

UNIVERSITY OF
BIRMINGHAM



U

B

Glyn Humphreys
Cognitive recovery after brain damage

Problems associated with the long-term effects of neurological change represent the largest demand on long-term NHS Services

In the aging population, neurological changes very often associated with gradual degenerative alteration in brain function

- Alzheimer's
- Parkinson's
- Healthy aging

In other cases you may have sudden step changes associated with brain injury or stroke

In general screens of the acute stroke population (even up to 3 months post stroke), cognitive deficits have been documented in at least 50% of the patients (*Adunsky et al., 2002*)

Cognitive status at admission is reliably related to rehabilitation outcome (*Galsky et al., 1993*)

Thus it is important to measure cognitive problems following stroke, and important to assess the optimal way(s) to rehabilitate such problems

- Here I will discuss our work in developing a screen for cognitive deficits after stroke
- Using tests that are applicable in acute stroke, that do not exclude patients with some of the more common cognitive problems ('aphasia friendly' and 'neglect friendly')
- The screen aims to pin-point specific problems that can be addressed through appropriate re-learning/rehabilitation strategies
- I will then go on to discuss how our understanding of the rehabilitation process can be aided by brain imaging functional recovery in patients

Previous studies have typically used either:

General (non-specific) measures of cognitive function:

Mini-mental state examination (Lawrence et al., 2001)

Clock drawing (Friedman, 1991)

Measures of single cognitive functions:

expressive aphasia (Kauhanen et al., 2000)

neglect (Cassidy et al., 1999)

executive functions (Leeds et al., 2001)

visuo-spatial abilities (Adunsky et al., 2002)

Some attempts to measure multiple cognitive functions, but:

- (i) few have been applied in acute stroke
 - (ii) few have measured executive processes alongside 'modular' cognitive processes such as language, memory, spatial processing
- yet executive processes [*sustained attention, reasoning, working memory*] may pervade many cognitive abilities and be important predictors of outcome

Aim:

- (1) to develop a 'broad but shallow' screen of multiple cognitive processes in acute stroke
- (2) to assess which tests (and cognitive functions) are impaired in different patient groups, and which factors predict cognitive deficits & recovery
- (3) to assess the utility of general (single test) measures of cognition relative to finer-grained analyses

Birmingham University Cognitive Screen (BUCS)

Part 1:

Broad but shallow screen to give a general picture of abilities, including measures that predict outcome

Part 2:

Application of finer-grained tests that pin-point a specific deficit that can be linked to rehabilitation

Phase 1 screen: 1 hr to administer, at bedside

Broad cognitive functions:

- Language (comprehension & production, written & spoken)
- Memory (short and longer-term, recognition & recall)
- Attention (spatial & controlled & working memory)
- Praxis (action recognition, production and multi-step sequencing)
- Numbers (number operations and money)

Example **Part 1** test: Controlled attention

Measuring sustained attention, selective attention & working memory

Hear a series of words and respond to
'no', 'hello', 'please'

BUT do not respond to 'yes', 'goodbye' or
'thanks'

Selective attention = tapping to targets and not
distractors

Sustained attention = compare performance
blocks 1 & 3

Working memory = practice to learn words, and
how many remembered at
end

*Test uses short, high frequency words,
suitable for aphasics*

*Uses auditory not visual material –
closer to everyday life
suitable for neglect patients*

Tests administered to 200 acute stroke patients (within 1 month of lesion)

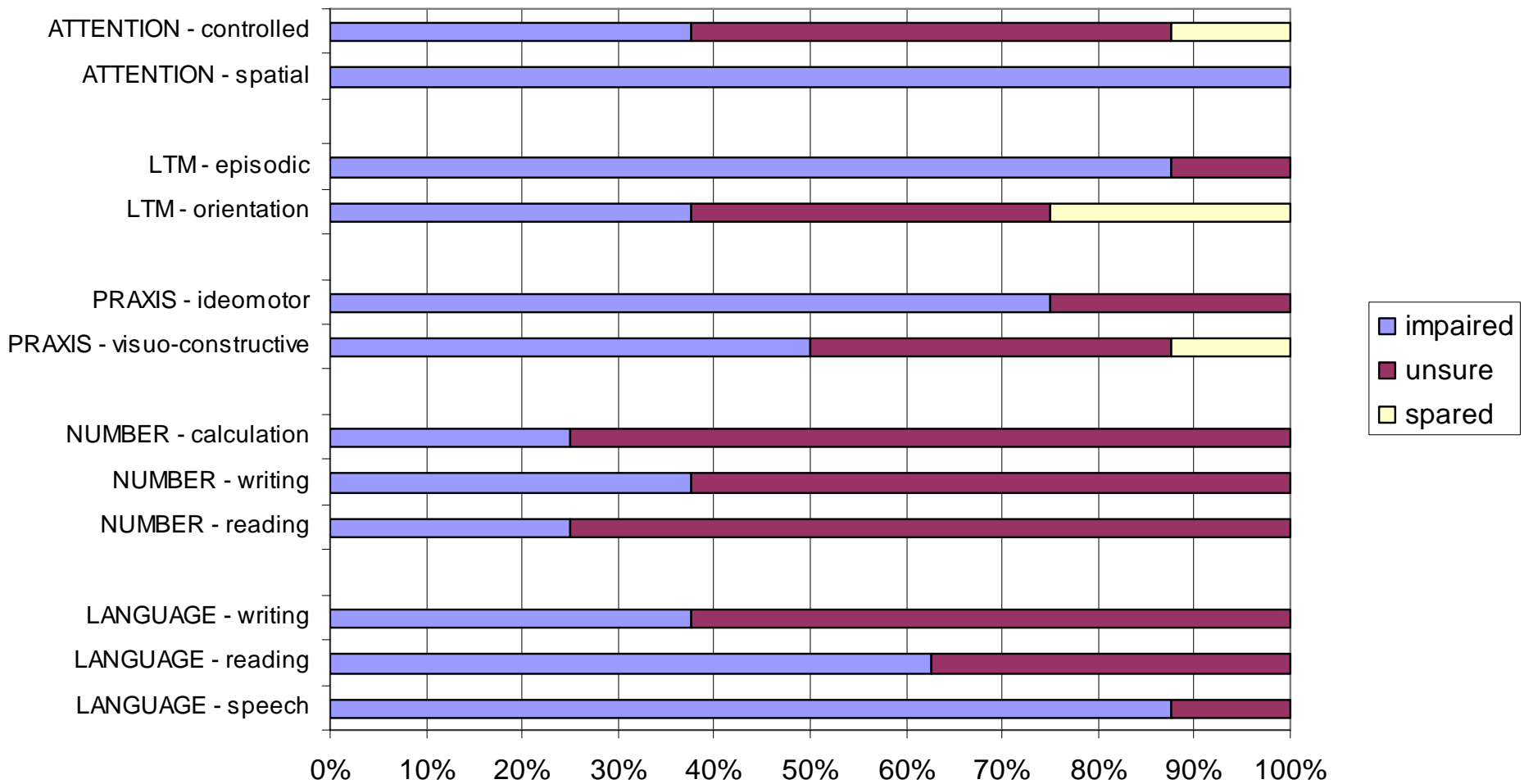
Follow-up at 9 months, including measures of activities of daily living

All tests validated against other standardised (but often much longer) tests in the literature

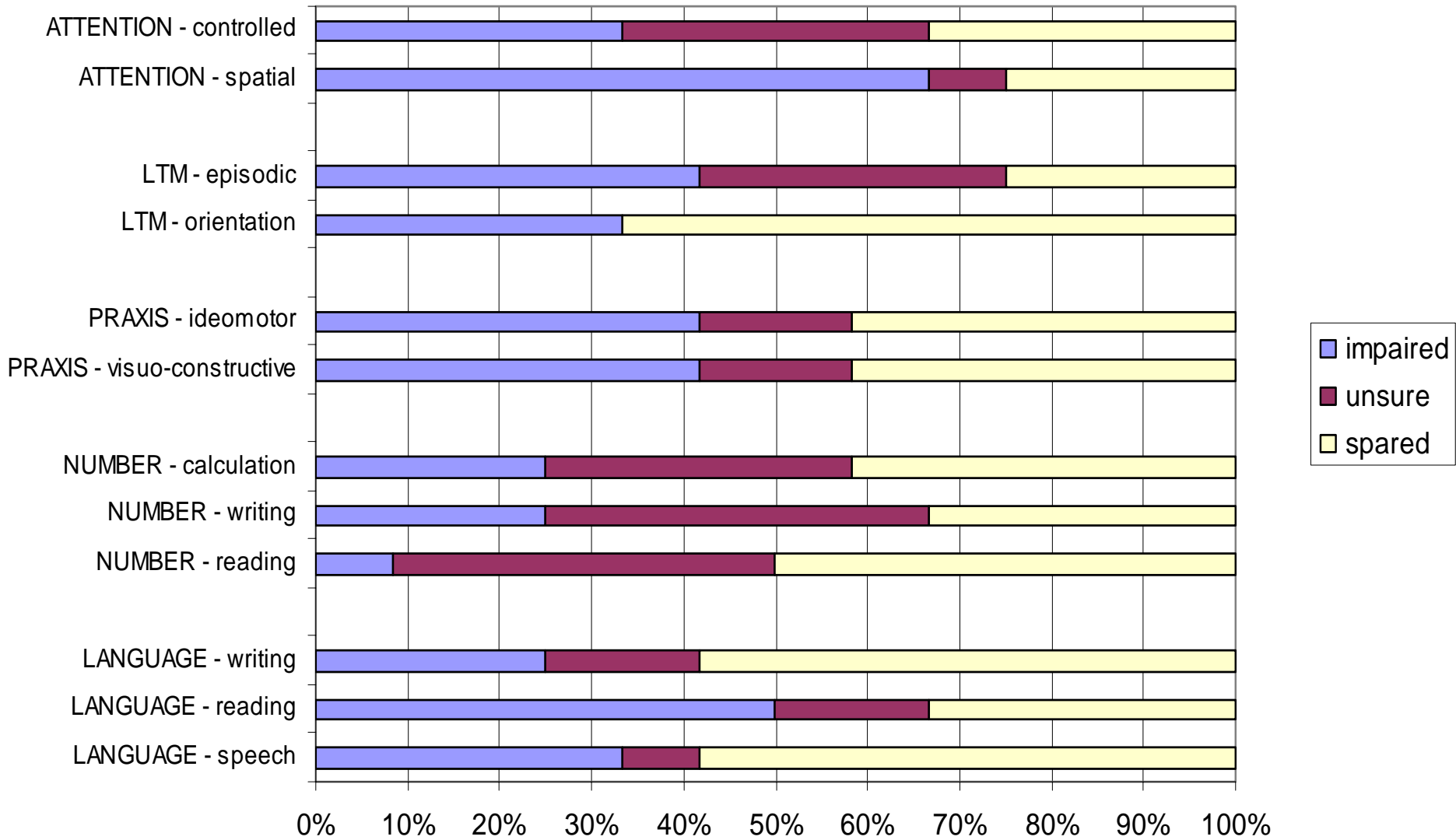
Age-matched norms developed for each test

Frequency of occurrence of **deficits** relative to controls

Frequency of occurrence of impairment - **Left** patients



Frequency of occurrence of impairment - **Right** patients



In general:

Patients are impaired on tests that 'load' on aspects of executive function – measures of controlled attention

Left hemisphere patients fare worse than right hemisphere patients, even on some 'non-language' tasks

even with variance due to language factored out, left hemisphere damage predicts measures of selective, controlled attention

On follow-up:

Good ADL outcome predicted by 'functional memory', & non-verbal reasoning (executive function)

(no effect of age)

BUCS is currently being rolled-out across the West Midlands (from 2 to 7 hospitals) - opening up the study to look at other factors, such as genetic predictors of recovery from stroke

The 'broad but shallow' approach can add to general measures of cognition (MMSE)

- particularly by incorporating results on executive functions -

without significantly increasing testing requirements on patients

Aim of the approach - to use the tests to target rehabilitation to the **specific** in the **specific** patient

Is this an effective approach?

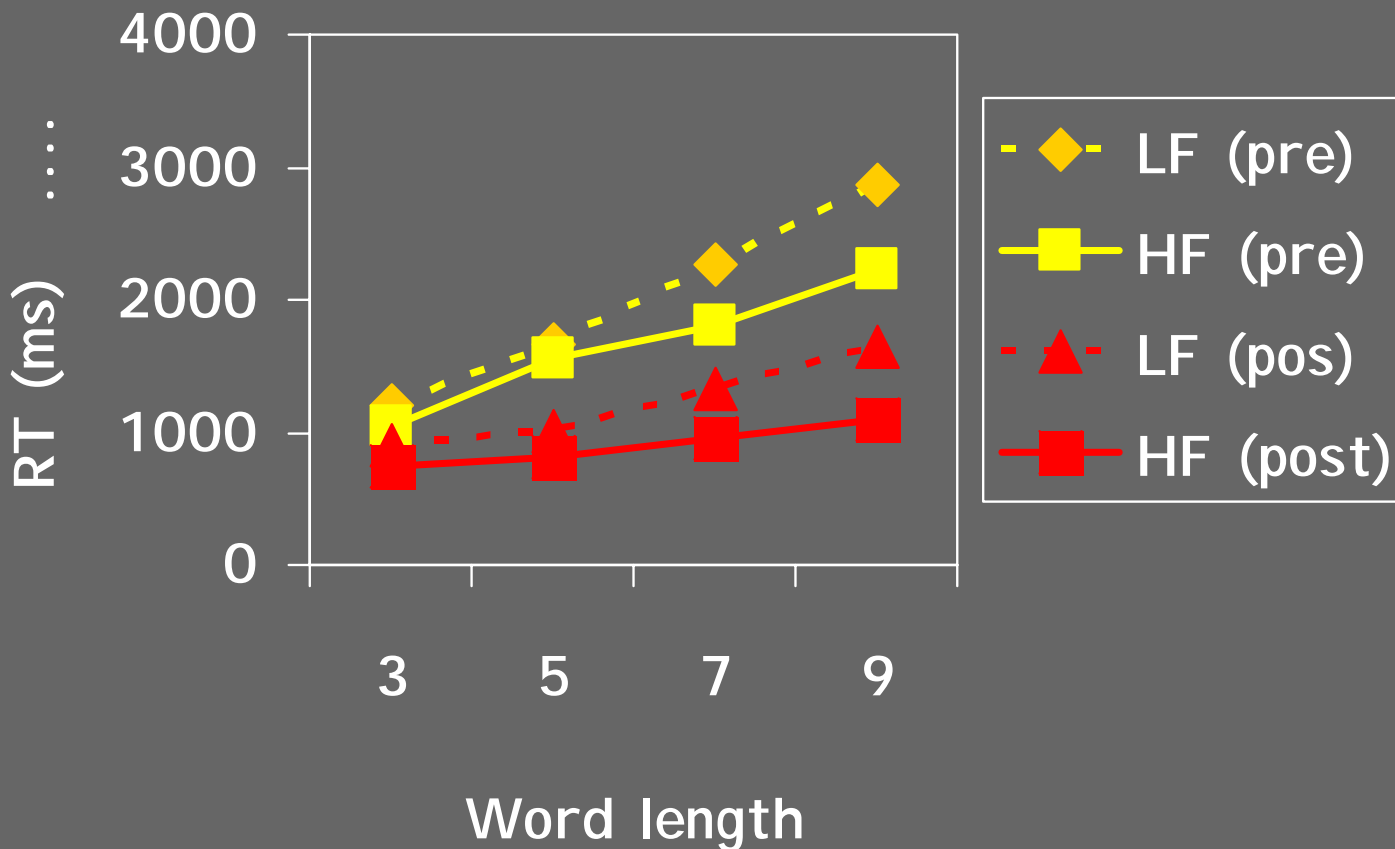
AH: 51 year old patient

Left posterior cerebral artery stroke

BUCS revealed: general word finding problem,
and a specific reading problem leading to 'letter
by letter' reading

This led to us targeting her reading problem
using computer-based reading therapy, with
words presented for decreasing durations

AH - effects of rehabilitation on letter-by-letter reading



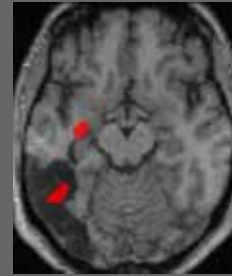
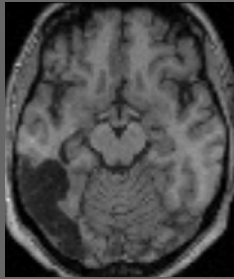
Recently this functional approach to understanding cognitive recovery after brain damage has been added-to with the study of the neural basis of recovery using functional brain imaging



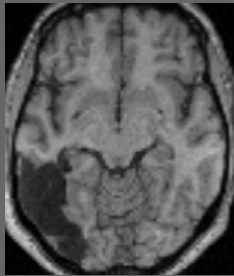
Structural Imaging in AH

Functional Imaging in normal subjects Reading

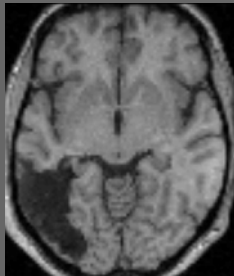
-16



-12



-8

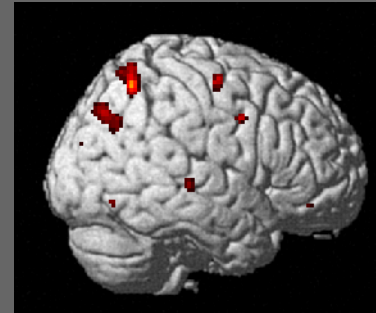
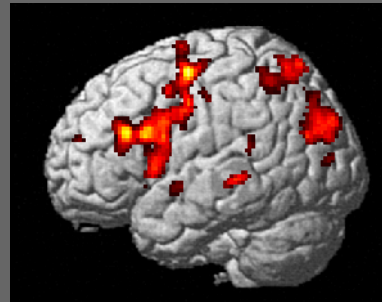


□ AH – scanned prior to and subsequent to the rehabilitation

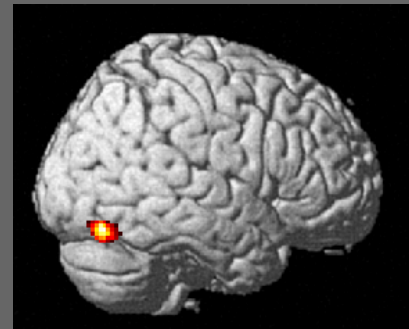
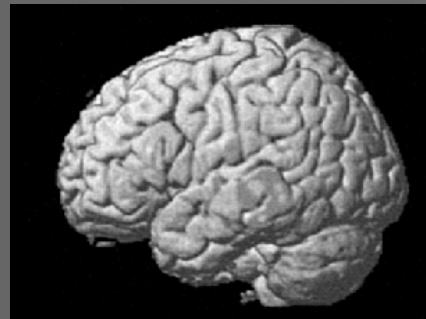
Left hemisphere

Right hemisphere

AH reading
(2004 & 2005)



AH 2005 > 2004



Evidence for right hemisphere recruitment

- Functional brain imaging here adds to our knowledge of how recovery is taking place
- Evidence suggests the recruitment of new brain regions for the task, in this instance
- Highlights the need to develop rehabilitation procedures that target the brain structures sensitive to rehabilitation

- So in sum, to assess cognitive recovery after brain damage means that it must be **measured**, and measures need to be applicable and sensitive
- These measures should be designed to guide therapy to the critical problem in individual patients
- **Measures of functional recovery can be added to by functional imaging, which charts the neural basis of recovery**

T
h
e

E
n
d