Volume I

An investigation into the relationship between performance on tests neuropsychological function and performance on three everyday problem-solving tasks.

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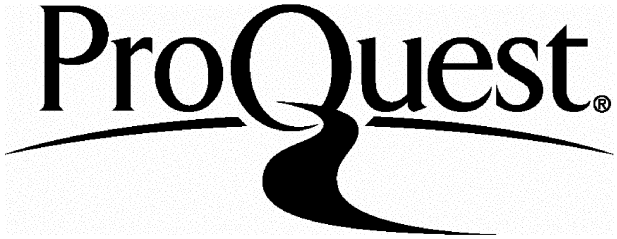

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Abstract

This study set out to examine the relationship between performance on neuropsychological tests and performance on everyday-problem solving tasks.

Three everyday problem-solving tasks covering three domains of daily life were developed, and a battery of neuropsychological tests known to have an executive function component was selected. A within participants design was used and tasks and tests were administered to a group of thirty-two individuals (hospital inpatients and outpatients) with non-progressive brain-injuries.

Correlations between individual tests and everyday problem-solving tasks were examined and three multiple regressions (one for each of the everyday problem-solving tasks) carried out.

Comparison of performances on individual neuropsychological tests with those on the three everyday problem-solving tasks showed: (a) Performance on the Six Elements Test, an executive function test considered to have high ecological validity, correlated well with performance on the three problem-solving tasks. (b) The pattern of significant relationships between individual problem-solving tasks and individual neuropsychological tests suggested that there was a degree of specificity to each of the three everyday problem-solving tasks designed. (c) In some participants a dissociation between

performance on everyday problem-solving tasks and on neuropsychological tests of executive function was observed.

The multiple regression analyses, carried out to explore the explanatory value of performance on the battery of neuropsychological tests for performance on the everyday problem-solving tasks, showed that, depending on the task, between one quarter and one third of overall performance were explained by the group of neuropsychological tests administered.

The study is best regarded as a pilot project on which to base further exploration of the association between performance on pure tests of neuro-psychological functioning and performance on tasks of everyday problem-solving.

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1. Introduction

1.1. Background

Cerebro-vascular accidents and traumatic brain injuries as a consequence of accidents are major causes of severe disability in England and Wales.

Cerebro vascular accidents are the largest cause of severe disability in England and Wales, where annually approximately one hundred thousand people suffer their first stroke. Three hundred-fifty thousand people are affected by stroke at any one time (Kneebone and Dunmore, 2000).

Head injuries are the reason for approximately one million individuals presenting to Accident and Emergency departments in the United Kingdom every year. Of these, around ten percent are classified as moderate and severe, and less than five percent are referred to a neurosurgical unit. (Kay and Teasdale, 2001).

Improvements in medical care mean that more people who have suffered brain damage and who would have died as a consequence in the past, do now survive (Labi et al., 2003; Ponsford, 1995). Improved survival rates also mean that the number of people who experience impairments as a consequence of these events has increased, and that the level of impairment seen in survivors, be it sensory-motor, behavioural and/or cognitive, is often more severe than in the past.

1.2. Cognitive difficulties in everyday life after brain damage

Depending on the localisation of brain damage, resulting deficits may be more focal, i.e. affecting more or less clearly circumscribed, specific cognitive functions, or more global, i.e. affecting a range of cognitive functions. Areas affected may include deficits in attention and speed of information processing, memory and learning, and higher order or executive functions to name, but a few (Ponsford, Sloan and Snow, 1995).

The degree of cognitive impairment is liable to impact on individuals' rehabilitation prospects and their ability to lead more or less independent lives following treatment, recovery and initial rehabilitation (e.g. Humphreys, Forde and Riddoch, 2001). Neuropsychological assessment may be able to identify, which cognitive processes are relatively impaired and which ones are relatively intact. However, predicting if, and exactly how cognitive impairment will impact on performance on activities of daily living, can be difficult (e.g. Wilson, 1996). Whilst traditional neuropsychological tests are widely used in the assessment of head injured patients to inform rehabilitation and treatment, the relationship between test performance and performance on activities of daily life is not always clear. Therefore, the validity of using these tests in rehabilitation settings has been questioned (e.g. Halligan, Cockburn and Wilson, 1987; Sunderland, Harris and Baddeley, 1983; Knight, C., Alderman, N. & Burgess, P., 2002).

1.3. Theories regarding the production of every day behaviour

Following brain damage, people may find it difficult to carry out routine actions, often involving multiple steps, which posed little difficulty prior to the injury.

Shiffrin and Schneider (1977) made a distinction between routine and non-routine behaviour, suggesting that well rehearsed and familiar actions rely on the activation of learned sequences of events. These sequences, stored in long-term memory, require few processing resources during their automatic execution. By comparison, non-routine or novel behaviour make more demands on processing resources since they require the conscious selection of appropriate component behaviours to achieve an overall goal.

This distinction is echoed in Shallice's (1982, 1988) and Shallice and Norman's (1986) work. They propose everyday behaviour to be assembled from a number of schemas or scripts, i.e. hierarchically organised mental representations of action sequences. The model posits two systems coordinating the production of everyday behaviour: unfamiliar or novel tasks depend on a higher order *Supervisory Attentional System*, whereas performance of routine tasks is more reliant on a lower level *Contention Programmer* (Please see also section 1.4.3. "Processes underlying executive functions").

Schwartz et al. (1993) conceptualise difficulties in everyday actions in terms of a disorder of executive function. In these authors' opinion, there is a

continuum of executive impairment, whereby, at the more severe end of the spectrum, planning and organisation even of routine activities of everyday life are affected. They refer to Luria's (1966, cited in Schwartz et al. 1993) observation that, in a syndrome Luria (ibid.) referred to as 'frontal lobe apraxia', even well rehearsed routine actions may disintegrate into individual component actions that are no longer executed in their proper sequence. Schwartz et al. (1993) suggest that the deficit underlying such problems could negatively affect the online planning of action, i.e. there is a deficit in the processes responsible for activation and assembly of individual component behaviours, or schemas, into a coherent and purposive overall behaviour.

Humphreys, Forde and Riddoch (2001) argue in a similar vein that there is a range of cognitive processes that underlie successful execution of routine tasks involving a number of different steps. These authors refer to 'action-planning disorder' and argue that the coherence of everyday behaviour can be negatively affected by either executive function problems, or by impairments in lower level modules and their processes. They distinguish between hierarchically organised, higher and basic level components of action. Higher-order components are abstract and context independent, and concern the question of: "What do I have to achieve in principle?". These have to be activated in order to select and execute the appropriate situation specific 'basic level components of action', dealing with the question of: "How will I achieve the goal in this particular situation?".

If the required action consists of partly routine and partly novel tasks, then familiar and task relevant information (schemas) can be accessed, whilst for the novel aspect of the task problem solving strategies, such as reasoning by logic or by analogy (comparing the present situation with a similar experience) have to be employed. Moreover, these authors suggest that the activation of higher-level representations (What am I doing?) may be important for successful completion of lower level procedures (How am I going to do it in this specific situation?).

1.4. Executive Function

1.4.1. Background

The previous section showed that current models propose routine or everyday behaviour to be assembled from individual component behaviours. In order to select and assemble relevant component behaviours, higher-order processes, referred to as executive functions, are activated.

Fortin, Godbout and Braun (2003) note how wide-ranging and often eclectically used the term executive functions is. As outlined above, the term refers to a wide range of hypothetical constructs of higher-level cognitive processes, which are assumed to underlie an individual's ability to produce "effective and contextually appropriate" (Spreen and Strauss, 1998; P. 171) and "independent, purposive, self-serving" (Lezak, 1995; P. 42) behaviour.

Cognitive functions subsumed under this term include initiation, cognitive flexibility, feedback utilisation, inhibition (Spreen and Strauss, 1998; Delis et al., 1992), concept formation, abstract thinking, organisation and regulation of behaviour (Delis et al., 1992), planning, hypothesis generation, decision-making, judgement and self-perception (Spreen and Strauss, 1998).

Tranel, Anderson and Benton (1994), in a literature review, found there was a consensus that the term executive eunction covers planning, decision-making, judgement and self-perception. The above authors regard these capacities as taking the highest position in the hierarchy of cognitive

functions. Planning is widely regarded as a key executive function, entailing the ability to think into the future, and to produce alternative responses to presenting situations. Decision-making describes one's ability to choose, from a range of options, one particular course of action. This, in the authors' view, involves a number of sub-tasks, such as accurate self-assessment, the ability to imagine a range of possible options, and to select and implement the most appropriate course of action. One aspect of decision-making is the ability to quickly compare and judge the relative merit of two or more possible courses of action. Finally, self-perception is about the ability to monitor and modulate one's behaviour.

Whilst the authors regard the notion of personality as too all encompassing to serve as a useful executive function, they do recognise that the dysexecutive syndrome associated with frontal lobe injuries is also frequently associated with personality changes. A number of hallmark case studies, such as those of Phineas Gage (Harlow, 1848) and EVR (Eslinger and Damasio, 1985), illustrate the striking effect brain injuries can have on an individual's personality. Such personality changes in the context of the dysexecutive syndrome are presumably best understood as an expression, or symptom, of the combination of impaired executive processes and functions outlined earlier.

Tranel et al. also mention creativity and artistic expression as deserving to be mentioned under the heading of 'Executive Function', but there appears to be little agreement as to how to measure these. In addition, they find broad

agreement on the view that executive functions develop early on in life, from approximately three years of age onwards with an acceleration in maturation between the ages of six and twelve, and decline with age, especially in those aged sixty and over.

1.4.2. Anatomical considerations

As outlined above, there is a range of cognitive functions referred to as executive functions and there is a close connection between these functions and the frontal and prefrontal areas of the human brain, which has led to the development of the term 'frontal lobe syndrome'. However, various authors (e.g. Rabbitt, 1997) have alluded to the observation that impaired executive functioning is often, but by no means always associated with frontal lobe damage. In an attempt to emphasize the functional aspects of the syndrome, rather than the possible localisation of the underlying damage, Baddeley and Wilson (1988) have proposed the term 'frontal lobe syndrome' be replaced by the term 'dysexecutive syndrome'.

1.4.3. Processes underlying executive functions

Having established that there are cognitive processes, which are referred to, in shorthand, as 'Executive Functions', and that these are somewhat difficult to operationalise and assess, there remains the problem of explaining how these themselves are co-ordinated to produce the, in normal individuals, generally highly complex and very effectively co-ordinated behavioural output.

The literature refers to a number of cognitive processes underlying executive function: Humphreys, Forde and Riddoch (2001) refer to the role of working memory, and Fortin, Godbout and Braun (2003) suggest that, amongst recent approaches, investigating the roles of prospective memory, script generation and the role of the 'Central Executive System' (Baddeley and Hitch, 1974) show most promise.

Humphreys, Forde and Riddoch (2001) suggest that a working memory module modulates task performance. In routine behaviour, basic level components are well represented within overall action schemas. Therefore their execution places fewer demands on working memory. In unfamiliar behaviour basic level components are less well represented. In order to be able to choose the most appropriate component behaviour a range of possibilities has to be temporarily represented, which makes additional demands on working memory. Consequently, if working memory is already impaired, then the ability to select an appropriate action schema is also impaired.

Prospective memory, i.e. the ability to remember to do something at a specific point in the future, relates to several executive functions (Mc. Daniel et al., 1999; cited Fortin et al., 2003). It is considered to be an important contributor to overall performance on everyday tasks (Marsh et al, 1998; Van den Broek et al., 2000; both cited Fortin et al., 2003) and frequently impaired in head injured patients (Shum et al., 1999; cited Fortin et al., 2003).

From an information-processing viewpoint, Shallice and Norman (1996) regard cognitive functions as programs, selected and co-ordinated by higher level supervisory programs. They distinguish between a decentralised system, referred to as 'Contention Scheduling System', which deals with the quasi automatic selection of routine operations (schemas) in simple problem solving situations, such as 'slicing bread' and the selection and co-ordination of higher level schemata or 'scripts'. Baddeley (1986) identifies the 'Central Executive' (Baddeley, 1990) with the 'Supervisory Attentional System' (Shallice and Norman, 1986). Neither concept is particularly well defined (Baddeley, 1990). The 'Supervisory Attentional System' is described as a centralised system that controls and co-ordinates executive functions (Norman & Shallice, 1986) or as a system that "modulates rather than dictates" (Shallice, 1988; P.332) how the remaining system will run. Baddeley (1990) describes its role as being to co-ordinate other cognitive sub-systems by "systematically biasing existing probabilities so as to make one line of action more likely and another line less" (P.127).

Shallice, for example, (1988) looked at the work carried out by Lhermitte et al. (1972) on patients who were unable to copy Rey's figure (a test that is thought to test constructional skill and memory). However, when the researchers broke the task down into smaller sub-tasks, these individuals were more successful at reproducing it, even though individual performances varied. Shallice argued that the four patients showed a deficit on a programming level. Similar difficulties on, what Shallice refers to as a 'program level', could be observed on other tasks, such as the WAIS 'Block

Design' sub-test and the solution of written arithmetic problems involving several stages. The performance of these patients here indicated that they were able to analyse the individual sub-tasks correctly, but were unable to join up individual components in order to arrive at a correct overall solution. On tasks, which needed less programming, such as Digit Span, Picture Completion and the 'Similarities' sub-test of the WAIS, the individuals appeared unimpaired. Shallice (1988) therefore suggested that these individuals were impaired in the "programming, regulation and verification of activity" (P.332). In his view these patients displayed behaviour resulting from routine programs, or schemas, being executed without proper selection, monitoring and control. On the basis of such evidence, he argued that there must be a higher order system co-ordinating these programs.

Shallice (1988) argues that the 'Supervisory Attentional System' is modular in construction, i.e. it should therefore fractionate. He bases this claim on computational theories and on empirical evidence pointing towards dissociations between different supervisory functions. He claims that by formulating a 'Modular Supervisory Attentional System' he avoids the difficult problem of defining the sub-processes involved in a 'Supervisory Attentional System', and proposes that any such attempt will involve great difficulty and be realisable only in highly abstract terms.

Shallice's (1988) suggestion that the 'Supervisory Attentional System' may be modular, has recently received some empirical support. Burgess et al. (1998) found that a factor analysis of data derived from the Independent rater

version of the Dex questionnaire yielded a five-factor structure, leading the authors to suggest that the dysexecutive syndrome may fractionate on the behavioural level and that there may be limits to this fractionation. They propose five factors as underlying the dysexecutive syndrome: *inhibition, initiation, executive memory, positive affect and negative affect.*

Burgess et al. (1998) draw three main conclusions from the above work: Firstly, patients' performance on neuropsychological tests of executive function correlates with symptoms observed in everyday life as expressed by factor scores derived from the Independent rater version of the Dex questionnaire. Secondly, although dysexecutive symptoms tend to co-occur on the behavioural level, at least in mixed aetiology with widespread damage, the dysexecutive syndrome can be fractionated into five factors. Of these, they suggest, the factors *inhibition, initiation,* and *executive memory* are well measured by neuropsychological tests, whereas there is a weaker relationship between test performance and the factors *positive affect* and *negative affect*, which pertain to aspects of individuals' motivation and personality. Thirdly, different executive function tests measure different aspects of the dysexecutive syndrome.

1.4.4. Executive Function Tests

If the dysexecutive syndrome does indeed fractionate, as suggested by Burgess et al. (1998), then this has important methodological implications. The fact that the syndrome fractionates would suggest that, underlying the cluster of behavioural symptoms covered under the umbrella term 'dysexecutive syndrome', there are a number of different modules or

cognitive processes. Burgess et al. (1998) argued that if this is the case, then it is important to establish whether some neuropsychological tests tap fewer underlying resources, i.e. are more specific than others that may simply measure overall performance without giving specific information regarding the functioning of any underlying modules or processes.

As pointed out earlier, executive functions are constructs that have been inferred on the basis of empirical work. A literature review shows that there is broad consensus about the existence and function of these executive functions and the term has communicative value. However, Tranel et al. (1994) noted also how difficult they are to describe, measure and quantify. Since the term 'Executive Function' covers such a wide range of cognitive processes it is clear that there should also be a large range of tests purporting to assess or measure executive functions.

Tranel et al. (1994), furthermore, drew attention to the problem that few, if any, assessment techniques commonly used in the measurement of frontal lobe functions, do reliably assess executive function. They pointed out how "some of the most well founded and widely studied procedures", such as for example the Wisconsin Card Sort Test, have serious shortcomings regarding their sensitivity and specificity to frontal lobe or executive functioning (P.144).

A similar point was made by Delis et al. (1992) who noted that poor performance on the 'perseveration' and the 'correct sort' score of the Wisconsin Card Sort Test could be due to impairments in a number of

different abilities, such as that of identifying new sort rules and utilising feedback, which are not measured specifically by this test. This has led to some arguing (e.g. Stuss and Benson, 1986, cited in Delis et al., 1992) that there is a danger for researchers to infer higher-level functions without clearly defining or measuring these. There also is, at times, considerable disagreement as to which 'higher level' function should be considered impaired in view of a particular set of test results.

Burgess et al. (1998) also noted that some neuropsychological tests are non-specific indicators of underlying neurological problems, i.e. whilst they are sensitive to neurological damage, they are nevertheless non-specific as regards underlying neurological damage. The Wisconsin Card Sort Test is one such test that was originally conceptualised as a specific frontal lobe or executive function test. However, recent literature indicates that this may have been wrong, as it appears to be sensitive to brain damage in general, and performance does not allow the conclusion that performance is necessarily due to frontal damage. These authors point out that this has important implications for research: If we administer a range of low sensitivity tests, performance on which only tells us that overall performance is impaired, then we may discover spurious correlations between test performance and symptoms and on performance on other tests and tasks. Again, these spurious correlations can I tell us little more apart from that there is a general impairment.

The assessment of executive functions is further complicated by our limited understanding of precisely what the underlying processes are and how these are implemented. Rabbitt (1997), for example, suggested that it is possible that separate working memory systems, each highly domain specific, i.e. dedicated to a single and situation specific function, may underlie overall executive function. He argued that this might explain why there is so little association between performance deficit and lesions. Another possible reason for such a lack of association is that lesions can occur anywhere along a neural pathway that contributes to the performance of a cognitive (sub-) system. Again, we may currently understand too little about the systems involved and their function to 'discover' relevant dissociations.

Related to this is the issue of 'task purity' noted by Weiskrantz (1992, cited in Rabbitt, 1997) who pointed out that in any task multiple cognitive functions will be tapped – hence it can be difficult to conclude what precisely a test result is able to tell us.

Rabbitt (1997) pointed out that highly practised executive skills do not only become remarkably robust to injuries that severely disable other functions of the cognitive system, but also extremely domain specific (e.g. Schneider and Shiffrin, 1977; Shiffrin and Schneider, 1977), resulting in individual patients with marked frontal lobe damage being able to carry out any number of executive function tests successfully whilst failing on others.

Related to this is the observation that executive function tests tend to have poor test re-test reliability (Burgess, 1997; Duncan, 1995): tests of executive function seize to be executive function tests if administered more than once since the important ingredient of 'novelty' has been lost.

1.5. Ecological Validity of neuropsychological tests

As we have seen above, there are a number of difficulties associated with neuropsychological tests of executive function that can make it difficult to arrive at conclusions as to what individual test results' implications are in terms of underlying cognitive and executive function.

Another very important aspect of test administration concerns the issue of ecological validity. The concept of ecological validity is related to that of external validity, which refers to the degree to which it is possible to generalise findings from one research situation to others (Barker, Elliott and Pistrang, 2002). In psychometric tests, ecological validity is concerned with the relationship between individuals' performance on psychometric tests, i.e. relatively abstract or artificial tasks, and their performance on real-life tasks.

The question as to how ecologically valid neuropsychological test are, has gained greater importance over recent years, as neuropsychologists have become increasingly involved in contributing to brain damaged individuals' rehabilitation programmes (Wilson, 1996). Whilst originally neuropsychology was predominantly concerned with diagnostic questions, i.e. answering questions, such as "does the patient's performance pattern on neuropsychological tests suggest that there is brain damage?" and, if so, "what information can we glean from that performance pattern regarding the localisation of damage?" (Wilson, 1996). This has led to the development of tests that aim to facilitate such understanding. Comparatively little attention

had to be paid to questions surrounding the implications of such findings for patients' functioning in their everyday lives.

Over the years, this has contributed to an improved theoretical understanding of cognitive processes. Coupled with the better understanding has been an increased expectation for this to facilitate the prediction of patients' difficulties in everyday life, so that these could be anticipated and addressed in rehabilitation programmes (Hart and Hayden, 1986; Wilson, 1996). As neuropsychologists increasingly contribute to work carried out in rehabilitation settings and since rehabilitation is by definition about functioning in the 'real' world, the question of what test performance can tell us about 'real world' behaviour has become ever more important (Wilson, 1996).

It is usually taken for granted that performance on neuropsychological tests represents underlying cognitive and brain processes. It is further assumed that the same processes underlie function in everyday life and that, therefore, performance on neuropsychological tests allows us to make predictions about performance on everyday performance. The latter assumption is, according to Burgess et al. (1998), rarely tested. As Burgess et al. (1998) and others have pointed out, the typical testing situation tends to be rather different to real life scenarios: usually patients are presented with clearly circumscribed tasks and given relatively clear instructions. This does not mirror everyday life particularly well where tasks demands are often

ambiguous and such that familiar and unfamiliar interact to provide unique experiences.

Similarly, Wilson et al. (1997) observed that, in patients with frontal lobe damage, performance on traditional neuropsychological tests of executive function gave comparatively little information regarding the types of problems these individuals would experience during rehabilitation. Furthermore, they pointed out that performance on executive tasks does not tell us much about performance on everyday tasks, nor does it tell us which difficulties are likely to cause patients most distress or permit us to predict whether or not patients will be able to return to their previous life-style. They suggest that the difficulty has to do with a fundamental difference between neuropsychological tests of executive function and tasks of activities of daily living: whilst the former tend to be highly domain specific, the latter demand that the individual is competent across a broad range of everyday skills. Cole (1999) suggests that if one wanted to predict real life behaviour based on a particular method, then it would be prudent to make sure that the tests (or experimental) situation corresponds as closely as possible to the real-life behaviour one is trying to predict. In terms of development of psychometric tests, this would mean modelling them closely on real-life scenarios.

These concerns have led to the development of a range of tests of executive function, which are considered to have greater ecological validity, i.e. tests that do mimic real life situations. At the same time, such tests aim to meet requirements placed on psychometric measures, such as provision of and

adherence to standardised instructions, provision of normative performance data, and meeting established validity and reliability requirements. One of the earliest examples of such tests is the Multiple Errands Test (MET; Burgess and Shallice, 1991). More recent examples of such tests available to professionals are the Behavioural Assessment of the Dysexecutive Syndrome battery (BADS; Wilson et al. 1997), the Test of Everyday Attention (TEA; Robertson et al., 1994) and, most recently, a hospital-based version of the Multiple Errands Tests (MET-HV; Knight, Alderman and Burgess, 2002).

Ecological validity of such tests is partly assumed, because they are closely modelled on everyday situations, as outlined by Cole (1999), and partly documented as, for example in the Behavioural Assessment of the Dysexecutive Syndrome, where a high correlation between test performance and real-life performance has been observed. Whilst some of these tests still rely on consulting-room based, paper and pencil methodology (e.g. TEA and BADS), others venture into the 'real world', requiring patients to undertake various tasks whilst adhering to certain rule and time constraints (e.g. MET-HV, AMET, MET).

1.6. Relationship between performance on tests of executive function and performance in real life.

Patients' performance on neuropsychological tests has not often been compared directly with their performance in real life. Some researchers and clinicians have made the observation that some individuals do not perform in everyday situations as expected and this raises the question as to exactly how test performance is related to everyday life performance.

Methodological issues have also complicated gaining a better understanding of this relationship. For example, different studies have used different measures of executive function, which has made comparison of their findings difficult (Fortin, Godbout and Braun, 2003). Studies of this relationship also often rely on questionnaire report measures regarding patients' behaviour, such as the Independent rater version of the Dysexecutive questionnaire, rather than a direct observation of behaviour.

The literature points to a number of individual cases and groups, illustrating how individuals may be able to perform well on neuropsychological measures, but badly on everyday tasks, and vice versa (e.g. Crawford and Channon, 1999; Eslinger and Damasio, 1985). In other patients basic cognitive abilities may be intact as indicated by their normal performance on tests of neuropsychological function, yet their ability to monitor, plan etc., often described as elements of executive functions, is impaired (e.g. Burgess, 1998; Wilson, 1993; Shallice and Burgess, 1991; Eslinger and Damasio, 1985).

Shallice and Burgess (1991) noted that some patients' performance on the Six Elements Test could be impaired whilst that on the WAIS was within normal range. They concluded that some conventional IQ tests do not tap into aspects of cognitive and everyday problems shown by dysexecutive patients. Eslinger and Damasio (1985) present the case of EVR, a previously successful individual who, during and following the development and subsequent removal of an orbito-frontal tumour, underwent a personality change. As a result he was unable to maintain his marital relationship, became unreliable, could not stay in employment, and made errors of judgement resulting in the loss of his personal wealth, although his scores on tests of intellectual function and memory remained in the superior range.

1.7. Rationale for this study and Hypotheses

Another approach to the issue of ecological validity of neuropsychological testing of executive function would be to investigate whether or not there is a correlation between performance on psychometric tests and performance on everyday tasks. Whilst correlations may be spurious, particular when employing tests with low specificity, if we did find that performance on certain neuropsychological tests of executive function correlates well with performance on everyday tasks, then one might legitimately infer that performance on one can tell us something about performance on the other. The advantages of this approach would be that we could refer to a range of existing test materials with associated research and norms, as well as having access to professionals already trained in their application.

Two hypotheses were formulated to explore this further:

- Performance on neuropsychological tests with high ecological validity will correlate better with performance on three everyday problem-solving tasks that on individual 'pure' neuropsychological tests.
- Performance on a battery of neuropsychological tests will correlate positively with performance on three tasks of everyday problem-solving.

As indicated earlier, a number of authors have commented how difficult it is to draw specific conclusions from patients' performance on neuropsychological tests of executive function about their ability to deal with

novelty in everyday life. An important reason behind this difficulty may be a tension between the requirements of tests administered for abstract and theoretical purposes, i.e. to help us gain a better understanding of the processes contributing to cognitive functioning, and tests administered for practical and predictive purposes, i.e. to help us understand and predict how an individual will fare when encountering novel situations.

An improved theoretical understanding depends upon successful attempts to break down overall behaviour into its component structures, i.e. we would like to have access to a range of tasks that are 'pure' in respect of the underlying processes they tap. Everyday life is, however, rarely pure. Instead, familiar and unfamiliar task demands interact with individual, situation specific and motivational factors to create complex everyday behaviour. To overcome this tension it will be necessary to develop and administer tests with high ecological validity. Alternatively, it may be possible to compose batteries of pure neuropsychological tests that are highly specific if administered on their own, but ecologically valid when administered and interpreted as a battery.

This project aims to contribute to a better understanding of the relationship between individuals' performance on neuropsychological tests of executive function and their performance on everyday problem solving tasks. In order to explore this relationship, participants' performance on a number of neuropsychological tests was compared with performance on three everyday problem-solving tasks. Burgess et al. (1998) had shown that the neuropsychological tests selected for this study have an executive function

component and that patients' performance on these tests correlated with their functioning in real life, as measured by the Independent rater version of the Dysexecutive questionnaire.

In addition, we administered the Hayling sentence completion test, a test of verbal response inhibition, and the Brixton Spatial anticipation test, a test of visual rule detection and switching. These are two relatively new neuropsychological measures of executive function and we were interested in getting a better understanding of their predictive value in terms of participants' performance on the everyday problem solving tasks administered.

Three everyday problem-solving tasks were designed with the aim of representing situations commonly encountered in daily life, whilst also containing 'executive aspects'. The tasks were a 'Drink Making Task', a 'Lamp Fixing Task' and a 'Journey Planning Task'. (Please see sections 2.4.2.1 to 2.4.2.3. Methods, for further details)

All tasks could be considered as tapping into a multitude of potential executive functions such as planning and sequencing of actions, 'intentionality' in that in all three tasks a goal state had to be reached (mixing of two drinks, fixing a lamp, planning a journey). They could also be conceptualised as tapping into executive or working memory, in that all three tasks required participants to hold in working memory their intention (the goal state), monitoring their performance and comparing it with the respective goal

state. The Journey Planning Task also involved a social interaction component.

In addition, the Journey Task consisted of two parts. Part One required participants to be able to infer what information a third person might need in order to successfully provide them with relevant details about a planned journey. For Part Two participants had to be able to infer what kind of information a friend might need in order successfully complete a journey, i.e. participants had to collect, retain and pass on relevant information.

Problem solving in the context of these tasks was then not only about dealing with the minutiae of the individual tasks but also required participants to be aware of their impairments and to employ suitable strategies, such as asking for help, taking notes etc. to successfully complete the tasks.

These tasks, whilst being closed in terms of the goals that had been set, were relatively open ended in terms of how participants went about solving them by, for example asking the experimenter for help in opening containers, taking notes on their behalf etc.

2. Method

2.1. Design

A within participants design was used to compare performance on a range of neuropsychological measures of cognitive functioning with performance on three everyday problem- solving tasks.

2.2. Participants

2.2.1. Inclusion criteria

Patients with non-progressive neurological disorders (traumatic brain injury, cerebro-vascular accident, anoxia, viral encephalitis) were selected. Where available, the results of imaging procedures were also taken into account. Participants had to be fluent English speakers without receptive or expressive dysphasia, and to be able to give informed consent.

2.2.2. Exclusion criteria

Patients with a current diagnosis of major psychiatric illness and/or alcohol or drug dependence were excluded from the study. Also excluded were patients unable to complete the set of experimental tasks selected (see below) due to severe visuo-perceptual problems, aphasia, and limited English, and those unable to perform any of the motor actions. Patients with milder physical impairments, who were able to carry out all the tests with exception of the everyday problem solving tasks, were included in the study. In these cases, participants were able to instruct the experimenter to carry out the physical actions on their behalf. Care was taken to ensure that participants gave detailed, step-by-step instructions.

2.3. Procedure

2.3.1. Ethical approval

Ethical approval for the project was obtained from both relevant Ethic Committees (see Appendix 2.1. and 2.2.).

2.3.2. Recruitment of participants

Clinicians working in the respective units identified potential participants, who met the inclusion criteria as outlined above. They would briefly discuss the study with them and seek their permission for me to approach them. During my initial visit I outlined the purpose of the study, answered any questions prospective participants had at that point, and gave them a copy of the patient information sheet (see Appendix 2.1.2 and 2.2.2) and consent form (see Appendix 2.1.3 and 2.2.3.). During a subsequent visit I read the information sheet to those participants, who wished me to do so and answered any questions arising.

Written consent to participate in the study was then obtained from participants. Consent included permission to peruse medical records, and to ask a member of the treatment team or another person, who knew the participant well, to complete the Independent Rater Version of the Dex. In addition, participants were asked if they wished me to pass on the test results to the Clinical Psychologist involved in their care.

Testing was carried out either at the referring unit or, for participants who had already been discharged, in their respective homes. Appointments were

arranged with participants and their treatment teams in order not to interfere with any rehabilitation programme.

The tests were administered over two sessions of approximately two hours duration each. Administration time varied, depending on participant's level of ability. If particular tests had already been administered as part of the patients' assessment and rehabilitation programme, then the results were, with participants' permission, used in this study. Participants were able to take breaks as and when necessary. On the rare occasion that a participant became upset by her/his performance, or when she/he felt no longer able to continue, testing sessions would be discontinued early, and extra session(s) scheduled as necessary.

2.4. Materials

2.4.1. Measures

Standardised Instruments – Tests of cognitive function

The tests were selected to provide a means of estimating participants' premorbid and current levels of cognitive function. In addition, a number of neuropsychological tests, all of which were known to have an executive component, were selected to reflect the range of clinical neuropsychological tests that previous research (e.g. Burgess et al., 1998) had shown to correlate well with Dex questionnaire data.

In addition, three everyday problem solving tasks, covering three domains of everyday life (mixing two drinks, technical problem solving, planning a journey) were developed.

All tests were administered following standardised test instructions.

2.4.1.1. *The Spot the Word Test* (Baddeley, Emslie and Nimmo-Smith, 1992)

Estimate of premorbid intellectual ability was based on participants' performance on the Spot the Word Test. This is a sub-test of the Speed and Capacity of Language Processing Test (Scolp, Baddeley et al., 1992), consisting of a list of sixty word and non-word pairs, with the real words being graded from commonly used (e.g. "kitchen") to quite uncommonly used words (e.g. "monad"). Participants are required to perform an un-timed

lexical decision task, i.e. they have to decide, which of the two letter strings in each pair is a real word.

Performance on the Spot the Word Test is reportedly highly correlated (.79, n = 552, p<.001) with performance on the National Adult Reading Test (NART; Nelson and Willison, 1981), another commonly used measure in premorbid IQ estimation. Spot the Word Test and National Adult Reading Test give the same mean (96.7 versus 96.8) and have similar standard deviations (16.0 versus 15.6). In a large sample (n > 500), Spot the Word Test performance was also found to be highly correlated (all ps<.001) with WAIS-R full scale IQ (.68), Verbal IQ (.69) and Performance IQ (.55), and with performance on the WAIS-R Vocabulary subtest (.73) (Powell, cited Thames Valley Test Corporation).

The main reasons for using the Spot the Word Test were that it can be administered to people, who have some form of language impairment as a result of their brain injury, and performance is less strongly correlated to head injury severity than in the National Adult Reading Test.

2.4.1.2. The Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999)

Current intellectual functioning was estimated based on individual's performance on the Wechsler Abbreviated Scale of Intelligence (WASI).

The WASI consists of four subtests. Two of these subtests, Vocabulary and Similarities, contribute to an estimate of the Verbal IQ score (WAIS-VIQ). The remaining two subtests, Block Design and Matrix Reasoning, form the basis for an estimate of the Performance IQ (WAIS-PIQ) score. The WASI Full-4 IQ score is calculated on the basis of participants' performance on all of the above subtests.

Overall, WASI performance is highly correlated with WAIS-III performance (*r* = .92), so are the individual sub-scales of these two tests (Vocabulary .88; Similarities .76; Block Design .83; Matrix Reasoning .66) (Psychological Corporation, 1999).

Administration of one or both of the verbal subscales (Vocabulary and Similarities) was omitted for three participants, who had word finding difficulties and found completion of the test(s) distressing. In these cases participants' Performance IQ performance was taken as the basis for an estimate of the WASI Full-4 IQ.

2.4.1.3. Modified Card Sort Test (Nelson, 1976)

The Modified Card Sort Test (MCST) is a simplified version of the Wisconsin Card Sort Test (WCST; Grant and Berg, 1948). It consists of two sets of twenty-four cards each and of four key cards, to which the forty-eight cards are to be sorted. The main difference from the WCST is that cards will only share one attribute each (colour, form or number) with three of the key cards,

i.e. there are no ambiguous stimuli (Parker and Crawford, 1992) sharing more than one of the attributes with a key card.

The key cards are displayed in front of the participant, who is then asked to sort the stack of forty-eight cards according to certain rules, which s/he is asked to work out based on right/wrong feedback given by the test administrator. Once participants have sorted six consecutive cards correctly to a category, they are told that: "The rule has now changed, I want you to use a different rule". This process is repeated until participants have either attained six categories, used up all cards, or are able to tell you what the underlying principle of the test is. The number of categories attained was used in the present study.

The test is considered to be sensitive to frontal lobe or executive dysfunction, and is traditionally considered to be a measure of perseverative tendencies (Milner, 1963; Nelson, 1976). It has, however, more recently been reported to be sensitive to any kind of neurological pathology (e.g. Anderson et al., 1991; Corcoran and Lipton, 1993).

2.4.1.4. Brixton Spatial Anticipation Test (Burgess and Shallice, 1997)

The Brixton test is a visuo-spatial rule attainment task, consisting of a 56-page stimulus booklet. Each page shows two rows of five circles. The ten circles are numbered from one to ten. One of the circles on each page is coloured blue, but its position within the array of ten circles changes from

page to page. The test is un-timed. Participants are shown the stimulus book, a page at a time, and told that the position of the circle changes from page to page, according to a rule that they are to work out. They are also told that the pattern will change from time to time and without warning. When the pattern changes, the participants are, again, expected to work out the new underlying rule. Overall, there are eight rule changes and six different rules, and participants' success or failure is measured by way of summing up the number of wrong predictions made during administration. The error score is then converted into a scaled score (range 1 – 10), where 'six' represents an Average score. This score was used in the present study.

2.4.1.5. Trail Making Test

The Trail Making Test (TMT) was originally known under the names "Partington's Pathways" or " Divided Attention Test" (Partington and Leiter, 1949 cited in Spreen and Strauss, 1998). It is considered to be a test of attention, sequencing, mental flexibility, visual search, and motor function (Spreen and Strauss, 1998).

The test consists of Forms A and B. In Form A participants are required to connect in the correct sequence twenty-five circles, numbered one to twenty-five and randomly arranged on an A4 sheet of paper. Form B also consists of twenty-five circles, twelve of these are labelled with the letters 'A' to 'L' and the remaining circles are numbered 'one' to 'thirteen'. Participants are required to join numbers and letters in alternating order, starting from '1' to 'A', from 'A' to '2', from '2' to 'B', and so on, until the sequence is completed.

Prior to administration of each Form, participants are read the instructions and given the opportunity to practice the task on a sample form. If a mistake is made on the sample forms, participants are given the opportunity to practise the task again. Once Sample A has been completed correctly, Form A is administered, followed by Sample B and Form B. If participants make a mistake on Forms A or B this is pointed out with the request to correct the error. The times taken to complete each of the Forms, including the time taken for corrections, is taken as performance measure.

The norms provided by Tombaugh, Rees and McIntyre (1996, cited in Spreen and Strauss, 1998, Table 12-13, Page 540) were used in scoring the test. For Part A norms from 10^{th} to 90^{th} percentile and for Part B from 20^{th} to 80^{th} percentile are provided. Participants whose performance fell above or below these norms were classified as falling into the nearest category. Only the measure for Form B was taken forward for further analysis.

2.4.1.6. Modified Six Elements Test (Burgess, Alderman, Evans, Wilson, Emslie and Shallice)

The Modified Six Elements Test (SET) is a subtest of the *Behavioural Assessment of the Dysexecutive Syndrome* (BADS; Wilson, Alderman, Burgess, Emslie and Evans, 1996).

Participants are given instructions to complete three tasks (dictation, naming pictures, arithmetic). Each of the three tasks is divided into Part A and Part

B. Participants are expected to attempt at least some of each of the resulting six subtasks during a period of ten minutes. In addition, participants are instructed not to attempt to do both parts of a task consecutively, i.e. they must not do Part A of a task immediately followed by Part B of the same task. Instead, any part of another task has to be attempted next. The test yields a *Total Profile Score* ranging from zero (lowest) to four (highest), which was used in the present study.

The test aims to provide a measure of how well an individual is able to organise him/herself (planning, organising and sequencing, multi tasking, monitoring). Whether or not individual items, such as arithmetic problems, are answered correctly is not evaluated. It also tests a person's prospective memory, i.e. her/his ability to remember to do things at some point in the future (Burgess and Shallice, 1997b). Failure on the SET may, however, not only be indicative of problems in the underlying processes listed above, but may also occur in individuals unable to understand the instructions due to impaired auditory-verbal comprehension (Wilson et al., 1996). Individuals, who were known to have such difficulties, were therefore excluded from the study.

2.4.1.7. Hayling Sentence Completion Test (Burgess and Shallice, 1997)

The Hayling Sentence Completion Test (HSCT) consists of two sections (Section 1 and Section 2). Both sections consist of fifteen items; sentences with the last word missing, such as "The old house will be torn ...". These

are read aloud to participants who, for Section 1 have been instructed to complete the sentences with a sensible word in as short a time as possible. In contrast, the instructions for Section 2 require participants to give a word that does not fit at the end of the sentence ("is unconnected in every way").

Performance is timed: in both sections the time taken by participants to start responding to each stimulus is measured. Individual latencies are then summed up and yield an overall response time for each of the sections. These are then converted into scaled scores where 'six' represents an Average score (range: 1 to 7 for Section 1; 1 to 8 for Section 2).

In addition, errors made on Section 2 are classified into Category A errors, i.e. words completing the sentence in a sensible way, and Category B errors, i.e. words completing the sentence with a semantically connected word, but not in an entirely sensible fashion. The error scores are converted into scaled scores where 'six' represents an Average score (range: 1 to 8).

Finally, the three scaled scores (Section 1 – Response latency; Section 2 – Response latency and Section 2 - Error score) are added up. This sum is again converted into a scaled score where 'six' represents an Average score (range: 1 to 10). This score was used in the present study.

2.4.1.8. Shape Detection Screening Test from the Visual Object and Space Perception Battery (VOSP; Warrington and James, 1991)

In the Shape Detection Screening Test participants are shown twenty stimulus cards showing a black and white random pattern. Half of the these patterns have a degraded letter 'X' superimposed on them, and participants are asked to decide whether or not there is an 'X' shown on each individual card.

This test was included in the VOSP in order to screen out individuals with inadequate visual sensory processing, i.e. scores of 15 or fewer correctly identified items.

2.4.1.9. Cube Analysis subtest from the Visual Object and Space Perception Battery (VOSP; Warrington and James, 1991)

This test consists of twelve stimulus cards (two practice items and ten test items), showing three-dimensional representations of structures constructed from a number of cubes. Participants are asked to decide how many cubes are represented on each stimulus card. The test items are graded by difficulty, showing between four and ten cubes, some of which may be obscured from participants' view. The number of items answered correctly was used in the present study.

According to the manual, this subtest provides a measure of participants' ability to perceive complex spatial relationships. Burgess et al. (1998) found performance on this test to be modestly correlated with Factor 1

(Intentionality; r = .26; p = .03) scores derived from the Dex - Independent rater questionnaire. Burgess et al. (1998) suggested that it is plausible that this test should have an executive component: it requires individuals to be able to predict and reason about a complex spatial relationship. This requires both, 'foresight' and 'insight'. Higher scores on the Dex Independent rater questionnaire are commonly associated with a lack of insight by the rated individual regarding the severity of his or her problems, which is also often associated with a lack of foresight into the consequences of their actions.

2.4.1.10. Recognition Memory Test for Faces (Warrington, 1984)

The Recognition Memory Test for Faces consists of fifty target items (photographs of male faces), which participants are shown and asked to memorise. In order to encourage processing of individual items, participants are also instructed to decide whether the item is pleasant or not so pleasant. Immediately after presentation of the target items participants are asked to perform a forced choice recognition task. During this task they are shown one target and one distracter item and have to decide, which of the two items presented was included in the original series. The number of correctly identified items is recorded and categorised (scaled scores or percentile scores, both by age bands) according to norms provided by the manual. The scaled score was used in the present study.

2.4.1.11. Dex questionnaire (Self rating, and Independent rating)

Participants were asked to complete the Self Rating version of the DEX questionnaire, and a relative or a member of ward staff, most familiar with individual participants' behaviour, was asked to complete a copy of the Independent Rater version of the DEX questionnaire. (Please see Appendices 2.4.1.a. and 2.4.1.b. for sample questionnaires)

The Dex questionnaires are part of the Behavioural Assessment of the Dysexecutive Syndrome battery (BADS; Wilson, Alderman, Burgess, Emslie and Evans, 1996). Both versions of the questionnaire consist of 20 statements concerning a range of difficulties people with dysexecutive syndrome commonly experienced in everyday life. Patient and independent rater are asked to rate the patient's behaviour on a Likert scale (range from '0' for 'never' to '4' for 'very often'). The questionnaire can thus yield an overall score ranging from 'zero' to 'eighty'.

The questionnaires were originally developed to sample four areas of behavioural change commonly associated with the dysexecutive syndrome: emotional and personality, motivational, behavioural, and cognitive. However, recent work by Burgess et al. (1998) suggests that there may actually be a five-factor fractionation (intentionality, inhibition, executive memory, positive affect, negative affect) to the areas sampled by the Dex questionnaire.

2.4.2. Activities of Daily Living Tasks

Three everyday problem-solving tasks were designed for this study. Rationale for their development was that each tasks should be ecologically valid, i.e. reflect problems that are commonly encountered in daily life. They also should cover a range of situations and domains to reflect the fact that executive functions are considered to be involved in virtually all novel daily activities. Therefore, whilst aiming to design tasks that are commonly carried out in daily life, we also wanted them to involve a degree of unfamiliarity in order to make demands on executive processes.

The tasks developed were a Drink Making Task, a Journey Planning Task and a Lamp Fixing Task. Further details regarding scoring are provided in the relevant parts of the Results section.

All materials used were mass-market products, bought in High Street shops. Alterations were made to products in the Lamp Fixing Task – these alterations are highlighted in the relevant task description.

2.4.2.1. Task 1 – Drink Making Task

This task involved participants preparing two beverages: one from a concentrate to be diluted with water, and one made with instant powder mixed with soya milk and one teaspoon of sugar added.

The set-up included the target items (underlined) and related distracter items, i.e. a choice of three fruit juice concentrates or cordials (Ginger, Elderflower, Summer Berry), four instant powders (strawberry milk shake, chocolate milk shake, coffee, lemon tea), two sweeteners (sugar and artificial sweetener), salt, three different types of milk (full fat and semi-skimmed ordinary, soya milk). Also provided were measuring utensils (three tea spoons, one table spoon, and a set of measuring spoons), a jug of water and four beakers.

The items were set up in the same order, on three sheets of standard kitchen roll to ensure a standardised arrangement for each participant (see picture in Appendix 2.3.1.). The verbal instructions given to participants are displayed in Figure 2.1 on the following page.

A summary of these verbal instructions was displayed in full view of participants throughout the procedure, in order to reduce memory load (please see Figure 2.2.).

Scoring was based on the number of drinks made with the correct ingredients (For further details regarding scoring please see Results, section 3.4.1.).

Figure 2.1. Drink Making Task – Verbal instructions

Instructions:
In this task, I want you to make up two different drinks. One from a concentrate and one from an instant powder.

Here you have:
- A choice of drink concentrates and instant drink powders. [Point to each one and read out name].
- There are also other things that you might find in a kitchen, like sugar, sweetener and salt. [Point to each one and read out name].
- Here you have some beakers, teaspoons, measuring spoons and measuring jugs. [Point to each one and say name].
- Here is a jug of water, a carton of skimmed ordinary milk, a carton of full-fat ordinary milk and a carton of soya milk called "Soyilk". [Point out].

Do you have any questions?

Now, I want you to make up two drinks. One of the drinks is a glass of Summer Berry juice, the other drink is a glass of Strawberry Flavour milkshake.

Please prepare the Strawberry Flavour milkshake with Soyilk and add one tea spoon of sugar.

If you can't manage part of a task you can ask me for help. For example, if you cannot read something or if you need help opening something.

Figure 2.2. Summary instructions – Drink Making Task

Task 1 - Making up two drinks

- Please make up 2 drinks.
- One glass of Summer Berries drink.
- Ingredients:
  - Summer Berries Cordial
  - Water.
- One glass of Strawberry Flavour milkshake.
- Ingredients:
  - Strawberry Flavour milkshake powder
  - Soyilk (soya milk)
  - 1 teaspoon of sugar.

- You can ask me for help.

2.4.2.2. Task 2 – Journey Planning Task

This task was concerned with social and planning aspects of the dysexecutive syndrome. Participants were asked to plan a journey for a friend, using a mobile telephone to obtain the necessary information. The telephone call involved interacting with a confederate ('telephone help line operator'). Figures 2.3. and 2.4. (below) respectively show the instructions read to prior to, and displayed in front of participants throughout the task.

Figure 2.3. Journey Planning Task – Verbal Instructions

Task 2 – Social interaction, gathering information, planning a journey.

In this task, I want you to plan a journey for a friend.

- The friend is coming from overseas and wants to visit you here in hospital.
- The friend will arrive at Gatwick Airport this Sunday morning at 9 o'clock.
- The friend has never been here before and asks you to plan the journey from Gatwick Airport to this hospital for him.
- He does not mind how much the journey will cost, but he does want to travel by train.
- He does want to join your for lunch at 1 p.m.

To help you plan the journey you can:

- Telephone an information line on [telephone number].
- Here is a pad and a pen to note down the information given.
- If you have difficulty writing you may ask me to write things down for you.

Now, go ahead and plan your friend's journey.

Figure 2.4. Summary Instructions - Journey Planning Task

Task 2 – Planning a journey

- A friend is flying to **Gatwick Airport** to **visit** you **here**.
- He arrives this **Sunday** morning at **9 a.m.**
- He wants **you** to **plan the journey** from the **airport to here.**
- He does **not mind** how much the journey will **cost.**
- He wants to travel by **train.**
- He wants to join you for **lunch at 1 p.m.**

- **To help you plan the journey you can telephone an information line on this number: [number]**

- Here is a pad and a pen to take notes.
- You can ask me for help.

Participants' performance on two aspects of this task was scored: the first score concerned the efficiency with which they provided details regarding their request to the 'operator' (part 1 - request efficiency), the second score concerned the efficiency with which they passed on the details gathered to the experimenter (part 2 - relay efficiency).

To ensure all participants would have the same opportunity to gather the relevant information, the 'operator' followed a script. This ensured that all participants were asked (prompted) for any of the pieces of information that contributed to the overall score on the 'request efficiency' part of the task that they had not volunteered. The reasoning behind the prompt was that, in a real life setting, help-line operators would try to elicit such relevant information from their clients. In addition, and as pointed out earlier, we did not want this to be a test of 'memory' per se.

For part two of the task, the operator was instructed to give correct travel information to participants, regardless of whether or not they had given the relevant information during part one of the task. Whilst this may not have been particularly realistic, it did allow us to compare participants' performance on part two of the task without it being dependent on, or confounded by, performance on part one.

For scoring purposes the experimenter and confederate both took notes regarding of the details of the conversations taking place.

Figure 2.5. Instructions for confederate - Journey Planning Task

Task 2 – Social interaction, gathering information, planning a journey.

General notes for confederate:

- If you are asked totally irrelevant questions say: "I don't have that information."
- If you are asked socially inappropriate questions say: "I believe you want to plan a journey." Or remind caller of last task-related item you discussed.
- If you are given wrong information about the task (e.g. 'Heathrow' instead of 'Gatwick') etc, repeat question to allow caller to correct.
- Give correct information to caller, regardless of whether or not he/she has given you the correct information in the first place.
- Callers may ring up again later (15- 30 minutes) if they remember something they should have done first time round, or if they forgot to take notes.
- If you are asked specific information, e.g. what is the District Line, then give the information.

Script for confederate:

1. Hello.
2. How can I help you?

If caller does not give details, or appears to have difficulty prompt as follows, but

- **Allow caller enough time to volunteer the information.**
- **Give prompts one-by-one, to allow caller to remember details.**
  - **I gather you want to plan a journey?**
  - **Where do you want to travel?**
  - **When do you want to travel?**
  - **Leaving Gatwick around what time?**
  - **Arriving at the hospital at what time?**

3. There is a connection that gets your friend to the hospital at 3 o'clock. It costs £25.
4. There is another connection that gets your friend to the hospital at noon. It costs £57.

Pause – see if caller tells you unprompted what s/he wants:

5. Which one would you like? **Tick choice: £25 or £57**

Pause - wait to see if caller asks you for the details.

If 'Yes', choose A or B below. If not, say:

6. Would you like me to give you the details of that connection?

If asks for details, say (SLOWLY, giving enough time for caller to note down):

A) If Hiliingdon

- The train leaves Gatwick at 9.30. **Pause** - Have you got that?
- It arrives at Victoria at 10 o'clock. **Pause** - Have you got that?
- At Victoria take the Underground. **Pause** - Have you got that?
- First take the District Line to Hammersmith. **Pause** - Have you got that?
- At Hammersmith change on to the Piccadilly Line to Hillingdon. **Pause** - Have you got that?
- Take the bus from Hillingdon Underground station to the Hospital. **Pause** - Have you got that?

B) If Northwick Park

- The train leaves Gatwick at 9.30. **Pause** - Have you got that?
- It arrives at Victoria at 10 o'clock. **Pause** - Have you got that?
- At Victoria take the Underground. **Pause** - Have you got that?
- Take the Circle Line to Baker Street. **Pause** - Have you got that?
- At Baker Street change on to the Metropolitan Line to Northwick Park. **Pause** - Have you got that?
- Walk from Northwick Park Station to the Hospital. **Pause** - Have you got that?

2.4.2.3. Task 3 – Lamp Fixing Task

This was a technical problem-solving task, involving a camping lamp[1] powered with four batteries[2]. After demonstrating the functioning of a working lamp, participants were given an identical lamp with one of the four batteries inserted the wrong way round. After participants had found out that this lamp was not working, they were asked if they could find out the reason for it not working and if they could fix the lamp.

The set-up included the lamp, three spare bulbs, only one of which was a suitable replacement bulb, and two spare sets of batteries, only one of which was a suitable replacement set. Of the replacement batteries, one set was smaller than the required one but made by the same manufacturer – it therefore had, apart from size, a similar visual appearance as the batteries already inserted in the lamp. The other spare set of batteries was of the required size but had a different visual appearance.

Instructions were read out to before and displayed in front of participants throughout testing to reduce memory load. Where physical disability prevented participants from carrying out the tasks, they were permitted to ask for assistance. When this was necessary, care was taken to ensure the experimenter did not provide cues to assist in problem solving, but carried

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1 Alterations made to lamp : Red adhesive stickers were placed inside the lamp to indicate or clarify correct polarity of batteries. Red adhesive arrows were placed on outside of lamp to make it easier for participants to close the lamp by lining up the arrows.

2 Alterations made to batteries: Red adhesive stickers were placed on either end of the batteries to clarify polarity.

out only instructions given by participants. The only prompt given was: "What would you like me to do next?".

Figure 2.6. Instructions – Lamp Fixing Task[3]

Instructions:

Using a working lamp say:

- This is a lamp that runs on batteries. [Show]
- It has a light bulb here. [Point]
- It switches on and off here. [Demonstrate]
- The batteries are kept in here. [Point, show how to open & close compartment and show batteries]
- This diagram shows you what I have just explained to you. [Place diagram in front of participant]

Do you have any questions?

- Here is another lamp.
- See if it works.
- It does not work.
- Can you work out what has gone wrong?
- Can you fix it?
- If you can't manage part of a task you can ask me for help.
- I can help you if you tell me what to do.

The sequence in which participants attempted to solve the problem and whether or not they succeeded in getting the lamp to work were noted down for scoring purposes.

Piloting

The three tasks were initially piloted on six healthy individuals (friends and neighbours). As a result of this it was decided to apply labels to the lamp with the aim of making it easier for participants to close the battery compartment and to detect the correct polarity with which batteries had to be inserted.

The tasks were subsequently piloted on four patients. This highlighted several practical problems (e.g. standardisation of set-up in changing environments), which were subsequently resolved.

[3] Please see Appendices 2.3.1. to 2.3.3. for photographs of materials and set-up.

3. Results

3.1. Sample characteristics

In total thirty-two (32) adult neurological in- or out-patients (11 female, 21 male), aged between nineteen and sixty-five years (Mean 45, SD=13.5), were recruited through the Regional Rehabilitation Unit, based at Northwick Park Hospital (n=15), and through the Alderbourne Rehabilitation Centre with the associated Head Injury Clinic, based at Hillingdon Hospital (n=17). The mean of participants' years of education was 12.2 (SD=2.4). The scaled score on the Spot the Word Test, used to estimate premorbid intellectual functioning, was 8.6 (SD=4.0) with a predicted premorbid IQ score of around 95. The mean WASI Full-4 IQ score was 90.4 (Range 62 to 122, SD=15.8). The mean interval between participants suffering their respective injuries and participation in this study was 713 days (SD=922). Forty four percent (n=14) of the sample had suffered a cerebro-vascular accident, twenty-eight percent (n=9) a traumatic brain injury in the context of a road traffic accident, three percent (n=1) in a fall. Twelve percent (n=4) had brain damage as a consequence of anoxia, hypoxia or carbon monoxide poisoning, a further nine percent (n=3) suffered their brain injury in an assault. Three percent (n=1) had suffered brain damage as a consequence of viral encephalitis. (Please see Table 3.1 for individual participants' details.)

Table 3.1. Sample characteristics

Number	Sex	Age (years)	Education (years)	Cause of brain Injury	Details of brain Injury
1	female	49	16	Anoxia	No details available
2	female	54	15	Anoxia and Stroke	Right cerebral ischaemic changes and generalised oedema
3	male	20	10	Assault	Left acute subdural haematoma
4	male	19	11	Assault;	Right frontal contusion; right int. carotid territory CVA; raised intra-cranial pressure
5	male	25	17.5	CVA	Arterio-venous malformation; Posterior fossa haemorrhage; hydrocephalus
6	female	35	13	CVA	Left fronto-parietal region
7	male	36	13	CVA	Right internal capsule, basal ganglia
8	male	40	10	CVA	Left and right cerebral peduncle; pons; mid brain
9	female	41	11	CVA	Left occipital region; blood in all ventricles
10	female	49	10	CVA	Left internal capsule
11	male	50	11	CVA	Right posterior carotid artery infarct; extensive sub arachnoid haemorrhage; post haemorrhage hydrocephalus
12	male	52	11	CVA	Multiple infarcts
13	male	52	19	CVA	Right int. capsule and basal ganglia
14	female	55	12	CVA	No details available
15	male	56	10	CVA	Left total anterior cerebral artery infarct; right lentiform nucleus

Number	Sex	Age (years)	Education (years)	Cause of brain injury	Details of brain injury
16	female	56	11	CVA	No details available
17	female	57	12	CVA	Right fronto-parietal area
18	male	65	14	CVA	No details available
19	male	58	15	Fall (ladder)	Diffuse bilateral frontal trauma; subdural haematoma;
20	male	37	11	Hypoxia;	Gross enlargement of lateral and third ventricles
21	female	46	13	Hypoxia	CT scan "essentially normal"
22	male	21	9	Assault	Right occipito-parietal skull fracture, Left frontal lobe haemorrhagic contusions
23	male	19	11	RTA	Left frontal haematoma; raised intra-cranial pressure
24	male	21	12	RTA	Bilateral frontal contusions and intra-cerebral haematoma
25	male	23	11	RTA	Diffuse cerebral oedema
26	male	25	16	RTA	Left frontal contusions
27	male	37	11	RTA	Severe diffuse brain injury
28	male	40	12	RTA	Right temporal and parietal contusions
29	female	41	11	RTA	Cerebral haemorrhage; midline shift; craniotomy
30	male	44	11	RTA	Diffuse axonal damage
31	male	48	10	RTA	Unconscious on admission, normal CT scan
32	female	42	11	Viral encephalitis	No CT report or similar found

3.2. Dysexecutive Questionnaire

Both, the self and independent ratings on the dysexecutive questionnaire confirmed that the group of participants showed dysexecutive behaviours in everyday life (for details see Table 3.2. below).

Table 3.2. Summary of Dex questionnaire results

	Lowest and highest possible score	Self rating (N=32) Range (Mean; SD)	Independent rating (N=32) Range (Mean; SD)
Normative Data for Overall scores (Wilson et al. 1996)	0 - 80	2 – 59 (27.21; 14.48)	9 – 67 (32.85; 15.98)
Overall Score	0 - 80	3 – 76 (28.5; 17.4)	0 – 63 (26.2; 16.1)

3.3. Neuropsychological measures of cognitive function

3.3.1. Results on neuropsychological tests

Means and standard deviations of participants' performance on neuropsychological measures are presented in table 3.3. below.

Table 3.3. Results on neuropsychological tests (N=32)

	Mean	SD
Intellectual ability		
Spot the Word Test – predicted IQ score (Mean scaled score: 8.6)	90-95	4.0
WASI Full-4 IQ*	90.4	15.8
Executive Tests		
Rule finding and Switching		
Modified Card Sort Test (categories attained, min. 0 max. 6)	3.9	2.2
Brixton Spatial Anticipation Test (scaled score, range 1 to 10)	4.0	2.2
Trail Making Test - Form B (percentile score)	38.7	27.8
Multi tasking and planning		
Six Elements Test (profile score)	2.4	1.3
Inhibition		
Hayling Sentence Completion Test (scaled score, range 1 to 10)	4.0	2.2
Visuo- perceptual tests		
Visual Object and Space Perception Battery		
• Shape Perception	19.3	0.9
• Cube Analysis	8.7	1.9
Recognition Memory		
Recognition Memory Test for Faces (scaled score)	5.7	3.1

* Three participants (numbers 6, 10 and 7) were unable to complete one or both of the subtests contributing to the WASI VIQ score. In these cases Full-4 IQ was substituted with an estimated IQ score based on these participants' WASI PIQ scores.

3.4. Everyday problem solving tasks

3.4.1. Drink Making Task

Scoring – Drinks efficiency score

Participants gained one point for each drink (summer berry juice and/or milk shake) made with the correct ingredients. This task could thus yield a score of zero (no drink produced), one (one drink produced) or two (one of each of the two drinks produced). The concentration of the end product was not rated, as dilution ratios are a matter of personal taste. If a participant produced several drinks, using the wrong ingredients, before correcting this successfully, then only the correct end product was scored, as long as the participant had received no prompting to initiate the correction.

Table 3.4. Number of drinks produced by participants

	Number of drinks produced by participants (N=32)		
	Two	One	None
	n (%)	n (%)	n (%)
Regardless whether correct ingredients used	29 (90.6)	3 (9.4)	0
Using correct ingredients	19 (59.4)	11 (34.4)	2 (6.2)

Types of errors

As anticipated, participants made a number of different types of errors (Table 3.5). Some participants produced only one drink, instead of two, others selected the wrong ingredients.

Table 3.5. Types of errors made in Drink Making Task

Type of error (across both preparations)	n of participants making this error (several participants made more than one error)
Substitution error (wrong ingredients used)	9
Omission error (omitted necessary ingredient)	10
Commission error (added unnecessary ingredient)	1

Coding of errors – examples

Substitution error: One participant (7) initially prepared her milkshake with water instead of milk.

Omission error: Nine participants omitted to add sugar to the milkshake, and one failed to add the instant milkshake powder.

Commission error: One participant appeared to mix up the instructions for the two drinks, i.e. she produced a juice from concentrate as instructed, but then added a teaspoon of sugar. This latter step formed part of the instructions for making the milkshake, which this particular participant forgot to produce altogether.

Other observations

Several participants made errors, which appeared to indicate that the instructions for the two drinks had been mixed up. For example, Participant 19 initially prepared the summer berry juice with milk and sugar. On noticing his mistake, he attempted to correct it by making up another drink. This time he correctly mixed concentrate and water, but then added one teaspoon of sugar (commission error).

A number of patients appeared to recognize that they had made an error, suggesting that they were able to monitor their performance, but their efforts to correct the error were unsuccessful. Participant 7, referred to above (substitution error), had prepared her milkshake with water instead of milk. When she noticed that something was wrong, she proceeded to add a further two teaspoons of milkshake powder, before topping the beaker up with soya milk.

3.4.2. Lamp Fixing Task

Scoring – Lamp efficiency score

The efficiency with which participants attempted to solve this problems was scored according to whether the participant succeeded in solving the problem in one step (scored as 1; see Figure 3.1), two and more steps (scored as 2), or not at all (scored as 3).

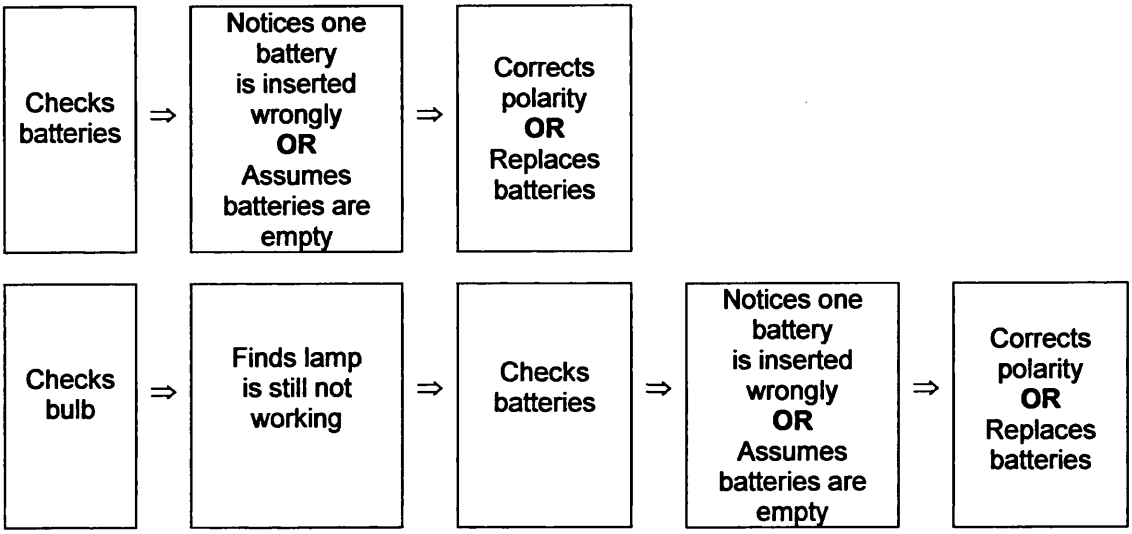
In order to solve this problem, participants had to create a hypothesis about what was wrong with the lamp, and to formulate a plan of how to find out what was wrong with it. The nature of this hypothesis would, in turn, determine whether participants would start by checking either the batteries or the bulb.

In order to receive the maximum efficiency score of one, participants could either start by checking the batteries or the bulb. Both starting points were considered equally efficient, because it was considered reasonable for participants to assume that the fault could lie with either.

As long as participants' attempts at solving the problem showed that they were working to this hypothesis and followed it through in a logical manner, the maximum efficiency score of one (1) would be awarded.

All other successful attempts at getting the lamp to work were coded as two (2), regardless of the number of steps needed. Unsuccessful attempts were coded as three (3).

Figure 3.1. Flowchart – the two most efficient ways to find out what was wrong with the lamp (one-step solutions)



All thirty-two participants attempted to solve this problem. Twenty-six (81.3%) succeeded, whilst six (18.7%) failed to do so. Sixteen of the successful participants (61.5%) chose one of the two most efficient one-step solutions. The remaining ten successful participants (38.5%) needed to complete two or more steps, before getting the lamp to work. (See also Table 3.6)

Table 3.6. (N = 32)

	1 step solution (2 points awarded)	2 step solution (1 point awarded)	Unable to solve (0 points awarded)
n (%)	16 (50)	10 (31.3)	6 (18.7)

Lamp Fixing Task - Qualitative information

As anticipated, participants' approaches to this problem ranged from a logical approach (Participant 18: "First check batteries – it's nearly always the batteries that go wrong, possibly they are in the wrong way round."), to solving the problem inadvertently (see Participant 28 and Participant 24 below), to failing altogether.

The following three examples illustrate how the problem was solved, although the individual performances indicated potential problems in planning and monitoring of overall performance.

Example 1:

Participant 9 started off by satisfying himself that the bulb was inserted correctly. Finding this to be the case, he removed all four batteries and selected the same brand, but wrong size replacement batteries. After inserting one of these, he removed it again and re-inserted the original batteries wrongly. Finding that the lamp was not working, he proceeded to check the polarity of the batteries, noticed that he had inserted them wrongly and corrected this. The lamp was now working. During our subsequent discussion, the participant explained to me that the original "batteries were dead", and "when the inserted *(replacement)* batteries didn't work, I realised I had inserted them the wrong way round".

Example 2:

Participant 24 started off by exchanging the batteries with their correct replacements, but inserted these wrongly. As the lamp was still not working, he concluded that the bulb was broken; he re-inserted the original batteries correctly, exchanged the bulb and found the lamp in working order.

Example 3:

Participant 2 started off with the intention to insert or change the batteries, but when she opened the battery compartment and found the batteries inserted, she abandoned her plan, saying: "The batteries are actually in", and changed the bulb instead. When the lamp was still not working, she remarked: "I have changed the batteries, what else might be wrong with it?", and was unable to think of another way to solve this problem. This suggests a memory lapse contributing to the task failure.

3.4.3. Journey Planning Task

This task presented an unexpected difficulty in that a number of participants (n=4) feared that their language impairment, such as slightly slurred speech or mild word finding difficulties, might make it difficult to negotiate over the telephone. Some participants wanted to know, who would be answering the telephone (answer given: "a colleague"), before attempting the task, and some needed to be persuaded to give it a try. In all, twenty-four of the thirty-two (75%) participants attempted this task, two of whom gave up on realising they had to speak to an actual 'help line operator'. The remaining eight participants (25%) refused to take part in this task altogether. As a result, the total number of participants carried forward for subsequent analysis of this task was twenty-two (68%).

Table 3.7. Attempts or refuses to carry out task (N=32)

	Frequency	Percent
Refused (8) or gave up mid-way (2)	10	31.2
Attempted	22	68.8

Two measures (request efficiency, relay efficiency) were taken from this task. These were subsequently combined to a third score (request and relay efficiency), which was taken forward for further analysis.

Request efficiency looked at the efficiency with which participants requested information from the help-line operator, relay efficiency at the efficiency with which that information was relayed to the experimenter. In the former, participants could achieve a maximum score of seven, in the latter a maximum score of eight points (for details see Table 3.8.). Individual items

were included on the assumption that they represented essential pieces of information a traveller would need to have in order to attempt the journey with a reasonable chance of completing it successfully.

Table 3.8. Scoring of Journey Planning Task and frequency with which individual items were requested and relayed

Request efficiency (1 point each)	Requested by n	Relay efficiency (1 point each)	Relayed by n
Departure station	22	Departure station	16
Departure time	15	Departure time	19
Mode of transport	18	1st station to change	19
Day of travel	20	Line to change to at 1st station	15
Destination	21	Destination of that line	19
Arrival time	17	Next line to change to	16
Chose correct ticket	21	Destination of that line	19
		Arrival time	6
Highest possible score	7	Highest possible score	8

Details of how often individual pieces of information were requested from the 'help-line operator', and subsequently relayed to the experimenter, are summarised in Table 3.8. (above). Information regarding the recoding of raw scores to efficiency scores, and details of the sample's performance, are presented in table 3.9.

Table 3.9. Conversion of raw scores to request efficiency and relay efficiency scores (N=22)

	Raw score	Efficiency score	Achieved by n (%) Participants
Request efficiency	6 to 7	2	17 (77.3)
	5	1	3 (13.6)
	0 – 4	0	2 (9.1)
Relay efficiency	7 – 8	2	11 (50)
	4 – 6	1	9 (41)
	0 –3	0	2 (9)

Combined efficiency score

The 'request efficiency' and 'relay efficiency' scores were subsequently added together to create the 'combined journey request and relay efficiency' score (see Table 3.10.). Participants could thus achieve scores in the range from zero through to four.

Table 3.10. Combined journey efficiency scores, recoded (N=22)

Combined score	Achieved by n (%) Participants
4	10 (45.5)
3	7 (31.8)
2	3 (13.6)
1	1 (4.6)
0	1 (4.5)

Journey Planning Task – Qualitative information

The following two examples have been selected to demonstrate the range of qualitative differences between individual participants' performances on this task.

Example 1:

Participant 11 collected the departure and arrival time and selected the correct ticket. He then ended the telephone call prematurely, i.e. without giving the help-line operator an opportunity to offer him further details regarding the journey. When it was pointed out to him that he had to plan a journey for a friend, who had never been here before, the participant suggested that he would go to Gatwick Airport himself to find out further details, such as platform numbers and train time tables. Prompted further that in his present condition this was not an option (the participant was unable to manoeuvre his wheelchair), he responded by suggesting he might get a friend to record a video of the airport. This video, in turn, would enable him to gather the necessary information, which he could then pass on to the visitor. As an alternative solution he suggested the visitor "use a black cab".

Example 2:

The performance of Participant 3 demonstrated how memory difficulties and a lack of problem solving skills might disrupt efficient task performance. This participant was unable to remember any of the journey details given to him by the operator. Asked how he might solve this problem in real life, he suggested that he "would phone the friend and tell him that I had a bit of a shock and tell him I see him later". It did not occur to him that he might

phone up the information line again to gather the information once more and take notes whilst doing so.

Other observations

Despite her serious memory impairment, Participant 29 completed the task successfully by reading the instructions word by word to the 'operator', and noting down the information given.

Participant 28 was reluctant to use the telephone and tried to avoid doing so. He was worried about what he might be asked (e.g. plane number) and told me, he was "unsure what to say". Instead of attempting the telephone call, he started to write a letter telling his 'friend' that he would send his "personal driver". When asked whether he actually had access to such a 'personal driver', he explained that he was intending to send his brother to collect the visitor. After approximately 15 minutes this participant was persuaded to use the telephone. He told the operator "a friend is coming from New Zealand this evening", i.e. Wednesday, instead of "Sunday morning" as outlined in the task instructions. Prompted by the operator, he said the friend wanted to be at the hospital "at 11:30 tonight" (wrong). The 'operator', having been instructed to adhere as far as possible to her script, did not query his request, but provided the scripted information instead. The participant, in turn, did not realise that the information collected regarding train times was incompatible with his request.

He attempted to write down the details given by operator, but had difficulties keeping up. He appeared keen to conclude the telephone conversation, and

he neither asked the operator to speak more slowly nor to repeat the information. His notes were consequently incomplete and difficult to read. He also did not notice the discrepancy between the arrival time of the plane ("tonight", Wednesday) and the departure time of the train (Sunday morning), i.e. he did not ask himself what his friend was supposed to do overnight and over the three following days.

Participant 12 insisted there were no trains from anywhere to Hillingdon. This is correct, when taken literally, as Hillingdon is not directly connected to the railway network, but served by London Underground. He saw no reason to use the telephone to contact the information service, and proposed instead to send his son to collect the visitor. When I attempted to persuade him to use the telephone in order to find out what solution the help-line might come up with, he declared that he would not use the telephone: "I don't trust them, I have never phoned a help-line before. In real life I would go to the station and find out or, more likely, phone somebody to find out for me". The participant did eventually suggest a solution that would have enabled the visitor to get to Hillingdon. His solution did, however, ignore the rule/requirement for the visitor to travel by train.

Pearson correlations (see Table 3.11, Page 75) were calculated in order to find out to what extent there was a relationship between participants' performances on individual tests of executive function and those on the three everyday problem-solving tasks. Given the categorical nature of the everyday task performance data, Spearman's *rho* could be considered a more appropriate statistical test. However, in this instance the Pearson correlation was considered to be appropriate as regression analysis assumes parametric status and all variables were normally distributed.

Significant correlations (see Table 3.11, Page 75) in the expected directions, i.e. better performance on tests being associated with better performance on everyday problem solving tasks, were found between participants' performance on the Six Elements Test and the Drink Making Task and the Journey Planning Task. The correlation with the Lamp Fixing Task approached statistical significance.

The number of categories attained on the Modified Card Sort Test was correlated with better performance on the Lamp Fixing Task. Participants' performance on the Trail Making Test – Form B was correlated with Drinks efficiency ratings. Performance on the Visual Object and Space Perception – Cube Analysis subtest was significantly correlated with participants' Drinks efficiency score.

Table 3.11: Pearson correlations between NP test performance and performance on everyday problem solving tasks

	Hayling	Brixton	SET	MCST	RMT-F	Trails B (log)	VOSP Shapes	VOSP Cubes
Lamp efficiency	.326	.150	.335	.595	.257	-.205	.347	.215
N = 32	.069	.411	.061	.000***	.155	.259	.052	.238
Drinks efficiency	.048	-.012	.395	-.010	.073	-.451	.124	.489
N = 32	.793	.949	.025*	.959	.692	.010**	.499	.005**
Journey efficiency	.136	-.096	.518	.322	.163	-.203	.342	.033
N = 22	.546	.672	.014*	.144	.469	.366	.119	.883

p < .05; ** $p < .01$; *** $p < .001$; two-tailed;

3.6. Multiple regressions

To establish whether participants' performance on the three everyday problems solving tasks could be accounted for by their overall performance on the tests of executive function, three regression analyses were performed (one for each of the everyday tasks).

Participants' scores on all the tests administered, with the exception of WASI and Spot the Word Test scores, were entered into the analysis as independent variables (predictors): Hayling Sentence Completion Test (Scaled score), Brixton Spatial Anticipation Test (Scaled score), Modified Card Sort Test (number of categories attained), Trail Making Test – Form B (percentile score), Six Elements Test (profile score), VOSP Shape detection and Cube analysis (Raw scores), and Recognition Memory Test – Faces subtest (Scaled score). Participants' efficiency scores on the three everyday problem-solving tasks were entered as dependent variables.

3.6.1. Drink Making Task

Together, the predictors accounted independently for 25.1% (adjusted R^2) of the variance, with the regression approaching statistical significance, $F(8, 23) = 2.30$; $\underline{P} = .056$. The Cube analysis sub-test from the Visual Object and Space Perception Battery predicted task performance best. None of the other scores' contributions reached statistical significance.

Table 3.9. Drink Making Task efficiency – Regression coefficients

	Standardized Coefficients Beta	T	Sig.
(Constant)		.52	.606
Hayling (Scaled score)	-.23	-1.24	.227
Six Elements Test (Profile score)	.17	.83	.414
MCST – (Categories attained)	-.08	-.44	.662
Brixton (Scaled score)	-.30	-1.43	.167
RMT-F (Scaled score)	-.20	-1.11	.278
TMT Form B (log)	-.33	-1.35	.191
VOSP Cube Analysis (Raw score)	.49	2.01	.056
VOSP Shape Detection (Raw score)	.06	.35	.730

p < .05; ** *p* < .01; *** *p* < .001; two-tailed;

3.6.2. Lamp Fixing Task

Together, the predictors independently accounted for 34% (adjusted R^2) of the variance. The regression was statistically significant, F(8, 23) = 2.99; P =.019. The number of categories attained on the Modified Card Sort Test predicted task performance best. None of the other scores' contributions reached statistical significance.

Table 3.10. Lamp Fixing Task efficiency – Regression coefficients

	Standardized Coefficients Beta	T	Sig.
(Constant)		2.91	.008
Hayling (Scaled score)	.15	.87	.394
Six Elements Test (Profile score)	.24	1.26	.221
MCST – (Categories attained)	.55	3.21	.004**
Brixton (Scaled score)	-.07	-.37	.711
RMT-F (Scaled score)	.13	.77	.448
TMT Form B (log)	.31	1.34	.194
VOSP Cube Analysis (Raw score)	.08	.35	.732
VOSP Shape Detection (Raw score)	.23	1.37	.183

p < .05; ** *p* < .01; *** *p* < .001; two-tailed;

3.6.3. Journey Planning Task

Together, the predictors independently accounted for 32.9% (adjusted R^2) of the variance. The overall regression was not statistically significant, F(8, 13) = 2.29; P =.089. Performance on the Six Elements sub-test, from the Behavioural Assessment of the Dysexecutive Syndrome battery, predicted the task performance best, and was statistically highly significant. None of the other scores' contributions reached statistical significance.

Table 3.11. Journey Planning Task efficiency – Regression coefficients

	Standardized Coefficients Beta	t	Sig.
(Constant)		-1.79	.096
Hayling (Scaled score)	.04	.18	.862
Six Elements Test (Profile score)	.78	3.13	.008**
MCST – (Categories attained)	.28	1.42	.180
Brixton (Scaled score)	-.21	-.90	.383
RMT-F (Scaled score)	.09	.47	.647
TMT Form B (log)	.33	1.03	.323
VOSP Cube Analysis (Raw score)	-.07	-.27	.789
VOSP Shape Detection (Raw score)	.35	1.78	.098

p < .05; ** $p < .01$; *** $p < .001$; two-tailed;

4. Discussion

4.1. Summary of aims of this study and its main findings

This study set out to examine the relationship between performance on neuropsychological tests and performance on everyday problem solving tasks. In this section the findings of the study regarding the two hypotheses raised will be discussed and related to the literature presented in the introduction. Methodological strengths and weaknesses will be raised, clinical and theoretical implications of the study highlighted and suggestions will be made regarding future research into this area.

4.1.1. Hypothesis 1

This hypothesis proposed that performance on individual neuropsychological tests with high ecological validity would correlate better with performance on three everyday problem-solving tasks than with that on individual 'pure' neuropsychological tests.

Examination of the Pearson correlations between performance on individual neuropsychological tests and performance on each of the three everyday problem solving tasks showed that performances on some of the tests did correlate with those on the everyday problem solving tasks. Moreover, it did show that the pattern of correlation was different for each of the three problem-solving tasks:

- Performance on the Drink Making Task was highly correlated with performance on the Cube Analysis subtest from the Visual Object and Space Perception battery. It also correlated significantly with performance on Form B of the Trail Making Test and that on the Modified Six Elements Test.
- Performance on the Lamp Fixing Task correlated best with the number of categories attained on the Modified Card Sort Test. In addition, correlations with the Shape Discrimination subtest from the Visual Object and Space Perception battery, with the Modified Six Elements Test, and with the Hayling Sentence Completion Test approached statistical significance.
- Performance on the Journey Planning Task correlated significantly with that on the Modified Six Elements Test. No other correlations approached statistical significance.

The hypothesis was thus confirmed for the Drink Making Task and for the Journey Planning Task, but not for the Lamp Fixing Task.

The finding that the pattern of correlation was different for each of the everyday problem solving tasks suggests a degree of specificity of both, problem-solving tasks developed for this study and the neuropsychological tests selected. More specifically, it suggests that particular neuropsychological tests may share specific resources with each of the problem solving tasks.

Pearson correlations showed that performance on all three problem solving tasks correlated with that on the Modified Six Elements Test, although the correlation between the Lamp Fixing Task and the Modified Six Elements Test did not quite reach statistical significance. This is hardly a surprising finding: the Modified Six Elements Test was specifically developed to have ecological validity and achieves this by mimicking some of the complexities of everyday life. As such, it is likely to be a less specific measure than most of the other neuropsychological tests administered in the present study.

However, simply referring to a test's ecological validity in order to explain its correlation with another task, also designed to be ecologically valid, appears circular and to have very little explanatory value. How else might we be able to understand the pattern of correlations observed?

Let us assume for the moment that these correlations are not spurious but do indeed tell us something about underlying processes and resources shared by the various tasks and tests. An interpretation of the correlation between the Drink Making Task and the Journey Planning Task with performance on the Modified Six Elements Test could not simply rely on the ecological validity as explanation. The pattern of significance statistics suggests that there may be a more specific reason underlying this finding. Burgess and Shallice (1997) suggested that the Modified Six Elements Test has a particularly strong prospective memory component. If we look at the Drink Making Task and the Journey Planning Task in this light, then it may be possible to frame these two tasks in terms of prospective memory demands. All three tasks do

ask of successful participants to employ a number of potential executive processes such as planning, sequencing, problem solving and dealing with novelty to name but a few. However, these two particular tasks do have in common that they consist of two distinct sub-tasks (to make two different drinks; to gather information and to pass on information), which participants needed to be able to remember to carry out.

Although this was not researched in detail, it could be argued that all three of the everyday problem-solving tasks used in the present study make demands on a prospective memory system as all of them involve the attainment of a goal state, which has to be remembered. In order to reach this goal state, participants have to monitor their performance and compare it with this goal state. In addition, participants had been provided with relatively detailed, written instructions that were displayed in front of them throughout the individual problem solving tasks. This had been done with the intention of reducing memory load for a group of patients who is known to frequently experience working memory and prospective memory problems. During test administration it was observed that few participants actually referred to these instructions (although this aspect of performance was not scored).

The correlation between performance on the Lamp Fixing Task and the Modified Card Sort Test was highly significant. This contradicts recent reports in the literature that the Modified Card Sort Test is unspecific and echoes Burgess et al's. (1998) suggestion that performance on this test does appear to have some specificity, as expressed by it loading onto the

executive memory factor proposed by these authors, rather than onto either one of the two other factors identified by these two authors. The Modified Card Sort Test is considered a test of rule attainment. It would seem reasonable to propose that an important factor in successful performance on the Modified Card Sort Test would be an ability to reason by logic. Humphreys, Forde and Riddoch (2001) identified reasoning by logic as a problem solving strategy that can be employed to deal with the demands of some unfamiliar tasks. Of the three everyday problem-solving tasks, the Lamp Fixing Task is a technical problem-solving task which does lend itself particularly well to being solved by following the rules of logical reasoning.

Reasoning that appears to be logical can underpin spurious successful task performance, as the following example shows: participant 10 succeeded in getting the lamp to work by coincidence, but gave a wrong explanation for her success. The participant had not noticed that one of the batteries had been inserted wrongly and chose to insert the correct set of replacement batteries, but did so in the wrong orientation. As she found the lamp was still not working she came to the erroneous conclusion that the bulb needed to be replaced. Having changed the bulb, she reinserted the original set of batteries, but this time in the correct orientation. On finding that the lamp now worked, she concluded that the bulb had been faulty.

A surprising finding in the context of the Lamp Fixing Task was the lack of correlation between performance on this task and that on the Brixton Spatial Anticipation Test. On the surface this test would appear to make rather

similar demands as the Modified Card Sorting Test, indeed it is described in the test manual as "a concept (or 'rule') attainment task" ... "of which the Wisconsin Card Sorting Test is the most well known example" (Burgess and Shallice, 1997a, P. 10). One might, therefore, have expected the performance on the Brixton test to show a similar correlation with performance on the Lamp Fixing Task as the Modified Card Sorting Test. This finding may be worth exploring further as it suggests that the two tests are not equivalent and one cannot be simply taken to substitute the other.

A closer examination of individual cases illustrated, however, also how there can be dissociations in performance on everyday problem-solving tasks and performance on neuropsychological tests, even on tests deemed to be of high ecological validity.

Example 1:

The performance of participant 29 on the Journey planning task illustrates how an individual with relatively low scores on the majority of neuropsychological tests administered and who has a serious memory impairment that includes impairment of prospective memory, was nevertheless able to complete this task successfully. She did so by adhering strictly to the instructions given and by making full use of the materials provided: She read the instructions, provided as an 'aide memoir', word by word to the help line operator and noted down the information she was given. After successfully completing the task she told the experimenter: "I found it easy – to tell you the truth, I thought I couldn't do it". This participant's injury occurred several years ago and she continues to have a low opinion of her

ability to cope in everyday life, as expressed by her Dex self-rating score of 76 of a maximum possible 80, which indicated she experienced the majority of the problems sampled 'very often'. The score on the DEX independent rater questionnaire (completed by her nearest relative) was forty-four, suggesting whilst the participant might have overstated her perceived difficulties, she did nevertheless experience significant problems in daily life. Her performance on the Journey planning task showed she had been able to acquire compensatory strategies that helped her to be successful on this occasion.

Her performance illustrates, however, another problem highlighted in the introduction: whilst she did well on this particular problems solving task, her performance on most of the neuropsychological measures was below average and in some cases in the Impaired range. For example, her WASI Full-4 score and those on the Performance and Verbal subtests were in the impaired range, she acquired only one category on the Modified Card Sort Test, and her Profile Score on the Modified Six Elements Test was two out of a maximum possible of four. Therefore, looking at her performance on neuropsychological tests would not have helped us to predict her performance on this particular problem-solving task.

Example 2:

Memory difficulties and a lack of problem solving skills disrupted efficient performance on the Journey Planning Task for participant 3. Whilst he had achieved the maximum possible score on the Modified Six Elements Test, he was nevertheless unable to complete the Journey Planning Task successfully

as he could not remember any of the journey details given to him by the help-line operator. Asked how he might solve this problem if happened in real life, he suggested that he "would phone the friend and tell him that I had a bit of a shock, and tell him I see him later". It did not occur to him that he might phone up the information line again to gather the information once more and to take notes whilst doing so.

4.1.2. Hypothesis 2

This hypothesis proposed that a battery of neuropsychological tests is able to make a substantial contribution to predicting participants' performance on individual everyday problem-solving tasks.

As outlined earlier, several significant correlations were found between performance on individual neuropsychological tests and each of the everyday problem solving tasks. Three multiple regression analyses were carried out to explore how much of the everyday problem-solving task performance could be explained by performance on the battery of neuropsychological tests, which had been selected for this study on the basis that they are known to have an executive function component.

These multiple regressions showed that between one quarter (Drink Making Task) and one third (Lamp Fixing Task and Journey Planning Task) of participants' performance on these three problem-solving tasks could be explained or predicted by their performance on neuropsychological tests. Examination of individual participants' scores confirmed, however, also the old adage that there are exceptions to any rule: whilst this study found

significant correlations on a group level, there were individual cases of participants (e.g. participant 34) who did not fit the group pattern. On one hand this may have had the overall effect of weakening the overall significance of the findings, on the other hand it suggests that predictions based on test results are just that: predictions that do hold true in the majority of, but certainly not all cases.

Finding a correlation between performance on neuropsychological tests and performance on everyday problem solving tasks suggests that both types of test may tap into similar resources. It also indicates a degree of specificity not only about neuropsychological tests but also to the three problem-solving tasks designed for this study: Whilst performance on all three of the problem-solving tasks did co-vary with that on the Modified Six Elements Test, once entered into the multiple regression the latter did actually turn out to have no more explanatory power than other neuropsychological tests for the Drink Making Task and for the Lamp Fixing Task. However, for the Journey Planning Task it did make a highly significant contribution to the overall explanatory power of the predictive model and an examination of the Beta values suggested that a one standard deviation change in the Modified Six Elements Test performance is associated with a change of around three-quarters of a standard deviation in overall Journey Planning Task performance.

4.2. Overall implications

This study looked at the relationship between laboratory based, abstract pencil and paper tests, and performance on everyday problem solving tasks. The results of the three multiple regressions can be interpreted in at least two ways. On one hand, we might conclude that we can predict a quarter to a third of overall performance on these particular everyday problem-solving tasks. This indicates that there is validity to using traditional neuropsychological tests. On the other hand, one might look at what we are missing: between two-thirds and three-quarters of overall performance is not explained by test performance.

As outlined earlier, a number of authors have stressed the importance of being clear about the purpose of tests administration. If we are interested in finding out more about individual and possibly highly specialised modules and processes contributing to overall cognitive function and behaviour then it is important to have access to test materials, which offer such specificity. If, however, our aim is to be able to anticipate problems individual patients may be confronted with in real life situations, then it may be better to use less specific tests which tap a wider range of resources and are more representative of real life settings than traditional neuropsychological tests.

Alternatively we may consider the administration of a battery of neuropsychological tests. This would allow us to draw conclusions regarding the specifics of possible deficits underlying deficits in performance, but also allow us to make more informed predictions regarding individuals' likely

functioning in everyday problem-solving situations. However, their predictive power in terms of individuals' overall performance does appear to be modest since between two-thirds and three quarters of variation remain unexplained. It does, however, seem likely that these figures could be further improved upon by systematically exploring correlations between traditional neuropsychological tests and tasks of everyday problem-solving, such as those employed in the present study.

However, as the two case examples given earlier showed, there is also always a margin of error. Performance on neuropsychological tests does allow us to make predictions about how individuals are likely to perform, but such predictions may not hold true in individual cases. Similarly, successful performance on everyday problem-solving tasks does not always imply successful performance on neuropsychological tests of executive function.

4.3. Coincidental finding.

A coincidental and surprising finding of this study was participants' reluctance to use the telephone in the Journey Planning Task. Whilst it is unclear whether this finding is representative and can be generalised across the population of brain injured individuals, it does have potential implications regarding rehabilitation programmes. More work may need to be done to allow patients to develop a greater sense of self-confidence about using the telephone. Bearing in mind that this tends to be a highly dependent population, often with physical impairments that make it difficult to physically access institutions such as benefit offices etc., it would seem desirable to

facilitate greater independence by being able to access services more confidently by telephone. Maybe problem solving strategies along the lines of "How do I communicate my special needs at the outset of the telephone conversation so that the other person understands my difficulties and is, therefore, less likely to become impatient?" etc. might be helpful.

4.4. Methodological shortcomings of project

4.4.1. Correlational research

This study was based around finding, and indeed did find some statistical correlations between two types of tasks. However, it would be premature to conclude from having found some statistically significant correlation on this occasion that this means these findings can be generalised. The correlations found on this occasion may well have been spurious and future research effort might usefully be directed into replicating this study in an attempt to confirm or disconfirm its findings.

Furthermore, statistical significance in correlational research can only tell us whether two or more measures co-relate, but tells us little about whether such correlation is clinically significant. Categorical data such as that collected from participants' performance on everyday problems solving tasks does not lend itself readily to analysis in terms of standard deviations. Further work should be carried out to establish the clinical significance of the above findings. Logistic regression would be a statistical procedure to use in exploring further the present dataset with performance categorised into two classes: 'goal achieved' versus 'goal not achieved'. Doing so would, however, have resulted in the loss of the qualitative aspect of the 'efficiency' rating employed in scoring the everyday problem solving tasks in the present study. Again, it would seem worthwhile to explore this question further during a future research project.

4.4.2. Sample size

The likelihood of this study detecting a statistically significant correlation between two variables, thus avoiding a Type-I error, was reduced by its small sample size. Comparable sample sizes are, however, not unusual in this kind of neuropsychological research

The tasks of everyday problem solving used in this study had been especially developed and therefore no previous performance data was available to guide us in deciding on the appropriate sample size. We did, nevertheless, succeed in finding a number of significant correlations and a predictive model that was able to explain a considerable amount of the variance in everyday problem-solving task performance.

The number of participants, and therefore statistical power, was particularly low for the Journey Planning Task. This did, however, not prevent us from finding a highly significant correlation between Six Elements Test performance and performance on this particular task. Furthermore, we were able to show that there was a good, but statistically non-significant correlation between performance on the neuropsychological test battery and performance on this particular task, suggesting that around thirty-three percent of the overall variance could be predicted by test performance.

As discussed earlier, the low number of participants on this particular task was a direct demonstration of just how profound and long lasting some of the effects of brain injury can be for some individuals, and to what extent this

may potentially limit some patients' chance to lead more independent lives. If the findings of the present study are anything to go by, then a significant proportion of brain-injured patients are aware of and feel embarrassed by their perceived problems in the area of social communication via telephone. It may be worthwhile to explore this issue further in future research. If this finding is replicated, then this could have direct clinical implications for rehabilitation services. Efforts may need to be directed more specifically at allowing patients to develop a greater sense of competency in the domain of social communications.

4.4. Summary and Conclusion

This study set out to examine the relationship between performance on neuropsychological tests and performance on everyday-problem solving tasks. Three problem everyday problem-solving tasks, covering three domains of daily life were developed and a battery of neuropsychological tests known to have an executive function component was selected. The tasks and tests were administered to a group of individuals with non-progressive brain-injuries and performances examined.

The main findings on comparing performances on individual neuropsychological tests with performances on the three everyday problem-solving tasks were: (a) Performance on the Six Elements Test, an executive function test considered to have high ecological validity, correlated well with performance on the three problem-solving tasks. (b) The pattern of

significant relationships between individual problem-solving tasks and individual neuropsychological tests suggested that there was a degree of specificity to each of the three tasks designed. (c) In some participants a dissociation between performance on everyday problem-solving tasks and on neuropsychological tests of executive function was observed.

Three multiple regression analyses carried out to explore the explanatory value of performance on the battery of neuropsychological tests administered for performance on the everyday problem-solving tasks showed that, depending on the task, between one quarter and one third of overall performance were explained by the group of neuropsychological tests administered.

Despite some methodological shortcomings the present study yielded interesting results in terms of individual tests' performance, e.g. the unexpected apparent specificity of the Modified Card Sort Test, and the apparent lack of correlation between performance on the Modified Card Sort Test and the Brixton Spatial Anticipation Test.

This study is best regarded as a pilot project on which to base further exploration of the association between performance on pure tests of neuro psychological functioning and performance on tasks of everyday problem-solving.

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Appendices

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Mr M Preisinger
Trainee Clinical Psychologist
Woodland Centre
Hillingdon Hospital

Ref: app1181

Date: 15 July, 2002

Dear Mr Preisinger

Re: Relationship between performance on neuropsychological tests of executive function and performance on tasks of activities of daily living
LREC Reference Number 1181 (This number MUST be quoted on all correspondence)

With reference to the above submission to the Hillingdon Local Research Ethics Committee, I am pleased to confirm that your study was approved at the meeting on 2nd July 2002. You may proceed with your proposed study subject to the following conditions:

1. You confirm that Clinicians will identify participants

Questionnaire

2. You change the heading on the "Informant's" questionnaire to "Carer" rather than "Informer"

Patient Information Sheet

3. You include information that help will be available for anyone experiencing stress during or after completing the questionnaire
4. You produce a separate leaflet for carers and include information that the questionnaire will be destroyed after the study

Consent Form

5. You request the participant's consent for someone else to complete a questionnaire about them

6. A brief report on the project (approximately 1-2 sides of A4 paper) should be submitted to the Ethics Committee at the end of the project or annually in the case of ongoing study.

Chair: Jane Kelly

7. Should you leave your current post before completing the project, the Ethics Committee will need to be advised on whether the project is to continue and the name of the researcher who will undertake the project in the future. If a project is discontinued, written information regarding progress should be sent to the Secretary of the Ethics Committee to be kept on file.

8. The attached consent form should be signed and returned to me to keep on file.

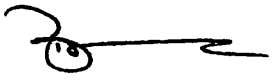
9. The Committee must be advised of all serious unexpected adverse reactions to patients participating in the study.

Should you have any queries regarding these points, then please do not hesitate to discuss them with the Secretary or the Chairman

I enclose a copy of the Annex to Directive 91/507/EEC on the conduct of clinical trials for your information. In addition you may wish to refer to detailed guidance issued by the Royal College of Physicians on Ethics Committees in Medical Research, a copy is available for perusal in the Post Graduate Medical Centre Library, or we do have a copy here.

If I can be of any further assistance, then please do not hesitate to contact me.

Yours sincerely



Brenda Thomas
Secretary: Hillingdon Local Ethics Committee

The Hillingdon Hospital

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Direct Phone: 01895-279964
Direct Fax: 01895-279737

Patient Information Sheet

Title of study: The relationship between performance on tests of neuropsychological function and performance on activities of daily living.

- You are being invited to take part in a research study.
- This sheet explains the purpose of the study and what you are being asked to do.
- Please take time to decide whether or not you wish to take part.
- If you do decide to take part you can change your mind at any time.
- Deciding not to take part, or changing your mind later will not alter your treatment in any way.

Why is this study being done?

- Neuropsychological tests are pen-and-paper tests used to assess people's ability to remember things, plan tasks, solve problems etc.
- This study will explore how these tests relate to people's ability to manage everyday tasks.
- This will help improve selection of tests used in future assessment and rehabilitation.

Why have you been chosen for this study?

- You have been chosen for this study because you are, or have been, an inpatient on the Alderbourne Rehabilitation Unit, or seen at the Head Injury Clinic at Hillingdon Hospital.
- You have also been chosen because you have had a head injury or a stroke.

What will happen to me if I take part? How will this differ from normal treatment?

- The tasks you will be asked to complete in this study are very similar to those you were asked as part of your assessment and treatment.

If you join the research study, you will be asked...

- about your education, occupation and about your medical history.
- to fill in a questionnaire. If you find this difficult someone will be there to help you.
- to carry out pencil and paper tests of problem solving skills, reading a list of words and some memory tests. This will take about 2 hours of your time.
- to carry out three everyday activities. These will take about 1 hour of your time.

- You will be able to take a break if you feel tired.

- With your permission, I shall also need to see your medical file.

- Somebody who knows you well, like a member of staff or a relative, will be asked to fill in a questionnaire about any difficulties you may have had since your stroke or head injury.

- All clinical information and interview records are kept fully confidential. I shall be the only person who has access to them.

- After completion of the study all records will be destroyed.

- If you would like me to, I would be happy to discuss your results with you and relevant members of the team responsible for your care on the unit.

What are the disadvantages and risks of taking part?

- There are no physical investigations of any kind, you will not be given any drugs and you will not be asked to do anything unpleasant or painful.
- All participants are expected to have some difficulty in completing at least some of the tasks. As a result, some people will may find the testing stressful.
- If you experience stress, or if you have any concerns as a consequence of participating in this project then you may discuss these with either Mr. Michael Preisinger or Dr. Bede Smith.

What if something goes wrong?

- The chances of something going wrong are very small.
- The normal NHS compensation scheme applies, should the need arise.

What will happen to the results of the study?

- The results will be written up as a thesis for a Doctorate in Clinical Psychology.
- You will be able to obtain a summary of the results by contacting Mr. Michael Preisinger on 01895-279 384.

If you have further questions about this study

- Please contact: Mr. Michael Preisinger on 01895-279 384.

- If you decide to take part you will be given a copy of this information sheet.
- You will also be given a copy of your signed consent form to keep.

Thank you for giving this your consideration.

The Hillingdon Hospital

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PATIENT CONSENT FORM

Title of Study:
Relationship between performance on neuropsychological tests of executive function and performance on tasks of activities of daily living.

The patient should complete the whole of this sheet himself/herself

Please tick appropriate box

- Have you read the Patient Information Sheet ☐ Y ☐ N
- Have you had an opportunity to ask questions and discuss this study? ☐ Y ☐ N
- Have you received satisfactory answers to all your questions? ☐ Y ☐ N
- Who have you spoken to? Dr*.....
- Do you understand that you will not be referred to by name in any report concerning the study? ☐ Y ☐ N
- Do you understand that you are free to withdraw from the study:-
  - at any time ☐ Y ☐ N
  - without having to give a reason for withdrawing? ☐ Y ☐ N
  - without affecting your future medical care? ☐ Y ☐ N
- Do you agree to somebody who knows you well completing a questionnaire about difficulties you may have been having since your stroke or head injury? ☐ Y ☐ N
- Do you agree to take part in this study? ☐ Y ☐ N

SIGNATURE OF THE PATIENT..... DATE.....

NAME IN CAPITALS.....

- I have given a clear explanation of the study to the patient and I am satisfied that they have given informed consent.

WITNESSED BY.....NAME IN CAPITALS.....

Appendix 2.1.4. Independent rater information sheet – Hillingdon Hospital

The Hillingdon Hospital

Dr R S Hanspal FRCP FRCS
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CARER INFORMATION SHEET

Title of Study:
Relationship between performance on neuropsychological tests of executive function and performance on tasks of activities of daily living.

Neuropsychological tests are pen-and-paper tests that are used to assess people's ability to remember things, plan tasks, solve problems etc. This study will explore how people's performance on these tests relates to their ability to manage everyday tasks.

This will help improve selection of tests used in future assessment and rehabilitation.

_____ (the patient) has agreed to participate in the above study and has given me permission to ask you to compete the enclosed questionnaire.

Both, the patient's and your participation in this study is voluntary. Whether you decide to complete or not to complete the questionnaire will not alter the patient's treatment in any way.

All information will be treated as confidential.

All records, including the enclosed questionnaire, will be destroyed after completion of the study.

You may keep this information sheet.

Thank you for giving this your consideration.

HARROW RESEARCH ETHICS COMMITTEE
(Chairman: Dr David Lubell)
Room 4B 011
Northwick Park Hospital
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13 May 2002

Mr M Preisinger
Department of Clinical Health Psychology
UCL
Gower Street
London WC1E 6BT

Dear Mr Preisinger

Ethics Submission No 2992: Relationship between performance on neuropsychological tests of executive function and performance on tasks of activities of daily living

The above project was approved by the Harrow Research Ethics Committee at its meeting on 13 May 2002. It would be appreciated if, in any future correspondence relating to this project or in any entry made in case notes about procedures undertaken in the course of this study, you would refer to it as EC 2712. ***Please note that, before you can proceed with the study, you will need to obtain formal authorisation from the NHS institution where it is to be undertaken.***

Set out overleaf is the REC membership list which should, if applicable, be copied to the sponsoring organisation.

General Practitioners should be kept informed of research work affecting their patients, particularly when the patient's involvement continues after discharge from hospital.

All adverse events arising during the course of this study should be notified, but please note that the Committee is only concerned to receive such notifications as they relate to subjects participating in trials in Harrow. Investigators undertaking trials on behalf of drug companies are asked to refrain from sending other adverse event reports, unless there are very exceptional circumstances.

The Committee operates according to GCP in most important respects.

Yours sincerely

Brian Saperia
Administrator

The North West London Hospitals
NHS Trust

Watford Road
Harrow
Middlesex
HA1 3UJ

Tel: 020 8864 3232
Fax: 020 8869 2009
DDI: 020 8869

Patient Information Sheet

Title of study: The relationship between performance on tests of neuropsychological function and performance on activities of daily living.

- You are being invited to take part in a research study.
- This sheet explains the purpose of the study and what you are being asked to do.
- Please take time to decide whether or not you wish to take part.
- If you do decide to take part you can change your mind at any time.
- Deciding not to take part, or changing your mind later will not alter your treatment in any way.

Why is this study being done?

- Neuropsychological tests are pen-and-paper tests used to assess people's ability to remember things, plan tasks, solve problems etc.
- This study will explore how these tests relate to people's ability to manage everyday tasks.

Why have you been chosen for this study?

- You have been chosen for this study because you are an inpatient on the Regional Rehabilitation Unit.
- You have also been chosen because you have had a traumatic brain injury or a stroke.

Headquarters, Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3UJ Tel: 020 8864 3232 Fax: 020 8869 2009

What will happen to me if I take part? How will this differ from normal treatment?

- The tasks you will be asked to complete in this study are very similar to those you were asked as part of your assessment and treatment.

If you join the research study, you will be asked...

- about your education, occupation and about your medical history.
- to fill in a questionnaire. If you find this difficult someone will be there to help you.
- to carry out some neuropsychological tests. These will take about 2 hours of your time.
- to carry out three everyday activities. These will take about 1 hour of your time.

- You will be able to take a break if you feel tired.

- We will also need to see your medical file.

- Somebody who knows you well will be asked to fill in a questionnaire about any difficulties you may have had since your stroke or head injury.

- All clinical information and interview records are kept fully confidential.

- If you would like us to, we would be happy to discuss your results with relevant members of the team responsible for your care at the RRU.

What are the disadvantages and risks of taking part?

- There are no physical investigations of any kind, you will not be given any drugs and you will not be asked to do anything unpleasant or painful.
- You might experience some tasks as difficult and stressful.

What if something goes wrong?

- The chances of something going wrong are very small.
- If you are harmed due to negligence of one of the staff, you are entitled to claim compensation in the normal way.
- If you have any complaints about a member of staff you should contact Professor Lynne Turner-Stokes, Consultant in Rehabilitation Medicine, Northwick Park Hospital (020-8869-2800).

What will happen to the results of the study?

- The results will be written up as a thesis for a Doctorate in Clinical Psychology.
- You will be able to obtain a summary of the results by contacting Mr. Michael Preisinger on 07092 170357.

If you have further questions about this study

- Please contact: Mr. Michael Preisinger on 07092 170357

Thank you for your attention.

Patient label

RRU Consent Form for Research

Title of Project: Relationship between performance on neuro-psychological tests of executive function and ADL tasks

Ethics Committee No: **2992** Principle investigator: **Mr Michael Preisinger**

Part A: To be completed by the investigator

I confirm that I have explained this research project to the patient and/or their family in terms which, in my judgement are suited to their understanding.

Michael Preisinger ***Name of researcher***	***Signature***	***Date***
Name of person taking consent (if different from researcher)	***Signature***	***Date***

Part B: To be completed by patient

- The purpose and nature of the study has been explained to me ☐
- I have had my questions answered ☐
- I understand what the study will involve ☐
- I understand that I can withdraw at any time ☐
- I understand that all information will be kept confidential ☐
- I understand about the study and agree to take part ☐

Name of Patient	**Signature**	**Date**
Name of Witness (if necessary)	*Signature*	*Date*

Or: To be completed by a family member

..... is unable to speak for him/herself.
I realise that I cannot consent on his/her behalf, but I believe that if he/she were able to give consent, they would wish to participate in this study.

Name of Family member	***Signature***	***Date***

TVTC
Thames Valley Test Company

BADS

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:

1 I have 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 I act without thinking, doing the first thing that comes to mind

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

3 I sometimes talk about events or details that never actually happened, but I believe did happen

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

4 I have difficulty thinking ahead or planning for the future

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

5 I sometimes get 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 I get events mixed up with each other, and get confused about the correct order of events

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

7 I have difficulty realizing the extent of my problems and am unrealistic about the future

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

8 I am lethargic, or unenthusiastic about things

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

9 I do or say embarrassing things when in the company of others

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

10 I really want 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 I have difficulty showing emotion

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

12 I lose my temper at the slightest thing

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

13 I am unconcerned about how I should behave in certain situations

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

14 I find it hard to stop repeating saying or doing things once I've started

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

15 I tend 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 I find it difficult to stop myself from doing something even if I know I shouldn't

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

17 I will say one thing, but will do something different

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

18 I find it difficult to keep my mind on something, and am easily distracted

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

19 I have trouble making decisions, or deciding what I want to do

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

20 I am unaware of, or unconcerned about, how others feel about my behaviour

☐0 ☐1 ☐2 ☐3 ☐4

Never Occasionally Sometimes Fairly often Very often

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BADS

Dex Questionnaire
Independent rater

Thames Valley Test Company

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

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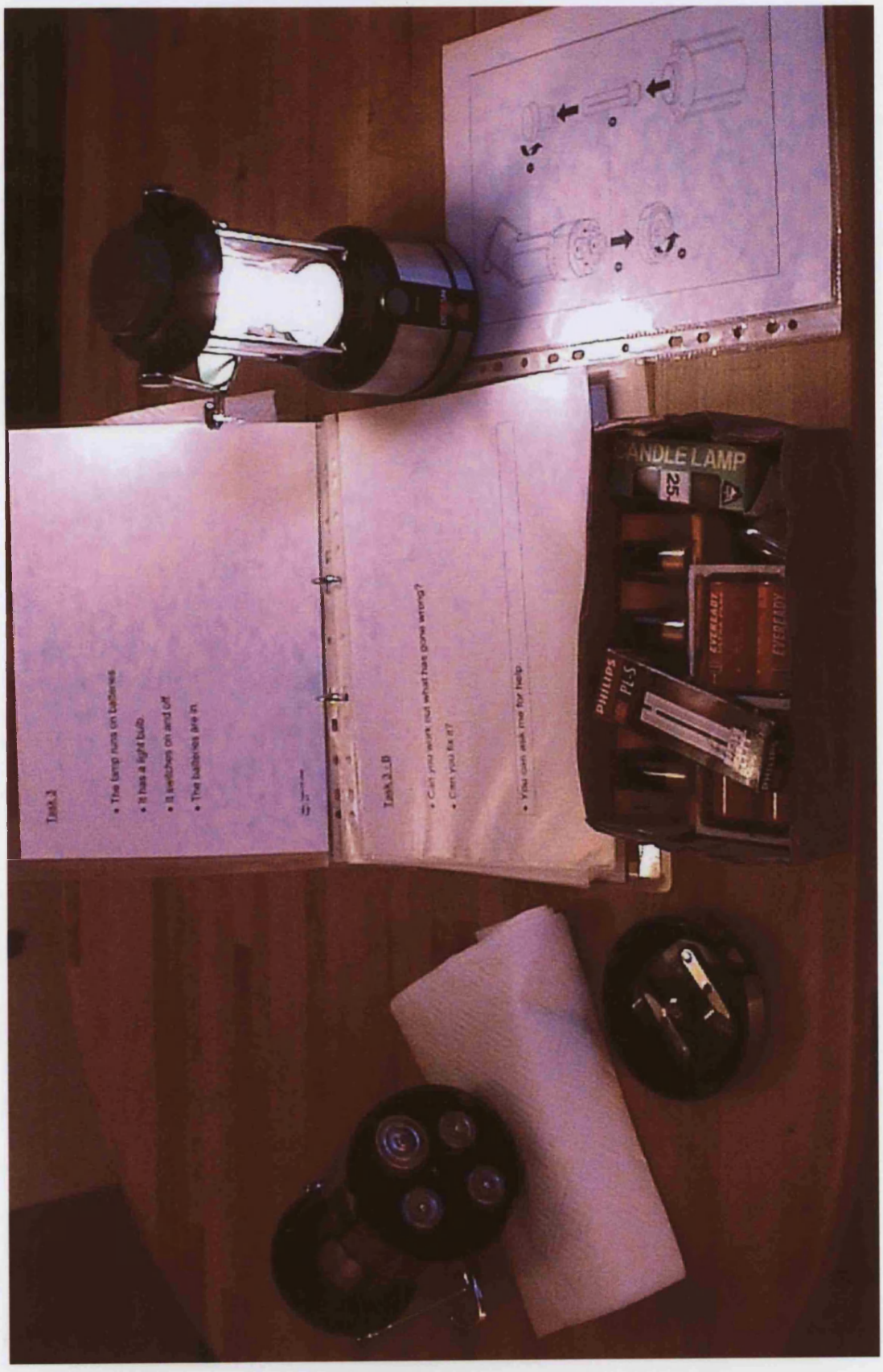
Appendix 2.4.2.1. Drink Making Task – Photograph of set-up.

Appendix 2.4.2.2. Lamp Fixing Task – Photograph of set-up.



Appendix 2.4.2.3.. Lamp Fixing Task – Detail photograph of set-up.