and format of the typescripts should conform to the specifications given in the *Publication Manual of the American Psychological Association* (5th ed.). Typescripts should be **double spaced** on **one side** only of A4 paper, with adequate margins, and numbered throughout. The title page of an article should contain only:

- (1) the title of the paper, the name(s) and address(es) of the author(s);
- (2) a short title not exceeding 40 letters and spaces, which will be used for page headlines;
- (3) name and address of the author to whom correspondence and proofs should be sent;
- (4) your telephone, fax and e-mail numbers, as this helps speed of processing considerably.

Abstract. An abstract of 50-200 words should follow the title page on a separate sheet.

Headings. Indicate headings and subheadings for different sections of the paper clearly. Do not number headings.

Acknowledgements. These should be as brief as possible and typed on a separate sheet at the beginning of the text.

Permission to quote. Any direct quotation, regardless of length, must be accompanied by a reference citation that includes a page number. Any quote over six manuscript lines should have formal written permission to quote from the copyright owner. It is the author's responsibility to determine whether permission is required from the copyright owner and, if so, to obtain it. (See the bottom of the page for a template of a letter seeking copyright permission.)

Footnotes. These should be avoided unless absolutely necessary. Essential footnotes should be indicated by superscript figures in the text and collected on a separate sheet at the end of the manuscript.

Reference citations within the text. Use authors' last names, with the year of publication in parentheses after the last author's name, e.g., "Jones and Smith (1987)"; alternatively, "(Brown, 1982; Jones & Smith, 1987; White, Johnson, & Thomas, 1990)". On first citation of references with three to six authors, give all names in full, thereafter use first author "et al.". If more than one article by the same author(s) in the same year is cited, the letters a, b, c etc. should follow the year.

Reference list. A full list of references quoted in the text should be given at the end of the paper in alphabetical order of authors' surnames (or chronologically for a group of references by the same authors), commencing as a new sheet, typed double spaced. Titles of journals and books should be given in full, e.g.:

Books:

Baddeley, A. D. (1999). *Essentials of human memory*. Hove, UK: Psychology Press.

Chapter in an edited book:

Plomin, R., & Dale, P. S. (2000). Genetics and early language development: A UK study of twins. In D. V. M. Bishop & L. B. Leonard (Eds.), *Speech and language impairments in children: Causes, characteristics, intervention and outcome* (pp. 35-51). Hove, UK: Psychology Press.

Journal article:

Schwartz, M. F., & Hodgson, C. (2002). A new multiword naming deficit: Evidence and interpretation. *Cognitive Neuropsychology*, 19, 263-288.

Tables. These should be kept to the minimum. Each table should be typed double spaced on a separate sheet, giving the heading, e.g., "Table 2", in Arabic numerals, followed by the legend, followed by the table. Make sure that appropriate units are given. Instructions for placing the table should be given in parentheses in the text, e.g., "(Table 2 about here)".

Figures. Figures should only be used when essential. The same data should not be presented both as a figure and in a table. Where possible, related diagrams should be grouped together to form a single figure. Figures should be drawn to professional standards and it is recommended that the linear dimensions of figures be approximately twice those intended for the final printed version. Each of these should be on a separate page, not integrated with the text. Figures will be reproduced directly from originals supplied by the author(s). These must be of good quality, clearly and completely lettered. Make sure that axes of graphs are properly labelled, and that appropriate units are given. Photocopies will reproduce poorly, as will pale or broken originals. Dense tones should be avoided, and never combined with lettering. Half-tone figures should be clear, highly-contrasted black and white glossy prints.

Black and white figures are included free of charge. Colour figures are not normally acceptable for publication in print – however, it may be possible both to **print** in black and white and to **publish online** in colour. Colour figures will only be printed by prior arrangement between the editor(s), publisher and author(s); and authors may be asked to share the costs of inclusion of such figures.

The figure captions should be typed in a separate section, headed, e.g., "Figure 2", in Arabic numerals. Instructions for placing the figure should be given in parentheses in the text, e.g., "(Figure 2 about here)". More detailed *Guidelines for the Preparation of Figure Artwork* are available from the publisher: Psychology Press Ltd, 27 Church Road, Hove, East Sussex BN3 2FA, UK (Email: web.queries@tandf.co.uk).

Statistics. Results of statistical tests should be given in the following form:

"... results showed an effect of group, $F(2, 21) = 13.74$, $MSE = 451.98$, $p < .001$, but there was no effect of repeated trials, $F(5, 105) = 1.44$, $MSE = 17.70$, and no interaction, $F(10, 105) = 1.34$, $MSE = 17.70$."

Other tests should be reported in a similar manner to the above example of an F -ratio. For a fuller explanation of statistical presentation, see pages 136-147 of the *APA Publication Manual* (5th ed.). For guidelines on presenting statistical significance, see pages 24-25.

Abbreviations. Abbreviations that are specific to a particular manuscript or to a very specific area of research should be avoided, and authors will be asked to spell out in full any such abbreviations throughout the text. Standard abbreviations such as RT for reaction time, SOA for stimulus onset asynchrony or other standard abbreviations that will be readily understood by readers of the journal are acceptable. Experimental conditions should be named in full, except in tables and figures.

AFTER ACCEPTANCE OF PUBLICATION IN THE JOURNAL

Proofs. Page proofs will be emailed to the corresponding author as a PDF attachment to check for typesetting accuracy. No changes to the original typescript will be permitted at this stage. A list of queries raised by the copy editor will also be emailed. Proofs should be returned promptly **with the original copy-edited manuscript and query sheet**.

Early electronic offprints (e-prints). Specified corresponding authors will receive their article by email as a complete PDF. This allows the author to print up to 50 copies, free of charge, and disseminate them to colleagues. In many cases, this facility will be available up to two weeks prior to print publication of the article. One copy of the journal issue in which their paper appears will be sent by post to all specified corresponding authors free after print publication. Paper offprints can still be purchased by authors if they complete the enclosed offprint order form and return with payment together with their corrected proofs.

COPYRIGHT PERMISSION

Contributors are required to secure permission for the reproduction of any figure, table, or extensive (more than six manuscript lines) extract from the text, from a source which is copyrighted – or owned – by a party other than Psychology Press or the contributor.

This applies both to direct reproduction or "derivative reproduction" -- when the contributor has created a new figure or table which derives substantially from a copyrighted source.

The following form of words can be used in seeking permission:

Dear [COPYRIGHT HOLDER]

I/we are preparing for publication an article entitled
[STATE TITLE]
to be published by Psychology Press in **Neuropsychological Rehabilitation**.

I/we should be grateful if you would grant us permission to include the following materials:
[STATE FIGURE NUMBER AND ORIGINAL SOURCE]
We are requesting non-exclusive rights in this edition and in all forms. It is understood, of course, that full acknowledgement will be given to the source.

Please note that Psychology Press are signatories of and respect the spirit of the STM Agreement regarding the free sharing and dissemination of scholarly information.

Your prompt consideration of this request would be greatly appreciated.

Yours faithfully

Volume contents and author index. The list of contents and the author index for the whole of the year's issues are published in the last issue of the year of each journal. For **Neuropsychological Rehabilitation**, this is issue 5 (December).

1.2. Copies of Letters of Ethical Approval

St Andrew's Group of Hospitals
Northamptonshire Essex Middlesex
INVESTING IN QUALITY PATIENT CARE



3 August 2005

Dr Elisabeth Pennington
Clinical Psychologist in Training
University of Leicester
School of Psychology Clinical Section
104 Regent Road
Leicester
LE1 7LT

Dear Elisabeth

Re: Research proposal 'Development of a ward-based version of the Multiple Errands Test to assess executive functioning

The above proposal has been reviewed within St Andrew's Group of Hospitals

I can confirm that we will host this research with the University of Leicester as the Research Sponsor. Thank you for forwarding details of their willingness to sponsor the project

Please advise me when the project has received ethical approval and also add me to the list of people who receive the final report

Yours sincerely

PP Geoff Dickens
Research Coordinator

cc Brian Moffat - for information

Please note
New Charity Number: 1104951
Company No: 5176998
Address shown is the registered office

St Andrew's Hospital
Welling, Essex, Northampton NN1 1JG
Tel: 01603 430000 Fax: 01603 430001
St Andrew's Hospital NHS Trust
Welling, Essex, Northampton NN1 1JG



Leicestershire, Northamptonshire & Rutland Research Ethics Committee 2

Research Ethics Office
Derwent Shared Services
Laurie House
Colyear Street
DERBY
DE1 1LJ

Telephone: 01332 868842

21 December 2005

Dr Elisabeth A. Pennington
Trainee Clinical Psychologist
University of Leicester
School of Psychology - Clinical Section
104 Regent Road
Leicester
LE1 7LT

Dear Dr Pennington

Full title of study: Development of a Ward-Based Version of the Multiple
Errands Task to Assess Executive Functioning Following
Acquired Brain Injury
REC reference number: 05/Q2502/109

Thank you for your letter of 19 December 2005, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Ethical review of research sites

The favourable opinion applies to the research sites listed on the attached form. Confirmation of approval for any other sites listed in the application will be issued as soon as local assessors have confirmed they have no objection.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
----------	---------	------

An advisory committee to Leicestershire, Northamptonshire and Rutland Strategic Health Authority

Application	1	17 August 2005
Investigator CV	05Q2502109_FieldSupCV_050817.doc	17 August 2005
Investigator CV	05Q2502109_CICV_050817.doc	17 August 2005
Protocol	1, 05Q2502109_RP_050817.doc	17 August 2005
Covering Letter	05Q2502109_Coveringletter_050817.doc	17 August 2005
Advertisement	1, 05Q2502109_poster_050817.doc	17 August 2005
Letter of invitation to participant	1, 05Q2502109_LOI_050817.doc	17 August 2005
Letter of invitation to participant	1, 05Q2502109_PLOI_050817.doc	17 August 2005
Participant Information Sheet	1, 05Q2502109_PIS_050817.doc	17 August 2005
Participant Information Sheet	1, 05Q2502109_IS_050817.doc	17 August 2005
Participant Information Sheet	2 31.10.05	31 October 2005
Participant Consent Form	1, 05Q2502109_CF_050817.doc	17 August 2005
Participant Consent Form	05Q2502109_PCF_050817.doc	17 August 2005
Response to Request for Further Information		19 December 2005
Academic Supervisor's CV	05Q2502109_AcSupCV_050817.doc	17 August 2005

Research governance approval

The study should not commence at any NHS site until the local Principal Investigator has obtained final research governance approval from the R&D Department for the relevant NHS care organisation.

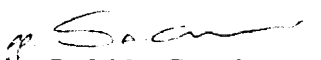
Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

05/Q2502/109	Please quote this number on all correspondence
---------------------	---

With the Committee's best wishes for the success of this project

Yours sincerely



Dr Adrian French
Chair

Email: sarah.gill@derwentsharedservices.nhs.uk

Enclosures:

Standard approval conditions (SL-AC2)
Site approval form

Copy to:

The University of Leicester
School of Psychology - Clinical Section
104 Regent Road
Leicester, LE1 7LT

R&D Department, UHL Trust

An advisory committee to Leicestershire, Northamptonshire and Rutland Strategic Health Authority

1.3. Details of the Recruitment Process

Informed consent from all participants was sought prior to any participant becoming involved in the study. The process of recruitment was overseen by Dr Nick Alderman, Consultant Clinical Neuropsychologist at the Kemsley Division.

Recruitment of Brain Injured Participants

The first stage in the recruitment process the Responsible Medical Officer (RMO) was approached to identify potential participants. In particular, emphasis was placed on ensuring that the potential participants were deemed by the RMO to be in a position to consent. A letter of invitation to the study and a patient information sheet were then forwarded to these individuals via their care-coordinator. Individuals who indicated an interest in the study met with the principal investigator. If the individual was comfortable to proceed, they were then asked to sign the consent form.

Recruitment of Neurologically Healthy Control Group

Participants were recruited from staff within St. Andrew's hospital. Posters advertising the study were placed around the hospital site, and those interested in participating contacted the principal investigator via email/ telephone. A letter of invitation to the study and an information sheet were then forwarded to these individuals. The people who wished to take part in the study then met with the principal investigator for a brief screening interview to ascertain whether they fulfilled the inclusion criteria. Suitable participants were asked to sign the consent form, and testing commenced straight after this procedure

1.4. Patient Information Sheet

Version 2 31/10/ 2005

 **University of
Leicester**
School of Psychology – Clinical Section

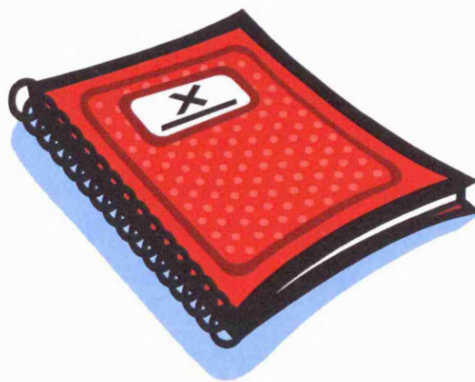
PATIENT INFORMATION SHEET

Development of a New Test to Examine Problem-Solving

Principal Investigator Dr. Elisabeth Pennington

You may contact Dr. Elisabeth Pennington at the
University of Leicester, Department of Clinical Psychology Tel. 0116 223 1649
Or Kemsley Division, St Andrew's Hospital Tel. 01604 616652

This study is sponsored by the Faculty of Medicine, University of Leicester



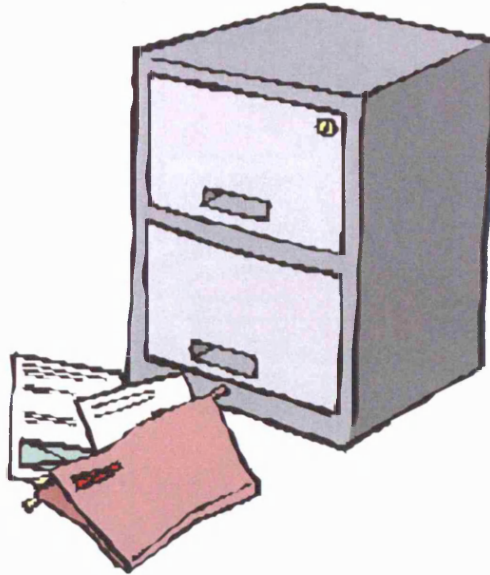
What is the purpose of the study?

- Some people who have suffered damage to the brain experience difficulties with their memory, and they may also find it harder to make plans and solve problems.
- I am carrying out this research to understand how these difficulties affect the daily lives of people living with brain injury. I hope that this information will help develop better ways of assisting people to cope with their difficulties.



What will be involved you choose to take part in the study

- If you agree to take part in this research, you will be asked to carry out a test that involves planning, problem-solving and memory. The test involves you carrying out some tasks in a hospital ward.
- The tasks comprise: finding several objects on the ward, finding out some information, and carrying out some actions. In addition, you will be asked to fill-in two short questionnaires.
- The test is not unpleasant to perform. You will not be asked to do anything that causes you either pain or discomfort, and you will not be asked to do anything that is riskier than the things that you do in your everyday life.
- If you agree to help me, you will be seen once for about an hour. I will make sure that the time you are seen will not interfere with your daily ward activities.
- With your permission, I will also access information that has been collected during your routine clinical examination. The information that I will be looking at concerns the details of your brain injury and the results of psychological tests.



What will happen to the information that you provide

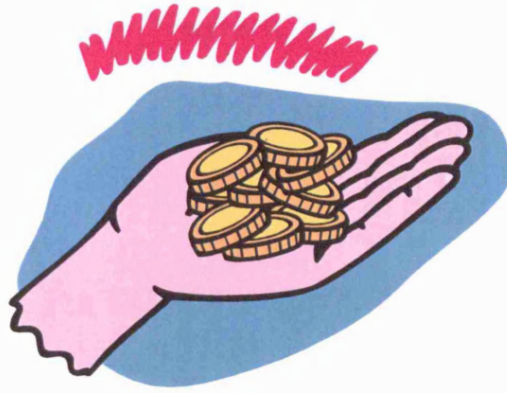
- The information collected will be kept securely under lock and key. It will also be treated with confidentiality under the data protection act. The information will be used only for the purposes of this research and it will not be shared with other people.
- If the research findings are eventually published, I will make sure that there are no personal details that could identify you.





Your rights as a participant

- You should understand that you do not have to take part in this research. No-one will mind if you chose not to take part and you do not have to offer an explanation. You may also leave the study at any time you wish, and you may do so without saying the reasons why.
- If you do not wish to take part, or if you wish to leave the study, this will not affect your normal care or future treatment.
- Medical research is covered for mishaps in the same way as for patients undergoing treatment in hospital, which means that compensation is only available if negligence occurs. In other words, you may have grounds for legal action if you are harmed by someone's actions.
- If you wish to complain, or are unhappy about the way that you have been treated during the course of this study, the normal National Health Service complaints mechanisms will be available to you.



Donation to Charity

For each person who takes part in this study a £3 donation will be made to **Headway - the brain injury association**, which is a registered charity in England. (Charity No.1025852).

Headway's aims are to promote understanding of head injury and to provide information, support and services to people who have suffered a head injury, their family and carers.

If you have any further questions, please feel free to ask me.

**Thank you
Dr. Elisabeth Pennington**

1.5. Patient Consent Form

Version 1 01/08/ 2005



PATIENT CONSENT FORM

Development of a New Test to Examine Problem-Solving

Principal Investigator Dr. Elisabeth Pennington

This form should be read in conjunction with the Patient Information Sheet, version no. 2
dated **31/10/2005**

- I agree to take part in the above study as described in the Patient Information Sheet.
- I give my permission for information gathered from my routine clinical examination to be accessed by the Investigator.
- I understand that I am under no obligation to take part in this research, and that I may withdraw from the study at any time without having to justify my decision.
- I understand that medical research is covered for mishaps in the same way as for patients undergoing treatment in hospital, which means that compensation is only available if negligence occurs. If I wish to complain, or have any concerns about any aspect of the way that have been approached or treated during the course of the study, I am aware that the normal National Health Service complaints mechanisms are available to me.
- I have read the Patient Information Sheet on the above study and have had the opportunity to discuss the details with *Dr. Elisabeth Pennington* and to ask any questions or raise any concerns. The nature and purpose of the tests to be undertaken have been explained to me and I understand what will be required if I take part in the study.

Signature of participant Date
(Name in BLOCK LETTERS)

I confirm that I have explained the nature of the tests, as detailed in the Information Sheet, in terms which in my judgement have been understood by the participant.

Signature of Investigator Date
(Name in BLOCK LETTERS)

Signature of Witness Date
(Name in BLOCK LETTERS)

Relationship to participant:

1.6. Information Sheet (neurologically healthy control group)

Version 2 22/12/ 2005



School of Psychology – Clinical Section

INFORMATION SHEET

The Development of a Ward-Based Version of the Multiple Errands Test to Assess Executive Functioning Following Acquired Brain Injury

Principal Investigator Dr. Elisabeth Pennington

You may contact Dr. Elisabeth Pennington at
Kemsley, National Centre for Brain Injury Rehabilitation
Tel. 01604 616652
Email: epennington@standrew.co.uk

This study is sponsored by the Faculty of Medicine, University of Leicester

What is the purpose of the study?

Some people who have suffered damage to the brain experience difficulties with their memory, and they may also find it harder to make plans and solve problems. Medical professionals often group these skills together using the term *Executive Functioning*. People who experience problems with these skills often find it more difficult to manage everyday life.

I am carrying out this research to understand how these difficulties affect the daily lives of people living with brain injury. I hope that this information will help develop better ways of assisting people to cope with their difficulties.

What will be involved if you choose to take part in the study

If you agree to participate in this research, you will be asked to carry out a test that involves planning, problem-solving and memory. The test involves you carrying out some tasks in a hospital ward. In addition, you will be asked to complete a short reading test and fill-in two short questionnaires.

The tests are not unpleasant to perform. You will not be asked to do anything that causes you either pain or discomfort, or puts you at a risk greater than you would face in your everyday life.

If you agree to help me, you will be seen once for about an hour.

What will happen to the information that you provide

The information collected will be kept under lock and key and treated with the usual degree of confidentiality under the data protection act, in other words the information will be used solely for the purposes of this research and will not be shared with outside agencies. If the research findings are eventually published, I will ensure that you remain anonymous by not revealing any details by which you may be identified.

Your rights as a participant

You should understand that you are under no obligation to take part in this research, no-one will mind if you chose not to take part, and you do not have to offer an explanation. Equally, you may withdraw from the study at any time you wish, and you may do so without justifying your decision.

Medical research is covered for mishaps in the same way as for patients undergoing treatment in hospital, which means that compensation is only available if negligence occurs. In other words, you may have grounds for legal action if you are harmed by someone's actions (where they are negligent). If you wish to complain, or have any concerns about any aspect of the way that have been approached or treated during the course of the study, the normal National Health Service complaints mechanisms will be available to you.

Donation to Charity

For each person who takes part in this study a £3 donation will be made to **Headway - the brain injury association**, which is a registered charity in England. (Charity No.1025852).

Headway's aims are to promote understanding of all aspects of head injury and to provide information, support and services to people who have suffered a head injury, their family and carers.

If you have any further questions, please feel free to ask me.

**Thank you
Dr. Elisabeth Pennington**

1.7. Consent Form (neurologically healthy control group)

Version 1 01/08/ 2005



**University of
Leicester**

School of Psychology – Clinical Section

CONSENT FORM

The Development of a Ward-Based Version of the Multiple Errands Test to Assess Executive Functioning Following Acquired Brain Injury

Principle Investigator

Dr. Elisabeth Pennington

This form should be read in conjunction with the Information Sheet version no. 2 dated
22/12/2005

- I agree to take part in the above study as described in the Information Sheet.
- I understand that I am under no obligation to take part in this research, and that I may withdraw from the study at any time without having to justify my decision
- I understand that medical research is covered for mishaps in the same way as for patients undergoing treatment in hospital, which means that compensation is only available if negligence occurs. If I wish to complain, or have any concerns about any aspect of the way that have been approached or treated during the course of the study, I am aware that the normal National Health Service complaints mechanisms are available to me.
- I have read the patient information leaflet on the above study and have had the opportunity to discuss the details with *Dr. Elisabeth Pennington* and to ask any questions or raise any concerns. The nature and purpose of the tests to be undertaken have been explained to me and I understand what will be required if I take part in the study.

Signature of participant Date
(Name in BLOCK LETTERS)

I confirm that I have explained the nature of the tests, as detailed in the Information Sheet, in terms which in my judgement have been understood by the participant.

Signature of Investigator Date
(Name in BLOCK LETTERS)

Appendix 2 Neuropsychological and Psychometric Measures

- 2.1. Background Measures
- 2.2. Questionnaires
- 2.3. Measures of Executive Function

2.1. Background Measures

Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1999): This scale claims to measure general cognitive functioning and yields a full scale IQ that is calculated from the scores of the individual subtests. Normative data exists for randomised samples in age bands of the general population.

The internal reliability of the WAIS for the full scale IQ is reported to be strong ($\alpha = .98$) (averaged across all age groups in the standardisation sample), and test-retest reliability is also very good ($r = .96$). Construct validity has been established by correlating the WAIS-III with other intelligence tests, including WAIS-R, Stanford-Binet (fourth edition) and Ravens Matrices; in all cases significant relationships emerged (see Wechsler, 1999).

The Wechsler Test of Adult Reading (WTAR; Wechsler, 2001): This test estimates general cognitive ability and can be used to estimate the level of cognitive function of an individual prior to brain injury. (The test yields an error score which can be converted into a predicted WAIS-III FSIQ score.) The test comprises a list of words that range from commonly used English words to infrequently used words. The test is based on the reading-recognition paradigm where the words can only be read correctly if the person knows and recognises them in their written form. Accordingly, the test assesses previous learning or knowledge of a word rather than current ability to apply standard pronunciation rules.

Examination of test-retest reliability indicates a high degree of consistency across assessments, with minimal practice effects (r range .92 - .94). With respect to construct validity, studies have found high positive correlations between other measures of reading recognition, including the National Adult Reading Test and

Wechsler Individual Achievement Basic Reading subtest (see Reynolds & Leung, 2003). Studies have also shown high positive correlations with the WAIS-III Verbal IQ, ranging from $r = .66 - .80$ (see Reynolds and Leung, 2003).

Confirmation that the WTAR resists the effects of neurological dysfunction has been established by the lack of significant differences in the performance of people with Parkinson's Disease, Huntingdon's Chorea and Korsakoff's Syndrome compared with matched non-clinical control samples (see Wechsler, 2001).

2.2. Questionnaires

Dysexecutive Questionnaire (DEX; Burgess, Alderman, Wilson, Evans, & Emslie, 1996): This forms part of the Behavioural Assessment of Dysexecutive Syndrome battery (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996). In the present study, two versions were used: a self-report measure completed by the control participants (DEX-S), and version completed by a carer regarding brain injured participants (DEX-O). Ratings are made on a Likert-type scale of twenty of the most commonly reported dysexecutive symptoms (e.g. disinhibition, confabulation). Normative data exists for controls, acquired brain-injured participants and schizophrenics.

Measures of the reliability of the DEX are not reported in the BADS manual. Indeed, the DEX was originally conceived as a means of capturing everyday problems associated with the dysexecutive syndrome (with which to validate the subtests on the BADS) rather than a formalised questionnaire and adjunct measurement of its psychometric properties (N. Alderman, personal communication, September 14, 2006). Statistically significant correlations were found between the DEX and all the subtests of the BADS as well as a number of traditional measures of frontal lobe function (Trail Making Test, COWAT, MCST, and Six Elements Test) (Burgess et al., 1998). The DEX provides one of the few standardised rating scales available to quantify everyday executive difficulties; clearly further examination of the psychometric properties of the questionnaire would be a fruitful exercise (see also Norris & Tate, 2000) .

Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983). The HADS yields an anxiety and depression scores which may be compared to cut-off

scores for “caseness”. Designed to overcome the effects of hospitalisation, it very widely used and validated for many conditions (see Bjelland, Dahl, Haug, & Neckelmann, 2002).

The internal reliability of the HADS-A (anxiety scale) and HADS-D (depression scale) have been found to be good (α range = .67 - .93). The sensitivity and specificity of the HADS-A and HADS-D were found to be equivalent to that of the General Health Questionnaire, and strong significant correlations between the HADS and other commonly used self-rating instruments used to rate anxiety and depression were also found (see Bjelland et al., 2002). Overall, the HADS was found to perform well in assessing the symptom severity and caseness of anxiety disorders and depression in both somatic, psychiatric and primary care patients and in the general population.

Dysexecutive Questionnaire (DEX-S, Completed by Control Participants)



BADSD Dex Questionnaire Self-rating

Subject's name _____

Date _____

This questionnaire looks at some of the difficulties that people sometimes experience. We would like you to read the following statements, and rate them on a five-point scale according to your own experience:

- | | |
|--|--|
| <p>1 I have problems understanding what other people mean unless they keep things simple and straightforward</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>2 I act without thinking, doing the first thing that comes to mind</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>3 I sometimes talk about events or details that never actually happened, but I believe did happen</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>4 I have difficulty thinking ahead or planning for the future</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>5 I sometimes get over-excited about things and can be a bit 'over the top' at these times</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>6 I get events mixed up with each other, and get confused about the correct order of events</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>7 I have difficulty realizing the extent of my problems and am unrealistic about the future</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>8 I am lethargic, or unenthusiastic about things</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>9 I do or say embarrassing things when in the company of others</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>10 I really want to do something one minute, but couldn't care less about it the next</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> | <p>11 I have difficulty showing emotion</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>12 I lose my temper at the slightest thing</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>13 I am unconcerned about how I should behave in certain situations</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>14 I find it hard to stop repeating saying or doing things once I've started</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>15 I tend to be very restless, and 'can't sit still' for any length of time</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>16 I find it difficult to stop myself from doing something even if I know I shouldn't</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>17 I will say one thing, but will do something different</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>18 I find it difficult to keep my mind on something, and am easily distracted</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>19 I have trouble making decisions, or deciding what I want to do</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> <hr/> <p>20 I am unaware of, or unconcerned about, how others feel about my behaviour</p> <p><input type="checkbox"/>0 <input type="checkbox"/>1 <input type="checkbox"/>2 <input type="checkbox"/>3 <input type="checkbox"/>4</p> <p style="text-align: center;">Never Occasionally Sometimes Fairly often Very often</p> |
|--|--|

Copyright © 1996, the authors. No part of this publication may be reproduced, in whole or in part in any form (except by reviewers for the public press) without written permission from the publishers. BADS ISBN 1 874261 95 4

Thames Valley Test Company, 7-9 The Green, Flempton, Bury St Edmunds, Suffolk, IP28 6EL, England.

Dysexecutive Questionnaire (DEX-O, Completed by Carer)



B A D S

Dex Questionnaire
Independent rater

Subject's name _____

Date of rating _____

Rater's name _____

Relationship to
subject _____

This questionnaire looks at some of the difficulties that people sometimes experience. We would like you to read the following statements, and rate them on a five-point scale according to your experience of _____ (the subject):

- 1 Has problems understanding what other people mean unless they keep things simple and straightforward
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 2 Acts without thinking, doing the first thing that comes to mind
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 3 Sometimes talks about events or details that never actually happened, but s/he believes did happen
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 4 Has difficulty thinking ahead or planning for the future
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 5 Sometimes gets over-excited about things and can be a bit 'over the top' at these times
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 6 Gets events mixed up with each other, and gets confused about the correct order of events
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 7 Has difficulty realizing the extent of his/her problems and is unrealistic about the future
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 8 Seems lethargic, or unenthusiastic about things
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 9 Does or says embarrassing things when in the company of others
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 10 Really wants to do something one minute, but couldn't care less about it the next
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often

- 11 Has difficulty showing emotion
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 12 Loses his/her temper at the slightest thing
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 13 Seems unconcerned about how s/he should behave in certain situations
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 14 Finds it hard to stop repeating saying or doing things once started
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 15 Tends to be very restless and can't sit still for any length of time
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 16 Finds it difficult to stop doing something even if s/he knows s/he shouldn't
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 17 Will say one thing but will do something different
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 18 Finds it difficult to keep his/her mind on something and is easily distracted
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 19 Has trouble making decisions, or deciding what s/he wants to do
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often
- 20 Is unaware of, or unconcerned about, how others feel about his/her behaviour
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4
 Never Occasionally Sometimes Fairly often Very often

Copyright © 1996, the authors. No part of this publication may be reproduced, in whole or in part, in any form (except by reviewers for the press) without written permission from the publishers, BADS, ISBN 1 874061 15 4.
Thames Valley Test Company, 7-9 The Green, Hempton, Bury St Edmunds, Suffolk IP28 6EL, England.

Hospital Anxiety and Depression Scale

Hospital Anxiety and Depression Scale (HADS)

inferNelson
UNIVERSITY OF SHEFFIELD

Name: _____ Date: _____

Clinicians are aware that emotions play an important part in most illnesses. If your clinician knows about these feelings he or she will be able to help you more.

This questionnaire is designed to help your clinician to know how you feel. Read each item below and **underline the reply** which comes closest to how you have been feeling in the past week. Ignore the numbers printed at the edge of the questionnaire.

Don't take too long over your replies: your immediate reaction to each item will probably be more accurate than a long, thought-out response.

<p>A</p> <p>5 4 3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>0 1 2 3</p>	<p>D</p> <p>5 4 3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>0 1 2 3</p>	<p>I feel tense or 'wound up'</p> <p>Most of the time</p> <p>A lot of the time</p> <p>From time to time, occasionally</p> <p>Not at all</p>	<p>I feel as if I am slowed down</p> <p>Nearly all the time</p> <p>Very often</p> <p>Sometimes</p> <p>Not at all</p>	<p>A</p> <p>5 4 3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>0 1 2 3</p>	<p>D</p> <p>5 4 3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>3 2 1 0</p> <p>0 1 2 3</p> <p>0 1 2 3</p>	<p>I get a sort of frightened feeling like 'butterflies' in the stomach</p> <p>Not at all</p> <p>Occasionally</p> <p>Quite often</p> <p>Very often</p>	<p>I have lost interest in my appearance</p> <p>Definitely</p> <p>I don't take as much care as I should</p> <p>I may not take quite as much care</p> <p>I take just as much care as ever</p>	<p>I can laugh and see the funny side of things</p> <p>As much as I always could</p> <p>Not quite so much now</p> <p>Definitely not so much now</p> <p>Not at all</p>	<p>I feel restless as if I have to be on the move</p> <p>Very much indeed</p> <p>Quite a lot</p> <p>Not very much</p> <p>Not at all</p>	<p>Worrying thoughts go through my mind</p> <p>A great deal of the time</p> <p>A lot of the time</p> <p>Not too often</p> <p>Very little</p>	<p>I look forward with enjoyment to things</p> <p>As much as I ever did</p> <p>Rather less than I used to</p> <p>Definitely less than I used to</p> <p>Hardly at all</p>	<p>I feel cheerful</p> <p>Never</p> <p>Not often</p> <p>Sometimes</p> <p>Most of the time</p>	<p>I get sudden feelings of panic</p> <p>Very often indeed</p> <p>Quite often</p> <p>Not very often</p> <p>Not at all</p>	<p>I can sit at ease and feel relaxed</p> <p>Definitely</p> <p>Usually</p> <p>Not often</p> <p>Not at all</p>	<p>I can enjoy a good book or radio or television programme</p> <p>Often</p> <p>Sometimes</p> <p>Not often</p> <p>Very seldom</p>
--	--	--	---	--	--	---	---	--	--	---	---	--	--	--	--

Now check that you have answered all the questions

TOTAL

A **D**

This form is printed in green. Any other colour is an unauthorized photocopy.

HADS copyright © R.P. Knauth and A.S. Symonds, 1968, 1982, 1984.

Revised form with original published in *Journal of Psychosomatic Medicine*, 1987, 19, 1-6. Copyright © 1987, by Taylor & Francis Ltd.

The revised form published in *Journal of Psychosomatic Medicine*, 1987, 19, 1-6.

This scale is not submitted to the British Psychological Society for publication.

414, The Grange, High Road, London W4 1TT.

Dr. Nelson is a consultant in Clinical Psychology, University of Sheffield.

Dr. Nelson is a consultant in Clinical Psychology, University of Sheffield.

2.3. Measures of Executive Function

Controlled Oral Word Association (Miller, 1984): This is a test of verbal associative fluency where participants are asked to say as many words as they can think of, excluding proper nouns, which begin with a given letter of the alphabet. The fluency score is the sum of all acceptable words produced in three one-minute trials, using the letter F, A, and S. Miller presented normative data for controls and neurological groups with a variety of pathologies.

Inter-rater reliability has been found to be near perfect, which is likely to be a reflection of the simplicity of the test and clear scoring procedures (see Spreen & Strauss, 1998). Test-retest reliability has also been found to be very good for neurologically healthy adults and adults with intractable epilepsy, ranging from .65 - .88, with an average gain of 1 point to the total score after 8 months duration (see Spreen & Strauss, 1998). A number of studies report that the COWAT is very sensitive to frontal lobe dysfunction (see Obonsawin et al., 2002), with performance found to be related to behavioural spontaneity, problem solving, sequencing, resisting distraction and measures of memory (Spreen and Strauss, 1998).

Cognitive Estimates Test (CET; Shallice & Evans, 1978): Participants are required to produce a reasonable estimate to ten questions that they that they are unlikely to know the exact answer to (e.g. How many camels are there in Holland?). Normative data are available for controls and several neurological groups. For neurologically healthy adults the inter-rater reliability has been found to be very good, although internal reliability is reported to be less than adequate ($\alpha = .41$) (O'Carroll, Egan & MacKenzie, 1994). The CET is assumed to be a reliable measure of frontal lobe function (see Della Sala, MacPherson, Phillips, Sacco, & Spinnler, 2003), with the

performance of patients with frontal lesions found to be significantly impaired relative to patients with temporal or diencephalic lesions and healthy controls.

Modified Card Sorting Test (MCST; Nelson, 1976): Participants are required to sort cards according to the characteristics of the stimuli printed on them, which differ in colour, form and number of elements. Participants are informed that the rule that they are sorting to has changed when they have achieved six consecutive correct trials – they are then asked to find “another rule”. After six correct responses in the third category are attained, the order of the rules implemented in the first three categories are then repeated in the original order. Performance measures are the number of categories achieved, the number of cards placed incorrectly (total errors), and the number of perseverations (cards placed in the same wrong category as an immediately preceding incorrect response). The test is considered a measure of executive function because it draws on cognitive and behavioural flexibility, organised searching, the ability to use environmental feedback, goal-oriented behaviour, and the ability to modulate impulsive responding (Obonsawin et al., 2003; Spreen & Strauss, 1998). Normative data exist for controls and neurological groups with a variety of lesions.

A search of the literature failed to find any studies assessing the reliability of the MCST. Nonetheless, the test from which it was derived, Wisconsin Card Sorting Test (WCST, Grant & Berg, 1948), has been found to have poor test-retest reliability. Here, it has been argued that once an individual with a reasonably intact memory has figured out the category sorts and shift principle, the WCST no longer measures problem-solving ability. Nonetheless, in clinical samples the reliability estimates have been found to be considerably higher (see Spreen & Strauss, 1998), which may

in part reflect the disruption to memory and attentional processes – making patients less susceptible to the reduction of novelty effects. The MCST has is reported to be sensitive to lesions within the frontal lobes (Nelson, 1976); specifically the locus of impairment has been suggested to be within the superior dorsolateral frontal cortex (Obonsawin, et al., 2002).

Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson et al., 1996):

This is reported to measure general executive functioning via a profile score, which is the product of the scores on six subtests. This score may be converted in a standard score and an age related standard score. Normative data exists for controls, acquired brain-injured participants and schizophrenics.

Inter-rater reliability is reported to be high, ranging between .88 and 1.00 across the six subtests (Wilson et al., 1996). Test-retest reliability after 6 -12 months has been found to be adequate for neurologically healthy controls, although the authors found that there was a tendency towards improvement with subsequent administration. Nevertheless, this phenomenon was also observed with traditional frontal lobe tests, which may reasonably be explained by a reduction in the novelty factor associated with these tasks (Wilson et al., 1996). The authors' assessment of the ecological validity of the BADS using the DEX-O (for brain injured groups) indicated that the profile score as the best predictor of each of the component factors of the DEX (behaviour, cognition, and emotion) when considered alongside measures of intelligence, traditional frontal lobe tests, and age.

Appendix 3 Pilot and Materials for the MET-WV

- 3.1. Piloting the MET-WV
- 3.2. MET-WV Exercise Sheet
- 3.3. MET-WV Instructions for Participants
- 3.4. (Cued) Recall for MET-WV (Rule Recall Response Sheet)
- 3.5. Participant Self-Rating Scales

3.1. Piloting the MET-WV

A pilot study of the MET-WV was initially carried out to establish the feasibility of the procedure. The test was administered to three neurologically healthy controls. The issues that were considered were: the duration of the exercise, clarity of task instructions, and possible ceiling effects (where the test was too “easy” leading to zero errors) or floor effects (where the requirements of the test are too difficult). The exercise was completed fairly swiftly, with participants completing the MET-WV within 20 minutes, and all participants were found to make errors (ranging from two to six errors) - in all cases the errors were either rule-breaks or task failures. The total procedure took less than hour, which included the administration of the WTAR, HADS, self-rating scales, and rule recall.

The pilot participants were interviewed after completing the MET-WV. The feedback confirmed that the requirements of the exercise were simple enough to follow and carry-out. Following the discussion, the only amendments implemented were the inclusion of an icon to illustrate the type of fire exit sign participants were to look for, and to change one of the tasks so that the information that was required was guaranteed to always be present. With respect to the latter, instead of finding out the time of the next activity in the activity room, participants were asked to find out the earliest time that the smoke room can be used in the morning (a timetable was permanently fixed to the smoking room door). Finally, given the swiftness with which the participants completed the exercise, the time to meet the examiner was reduced to 10 minutes after starting the test (rather than 20 minutes as in the previous simplified versions of the MET). Here, the amendment meant that participants needed to keep track of the time passing whilst doing the other tasks, rather than

simply meeting the examiner last (since the other tasks were easily accomplished within the 20 minute time-frame).

You have been given the following items to use during the test:-

pen/pencil
A paper bag

A watch (if necessary)

Exercise Sheet (this sheet)

2 pads of notepaper, one lined and one plain


A clipboard

In this exercise you should complete the following three tasks:

1. You should do the following 6 things:

- Ask for an A4 brown envelope from the Nursing Office.
- Find a magazine and give this to the person observing you.
- Put your *completed* Exercise Sheet into the A4 brown envelope.
- Select an item that is light enough to hold with one hand, and place it under a chair in the lounge.
- Slide the pad of lined notepaper under the door of the Training Kitchen.
- Knock on the nursing office door and say who you are, what time it is, and what you are doing.

2. You should obtain the following information and write it down in the spaces below:

a) How many  signs are there on the ward?
b) What is the name of the nurse in charge?
c) What is the earliest time that the Smoking Room can be used in the morning?
d) Write down a headline from one of today's newspapers.

3. You must meet me outside the Laundry 10 minutes after you have started the exercise and tell me the time.

TELL THE PERSON OBSERVING YOU WHEN YOU HAVE COMPLETED THE EXERCISE

Whilst carrying out this exercise you must obey the following rules:

- You must carry out all these tasks but may do so in any order.
- You should stay within the limits of the ward.
- You must not enter any bedrooms.
- You should not go back into any room that you have already been in, so if you have been into a particular room you should not go back into it again later in the exercise.
- You should not carry more than 1 item at a time (in addition to those items that you were provided with at the start of the test).
- Take as little time to complete the exercise as possible, but without rushing excessively.
- You should ask no more than 2 questions to the same member of staff.
- Do not speak to the person observing you *unless* this is part of the exercise.

This test makes use of the following items:

- Pen/pencil
- Instructions (titled “Exercise Sheet”) on a clipboard for the participant
- 2 pads of notepaper – 1 lined and 1 plain
- A paper bag
- Assessor to have stopwatch, pad and pen to record observations of the participant

Ensure that the participant is wearing a watch, and that there is an A4 brown envelope left at the Nursing Office.

Before starting, obtain ratings for efficiency and familiarity (see separate sheet)

On completion of the test, ask the participant to recall the rules for the test, and note the responses verbatim – using the form titled “(Cued) Recall for MET-WV” . Offer prompts for rules that have not been recalled.

Then, obtain the ratings for task ease and how well the participant felt they had executed the task (continue on the same sheet where ratings of efficiency and familiarity were noted).

Begin the task outside the Nursing Office in the ward. Give the participant the clipboard, Exercise Sheet, pen/pencil, 2 pads of notepaper and the paper bag. Read the following instructions to the participant:

“In this exercise I want you to complete three tasks. The tasks are: to do the six things listed on this sheet (*assessor to indicate and describe items on the exercise sheet*); to obtain and write down four pieces of information (*examiner to indicate and describe items on the exercise sheet*); and to meet me outside the laundry 10 minutes after I have said “.....begin the exercise” and tell me the time.

However, while completing this exercise you must obey the rules listed on your exercise sheet (*examiner to indicate and describe the rules on the exercise sheet*).

You must carry out all the tasks but you may do so in any order. You should stay within the limits of the ward. This means you must not leave by any of the entrances or exits. You must not enter any bedrooms. You should not go back into any room that you have already been in, so if you have been into a particular room you should not go back into it later in the exercise. You should not carry more than 1 item at a time - this is in addition to those items that you were provided with at the start of the exercise. Take as little time to complete the exercise as possible, but without rushing excessively. You should ask no more than two questions to the same member of staff.

During the exercise I shall be following you from a distance and observing what you are doing. Please do not speak to me unless this is part of the exercise.

Finally, approach me and tell me when you have completed the exercise.

Is that clear, have you any questions? (*clarify any questions the participant has.*)

Now tell me what you must do. (*Ensure participant is clear about what they must do.*)

“Begin the exercise” (*assessor to start timing at this point.*)

3.4. (Cued) Recall for MET-WV (Rule Recall Response Sheet)

Version 1 15/12/05

Participant Code:

Date of Testing:

(CUED) RECALL FOR MET-WV

RULE	Recall Yes/No	Cued Rule	Recall Yes/No
You must carry out all these tasks but may do so in any order.		<i>There was a rule about Carrying out the tasks Do you remember what the rule was?</i>	
You should stay within the limits of the ward.		<i>There was a rule about Leaving the ward Do you remember what the rule was?</i>	
You must not enter any bedrooms.		<i>There was a rule about Bedrooms Do you remember what the rule was?</i>	
You should not go back into any room that you have already been in, so if you have been into a particular room you should not go back into it again later in the exercise.		<i>There was a rule about Going back into rooms Do you remember what the rule was?</i>	
You should not carry more than 1 item at a time (in addition to those items that you were provided with at the start of the test).		<i>There was a rule about Carrying items Do you remember what the rule was?</i>	
Take as little time to complete the exercise as possible, but without rushing excessively.		<i>There was a rule about How long you had to complete the task Do you remember what the rule was?</i>	
You should ask no more than 2 questions to the same member of staff.		<i>There was a rule about Asking questions to a member of staff Do you remember what the rule was?</i>	
Do not speak to the person observing you <i>unless</i> this is part of the exercise.		<i>There was a rule about Speaking to person observing you Do you remember what the rule was?</i>	

3.5. Participant Self-Rating Scales

Version 1 01/08/ 2005

Self-Rating Scales for MET-WV

Date of testing:

Participant Code:

Control ☐ or BI ☐
Male ☐ or Female ☐

Date of birth:

1. Efficiency

How efficient would you say were with tasks like shopping, finding out information, and meeting people on time?

hopeless

excellent

1 2 3 4 5 6 7 8 9 10

2. Familiarity

How well would you say that you know this ward?

not at all

somewhat

fairly well

very well

0 1 2 3

3. Task Ease

How easy did you find the task?

very difficult

difficult

moderate

easy

very easy

1 2 3 4 5

4. Competence

How well do you think you did with the task?

hopeless

excellent

1 2 3 4 5 6 7 8 9 10

Appendix 4 Raw Data (Patients Only)

- 4.1. BADS and MET-WV Error Scores
- 4.2. DEX-O Total Scores and DEX Symptom Cluster Scores

4.1. BADS and MET-WV Error Scores

Participant	MET Total Rule Breaks	MET Task Failures	MET Total Errors*	BADS Profile Score*
1	4	7	11	10
2	7	9	18	5
3	8	4	12	14
4	10	2	12	18
5	7	3	10	18
6	6	3	9	16
7	6	11	17	8
8	2	8	11	13
9	2	1	3	16
10	17	5	22	12
11	9	11	20	14
12	9	6	16	17
13	3	4	7	18
14	3	3	7	19
15	4	4	8	20
16	10	7	18	11
17	4	4	8	16
18	8	4	12	16
19	6	5	13	10
20	4	3	9	12
21	13	6	19	14

* MET Total Errors comprise: total rule breaks, task failures, inefficiencies and interpretation errors.

* BADS profile score: lower profile scores tend to executive dysfunction (range 0 – 24).

4.2. DEX-O Total Scores and DEX Symptom Cluster Scores

Participant	Total DEX-O Score [♥]	DEX Symptom Clusters [*]				
		Inhibition	Intentionality	Executive Memory	Positive Affect	Negative Affect
1	35	5	16	4	2	8
2	49	15	16	10	7	1
3	46	21	8	5	10	2
4	19	9	6	2	2	0
5	38	17	12	4	2	3
6	33	13	9	3	6	2
7	29	10	7	3	7	2
8	36	12	10	2	6	6
9	32	14	9	5	3	1
10	40	11	12	6	6	5
11	44	14	13	7	3	7
12	27	12	6	6	3	0
13	45	13	18	3	6	5
14	53	24	15	5	8	1
15	32	12	8	3	5	4
16	15	5	4	0	2	4
17	20	2	10	1	0	7
18	45	21	9	4	10	1
19	28	7	12	4	2	3
20	30	9	6	4	5	6
21	23	11	3	3	3	3

[♥]Total DEX-O Score: Higher scores tend to greater occurrences of behaviours symptomatic of executive dysfunction (range 0 – 80).

^{*}Inhibition: range 0 – 28

Positive Affect: range 0 - 12

Intentionality: range 0 - 20

Negative Affect: range 0 - 8.

Executive Memory: range 0 – 12