The development of a task applied executive function model to inform assessment and intervention in stroke rehabilitation

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Background

- Following stroke, up to 75% of patients will experience impairment of executive function (Riepe et al. 2003)
- Executive dysfunction may limit participation in occupation and hinder engagement in rehabilitation.
- Existing assessment methods cannot determine how executive function is being applied to real-life tasks during their performance.
Executive Dysfunction – impact on occupational participation

- Awareness and quality of life (Brookes 2014)
- Falls in older people (Kearney 2013)
- Around 64% of people with Alzheimer’s Disease have executive dysfunction (Swanberg 2004)
- Correlation between early Alzheimer’s Disease, activities of daily living and executive function (Martyr 2012; Marshall 2011)
- Executive function is correlated with activity participation in people with Parkinson’s Disease (Foster 2011)
- Executive dysfunction correlates with poor diabetes control (Grober 2011)
- Executive dysfunction can reduce gait stability (Allali 2008)
Executive Function

“refers to a set of skills or processes required for effective problem-solving, planning and organisation, self-monitoring, initiation, error correction and behavioural regulation” (Evans 2003) p. 53
There are various models of executive function but the application to task is usually included as a single stage which does not account for the complexity of task performance.

Borkowski and Burke (1996)
The Executive Function Task Application Model (EFTAM) was developed for this study to provide a framework to study how executive function is applied at the various stages of task performance.
Task Performance Theory
Task Concept

There are five stages to the aspect of client engagement which are essential for productive action. These are:

1) **Task selection**, where the individual makes the decision to engage in the activity.

2) **Task execution**, where the individual undertakes the process of the activity.

3) **Task completion**, where the individual is aware that the end of the activity has been reached.

4) **Task evaluation**, where the individual can evaluate the quality of the activity performance.

5) **Task satisfaction**, where the individual can achieve a positive emotional response from the activity engagement.

(du Toit 1991)
Executive function components and concepts
<table>
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<tr>
<th>Concept Formation</th>
<th>Planning</th>
<th>Initiation</th>
<th>Inhibition</th>
<th>Flexibility</th>
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<tr>
<td>Perception of sensory information</td>
<td>Strategy choice through supervisory attentional system</td>
<td>Schema activation through contention scheduling and supervisory attentional system</td>
<td>Choosing to discontinue a response which is no longer relevant for the current goal</td>
<td>Spontaneous flexibility characterized by free-flowing between ideas</td>
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<td>Access to memory (semantic and episodic)</td>
<td>Strategy choice through contention scheduling</td>
<td>Balance between arousal and reduction in purposeful activity</td>
<td>Stopping prepotent responses</td>
<td>Reactive flexibility characterized by switching and adapting responses to environmental demands</td>
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<td>Simultaneous processing (utilising working memory)</td>
<td>Self-regulation</td>
<td>“Apathetic” executive function type is characterised by lack of initiation</td>
<td>Stopping responses to irrelevant stimuli</td>
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<td>Comparing between current and desired states</td>
<td>Goal maintenance</td>
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<td>Removing irrelevant information from working memory</td>
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<td>Identification of goals</td>
<td>Understanding the relationship between subgoals and goals</td>
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Five components:

- **Concept formation** - drives the ability to use categories, generalise situations, apply general principles, and to account for past, future or out of sight situations and people (Lezak, Howieson, & Loring 2004).

- **Planning** - 1) forming the concept of the problem, 2) selecting goals which represent the desired outcome of the intention, 3) deciding not to take immediate action, but to analyse the problem to determine what is required to solve it, and 4) choosing a strategy (Borkowski & Burke 1996).

- **Initiation** - the ability to commence activities under one’s own volition, related to the balance of activity between the cingulum and the supplementary motor area (Duffy & Campbell, Ill 1994) where the cingulum is related to arousal.

- **Inhibition** - the ability to discontinue or stop a behaviour from happening if it is inappropriate to the situation especially on novel tasks or those with a stronger chance of attracting a prepotent or automatic response (Mateer 1999).

- **Flexibility** - Where a task demands that individuals regulate their own behaviour in response to changes which can be sudden and rapid, the ability to change perceptual, cognitive or response sets (Lezak, Howieson, & Loring 2004).
Executive Function Levels

(Sohlberg et. al 1993)
Scripts and schemas

- This set of actions for a specific purpose has been called a “script” and strategy selection can be termed *script generation* (Shallice 1988).
- Action responses or schema control units are behaviours which are activated to fulfil the goal arising from the specific situation (Shallice & Burgess 1998).

Schemas may be very brief such as head turning to determine where a sudden noise has come from, or task specific such as fastening buttons when dressing.

With routine activities, schemas are activated at an automatic level called *contention scheduling*, whereas, when faced with novel situations it is proposed that schemas require a more conscious EF process involving the supervisory attention system (Shallice & Burgess 1998).
Automatic and routine schema generation

(Sohlberg et. al 1993)
Executive function is required for tasks which:

- Are novel
- Are complex
- Are difficult
- Are dangerous
- Require error correction

(Gazzaniga 2002)
The Executive Function Task Application Model

- **Task**
  - Routine
  - Domain specific knowledge
  - Contention scheduling
  - Longer sequence
  - Basic knowledge level
  - Novel
  - Complex
  - Task selection
  - Executive Function Level
  - Concept formation
  - Initiation
  - Planning
  - Executive Function Level
  - Goals
  - Strategy selection
  - Initiation
  - Executive Function Level

- **Evaluation**
  - Self reflectiveness level
  - Concept formation
  - Flexibility

- **Completion**
  - Executive Function Level
  - Concept formation
  - Inhibition
  - Flexibility

- **Satisfaction**
  - Self reflectiveness level
  - Self knowledge
  - Concept formation
  - Emotion
  - Values
  - Beliefs
  - Motivation

- **Execution**
  - Executive Function Level
  - Self-monitoring
  - Initiation
  - Inhibition
  - Flexibility
  - Self-regulation
The EFTAM may have the potential to help us understand how people apply executive function to the stages of a task, but how can we determine which processes people are applying during task performance?

Ask them to talk about it?

Ask them to demonstrate?
Research Questions

- What insights into executive function do narratives (stories) about dressing tell us?
  - 1) How do participants explain, plan and prepare when dressing their upper bodies?
  - 2) How do participants respond when they encounter difficulties during dressing?
  - 3) How do participants explain their reasoning process when problem solving?
  - 4) How do participants indicate when they have finished dressing?
  - 5) How do participants express satisfaction with their performance?
  - 6) How do participants recount their reflections on their dressing?
  - 7) How do participants explain how they dressed?
  - 8) How do participants evaluate their dressing performance?
Methodology

- Phenomenology has been considered an approach used to discover regularities and patterns though providing a means to understand text and actions and discerning themes (Miles & Huberman 1994).
- As the intention of this study was to explore any patterns of expressed EF and how they relate to the actions of the dressing task, a phenomenological philosophy was considered most appropriate for this study.
Methodology

- Ethnomethodology is the study of how people accomplish everyday communications, interactions and actions and describes how taken for granted rules lie behind everyday conversations and interactions (Finlay & Ballinger 2006).
- Ethnomethodology was an appropriate “fit” for this study, but with the focus on story content and actions to explore how people achieve the task of dressing from their actions, as well as exploring EF processes by taking account of the stories.
Strategic sampling strategy

- The purpose of strategic sampling is to produce a relevant range of phenomena to allow cross-contextual comparisons for the formulation of a well-constructed argument (Mason 2002).
- Stories were sampled from along the stroke pathway and from participant with upper-limb injury and healthy participants.
Participants were instructed to verbally (or non-verbally) provide an account of their intended methods before dressing, reasoning processes during dressing and reflection after completion of the dressing task.
Analysis
Narrative types – DARNE textsort analysis

In addition to story content, the actual types of narrative could provide clues on executive function application. Argumentation and evaluation may indicate the potential for executive function application.

- **Description**: A situation may be described but in a timeless way and not part of a story.

- **Argumentation**: Where individuals will construct and take a stance within their argument.

- **Report**: A timeline of events but delivered in a detached fashion, with no sense of emotion.

- **Narrative**: Story telling where there are characters, including the participant himself, and accounts of how people affect each other.

- **Evaluation**: Providing the point of the story (like a moral), explicitly stated before or after the story.

(Wengraf 2001)
Analysis

- Stories and actions were transcribed and imported into the qualitative analysis software NVivo 10 (QSR International 2012).
- Textsort and EFTAM frameworks were used to explore the relationship between stories, actions and executive function.
- Story content and actions were coded into emerging themes, executive function components, narrative types and EFTAM stages addressed.
- A second member of the research team was involved in the analyses which were also presented to the whole team.
Findings
The participants

- Twenty participants were included.
- 18 were post-stroke, 1 was post-shoulder fracture and 1 was a 73 year old healthy participant.
- 11 in acute stroke unit, 3 in rehabilitation units and 6 living at home.
- Age range from 40 years to 87 years.
- Nine males and 11 females.
- No participant under the age of 40 years although one had her stroke when she was 29 years old.
- Four were in employment.
- Time since stroke was between two days and 11 years.
Four categories emerged, seven participants selected to represent the categories and for deeper analysis.
Summary of participant sessions

- Trevor (mild right weakness) – stories characterised by some argumentation but evaluation limited. Actions appeared to inform his story.
- Mary (left weakness) – stories characterised by report and description narrative types. Concept formation was challenged. Difficulty providing an account of the intended procedure. Schemas probably selected by contention scheduling.
- Janet (left weakness) – stories contained frequent examples of argumentation and evaluation narrative types. Provided a full account of her intended dressing process but unable to overcome problems when they emerged during task execution.
- Bill (left weakness)/Wilma (left shoulder fracture) – some argumentation but mainly report and description narrative type. Provided a detailed account of dressing procedure and executed a self-developed strategy successfully.
- Beth (right weakness) – expressive aphasia limited her verbal story production but demonstrated her intentions through actions. Demonstrated ability to address problems through actions.
- Gladys (healthy participant) – stories characterised by narrative and report. Dressed using routine procedure.
Mary

- Task would be considered as complex
- Uncertain understanding of the context of dressing during the interview
- Very basic and disjointed account of her procedure
- Assistance to initiate
- Unable to execute the task and unable to provide an account of her reasoning

Mary

- Task
  - Routine
  - Novel
  - Complex
  - Difficult
  - Error correction
  - Dangerous

- Task selection
  - Executive Function Level
  - Concept formation
  - Initiation

- Planning
  - Executive Function Level
  - Goals
  - Strategy selection

- Initiation
  - Executive Function Level

- Execution
  - Executive Function Level
  - Self-monitoring
  - Inhibition
  - Flexibility
  - Self-regulation

Mary

- Satisfaction was based on poor evaluation
- Difficulty understanding what she contributed and what was contributed by the researcher
- Recognition of completion was assisted by the researcher
Janet had been practised but considered complex.

Demonstrated understanding of the context of dressing.

Task had been practised but considered complex.

Domain specific knowledge

Contention scheduling
Basic knowledge level

Planning
Goals
Strategy selection

Provided intended dressing method in detail.

Task

Routine

Longer sequence

Dangerous

Complex

Novel

Error correction

Task selection
Executive Function Level
Concept formation
Initiation

Executive Function Level

Planning

Evaluation
Concept formation
Flexibility

Satisfaction
Self reflectiveness level
Self knowledge
Concept formation
Emotion
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Beliefs
Motivation

Completion
Concept formation
Inhibition
Flexibility

Janet recognised when the task was complete.

Execution

Initiation
Inhibition

Self-monitoring
Self-regulation

Flexibility
Task would be considered as complex and novel as this was her first attempt.

Partnership communication provided evidence for a good understanding of the dressing context.

Provided a basic demonstration of her intended dressing procedure.

Able to initiate.

Satisfaction was expressed and she indicated that she would use the method again.

Indicated that she felt that the method had worked and would not make changes.

Demonstrated examples of all components when problem solving the difficulty with her cardigan.

Completion reached after making final adjustments and stopping.
Main findings

- The application of narrative type appeared to relate to the level of challenge being undertaken.
- Narrative type may suggest executive function limitation when not consistent with the challenge.
- Well-practised adaptive strategies may have developed dressing into a routine task with less executive function application.
- It was possible for the participants with expressive aphasia to demonstrate executive function application through actions.
- The reduced effectiveness of actions selected by contention scheduling may limit feedback from the task.
- Participants presented with varying profiles which may inform more specific interventions.
The findings also indicated that working memory and the selection of actions through contention scheduling are essential aspects of the execution stage and were added to the model.
Implications for clinical practice

- Rather than providing a generic intervention, determining which executive function components are challenged to provide a targeted intervention is recommended.
- Many trials of interventions have included participants with mild cognitive impairment. For moderate impairment, the development of interventions targeting concept formation are recommended.
- Sensorimotor interventions may also have a positive impact on executive function by improving the effectiveness of actions selected by contention scheduling.
Implications for further research

1. Study the application of storytelling and EFTAM profiling to other activities of daily living.
2. Evaluate the impact of the opportunity to develop the evaluation and satisfaction stages on subsequent task performance.
3. Further evaluation of existing and newly developed interventions for executive function.
Study limitations

- The researcher is a clinically based occupational therapist which introduces a bias into the study.
- Participants were from similar ethnic and cultural backgrounds.
- Saturation was probably not achieved within the time limits of the study.
- Bias may have been introduced by the information sheet signposting participants to the topic of dressing after stroke.
- The presence of the video-camera may have affected participant responses.
- Limited number of follow-up questions asked of participants who dressed with no assistance.
- Data was collected during only one task cycle which misses the opportunity to explore learning.
References


References

QSR International 2012, *NVivo Qualitative Data Analysis Software* QSR International Pty Ltd.


Further Resources

Chest Heart & Stroke Scotland:

Stroke Training and Awareness Resource (STARs)
http://www.stroketraining.org/
STARs cognition module -
http://www.strokeadvancingmodules.org/node.asp?id=cognition

Stroke4Carers
http://www.stroke4carers.org/

SelfHelp4Stroke
http://selfhelp4stroke.org/
Thank you!

Sincere thanks to the 20 people who volunteered to participate in this study.

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