Cognitive-motor interaction and recovery from stroke

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Background

- In many situations, two or more activities, e.g. walking and talking, can be carried out at the same time, without either being compromised to any noticeable extent.
  - What happens when this breaks down?
  - What circumstances attend breakdown?
Cognitive-motor interference (CMI)

• Several studies have reported that older adults have difficulty controlling posture while simultaneously attending to a cognitive task.
• Less information has been gathered on CMI following brain injury.
• However, patients may have damage to both motor and cognitive systems.
• Everyday activities may place substantial demands on overall attentional resources during recovery.
CMI in neurological rehabilitation

- When motor skills have to be relearnt after stroke, they are no longer performed automatically and so use overall attentional resources.

- Responses to early rehabilitation may be affected by:
  - Distractions in the immediate environment
  - Cognitive limitations following stroke
  - Fatigue following stroke
Dual-task methodology

- A useful tool for determining the relative demands of different activities.
- Two tasks are performed separately and then together.
- Outcome (e.g. speed, accuracy) is measured for each task alone and when combined with the other.
- A dual-task decrement is assumed to represent competition for processing resources.
- The direction of the decrement may indicate resource allocation.
Our interest

- Our work developed from clinical observations of patients recovering from neurological injury.
- We were interested in:
  - Which task combinations resulted in greatest interference?
  - What other factors might influence dual-task performance?
Why is this interesting?

• Theoretical interest: Understanding and explaining allocation of attention.

• Clinical interest: Studies of competition for available resources may help in
  – Understanding course of recovery
  – Planning physical and cognitive content of therapy programmes to meet individual capabilities.
Background to this study

• During early weeks after stroke, the main focus of treatment is on motor recovery.
• Stable sitting balance is an important motor predictor of outcome after stroke.
• However, attentional demands of regaining and maintaining postural control are rarely considered.
CMI in balance recovery early after stroke

• Postural control may be affected by a cognitively demanding activity when both systems have been affected by stroke.
• There may, however, be an interference effect from any activity, even if it makes minimal cognitive demand.
• Speech is, itself, a motor act and may interfere with postural control.
Study design

• We measured cognitive performance and postural control in sitting, using a counterbalanced design, with eight one-minute trials:
  – Unsupported sitting balance single task 1
  – Unsupported oral word category generation 1
  – Unsupported sitting repetitive word 1
  – Supported sitting word category generation 1
  – Unsupported word category generation 2
  – Unsupported sitting repetitive word 2
  – Supported sitting word category generation 2
  – Unsupported sitting balance single task 2
Equipment

- Postural control in sitting was measured by a modified Balance Performance Monitor™ set on an adjustable plinth.
- 4 force sensors, one in each corner of seat.
- Data acquisition card, recording movement about centre of pressure directly into computer.
- 2 measures of movement: sway area; sway path
- Speech output (no. of words) recorded via microphone into the same computer.
Supported sitting
Study sample

• 36 stroke patients from hospitals in Oxfordshire and Berkshire:
  – Mean age 62 years (range 23 - 91)
  – Male = 23, Female = 13
  – Median time post-onset 46 days
  – Mean Barthel Scale score 12.86 (range 6 – 20)
  – Left hemiplegia = 25, Right hemiplegia = 11.
Results: Sitting balance

- Significant overall effect of postural control (difference in path length across tasks).
- Significant difference between sitting alone and sitting + word generation.
- Significant difference between sitting alone and sitting + repetitive speech.
- Significant difference between sitting + repetitive speech and sitting + word generation.
Difference in path length across sitting conditions

![Bar chart showing path length in centimeters for different sitting conditions: Still, Repetitive, Category. The chart indicates that the path length for Repetitive sitting is the longest, followed by Category and then Still sitting.]
Relative effect on sway path of word generation and repetitive speech

![Bar chart showing relative decrement in path length for category and repetitive speech.]
Results: Cognitive task

- Small but significant difference in number of words generated over one minute during supported sitting and during unsupported sitting:
  - 15 words on average when supported
  - 14 words on average when unsupported.
Effect of postural control on word generation

Mean number of words generated

Words

 Unsupported Supported
Relationship with Age

• Significant correlation between Age and Sway path decrement during category generation.
  – Older patients move more than younger patients
• No similar significant correlation for repetitive speech.
• No significant relationship between Age and decrement in words generated.
Conclusions

- Maintaining sitting balance does make demands on attentional resources after stroke.
- Competition from a spoken activity increases extent of sway.
- Distance travelled (path length) is greater for a cognitively demanding spoken task than for repetitive speech.
- Postural disruption from cognitively demanding tasks may be more pronounced for older stroke patients.
Thank you

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