Rehabilitation of executive dysfunction: A controlled trial of an attention and problem solving treatment group

Eliane C. Miotto a,b, Jonathan J. Evans c, Mara C. Souza de Lucia a, Milberto Scaff a

a Hospital das Clinicas, University of Sao Paulo, Brasil
b Section of Psychological Medicine, University of Glasgow, UK
c Oliver Zangwill Centre for Neuropsychological Rehabilitation, Ely, UK

To cite this Article Miotto, Eliane C., Evans, Jonathan J., Souza de Lucia, Mara C. and Scaff, Milberto (2009) 'Rehabilitation of executive dysfunction: A controlled trial of an attention and problem solving treatment group', Neuropsychological Rehabilitation, 19: 4, 517 — 540

To link to this Article DOI: 10.1080/09602010802332108

URL: http://dx.doi.org/10.1080/09602010802332108

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
Rehabilitation of executive dysfunction: A controlled trial of an attention and problem solving treatment group

Eliane C. Miotto, Jonathan J Evans, Mara C. Souza de Lucia, and Milberto Scaff

Hospital das Clínicas, University of São Paulo, Brasil; Section of Psychological Medicine, University of Glasgow, UK and Oliver Zangwill Centre for Neuropsychological Rehabilitation, Ely, UK

In this study, the effectiveness of a group-based attention and problem solving (APS) treatment approach to executive impairments in patients with frontal lobe lesions was investigated. Thirty participants with lesions in the frontal lobes, 16 with left frontal (LF) and 14 with right frontal (RF) lesions, were allocated into three groups, each with 10 participants. The APS treatment was initially compared to two other control conditions, an information/education (IE) approach and treatment-as-usual or traditional rehabilitation (TR), with each of the control groups subsequently receiving the APS intervention in a crossover design. This design allowed for an evaluation of the treatment through assessment before and after treatment and on follow up, six months later. There was an improvement on some executive and functional measures after the implementation of the APS programme in the three groups. Size, and to a lesser extent laterality, of lesion affected baseline performance on measures of executive function, but there was no apparent relationship between size, laterality or site of lesion and level of benefit from the treatment intervention. The results were discussed in terms of models of executive functioning and the effectiveness of domain specific interventions in the rehabilitation of executive dysfunction.

Keywords: Executive function; Problem solving; Rehabilitation; Frontal lobes; Brain injury.
INTRODUCTION

Evidence for the effectiveness of treatments for impairments in executive functioning remains scarce. In part, this may be because the development of rehabilitation interventions for this area of cognitive functioning has been limited by a lack of conceptual clarity and consensus on the precise definition of executive function and dysfunction. The term executive function has primarily been linked with an anatomically based description of a variety of functions attributed to the frontal lobes (Fuster, 1997; Stuss & Benson, 1986). Baddeley (1986) coined the term “dysexecutive syndrome” to characterise the range of impairments that commonly arise with frontal lobe lesions. In the last two decades numerous studies have indicated the presence of dissociations in the cognitive functions served by the frontal lobes and this has led to more circumscribed descriptions of the component processes within the broader construct of executive functions. The general concept of executive functions has thus been associated with more specific concepts of problem-solving, planning and organisation, initiation, monitoring, and behaviour regulation (Baddeley & Wilson, 1988; Duncan, 1986; Miotto, 1994; Miotto et al., 2006; Shallice, 1988; Stuss, 2007). Cicerone, Levin, Malec, Stuss, and Whyte (2006) break down the broader concept of executive functioning into four domains: (1) executive cognitive functions – involved in the control and direction of action; (2) behavioural self-regulatory functions – involved in emotional reward processing; (3) activations regulating functions – providing initiative and energising behaviour; and (4) metacognitive processes. Focusing on the first of these domains, there are a number of theoretical models of control of everyday action and its fractionation (Duncan, 1986; Grafman, 1989; Kimberg & Farah, 1993; Norman & Shallice, 1986), but perhaps the most influential model is that of Norman and Shallice (1986), which characterises a key function of the frontal lobes in terms of a supervisory attentional system.

The supervisory attentional system

Norman and Shallice (1986) argued that two systems control action, the contention scheduling system (CSS) and the supervisory attentional system (SAS). The former is conceived as a hierarchically structured network of action schemas or well-learned action sequences. The SAS is invoked in circumstances where the CSS does not contain a schema for the desired behaviour or where it is necessary to avoid strong habitual responses by exciting or inhibiting particular schemas within the CSS to achieve an intended aim or goal. Subsequently, Shallice and Burgess (1996) suggested an internal structure for the SAS, describing the function of the SAS in terms of problem solving and fractionating it into a set of sub-processes. In novel situations
the interaction between the SAS and CSS is effected through: (1) a planning process leading to the construction (by the SAS) of temporary new schemas, (2) a special purpose working memory system holding relevant information on-line for the implementation of the temporary new schema, and (3) a system responsible for monitoring and evaluation which allows or rejects actions according to the problem solution.

Shallice and Burgess’s model thus provides a structured problem-solving framework, divided into stages consisting of more basic dissociable cognitive processes, which can potentially be examined independently. This has special relevance to rehabilitation in that, as suggested by Crepeau, Scherzer, Belleville, and Desmarais (1997), it allows for the possibility of more precise identification of impaired and preserved components of executive functions. For each stage of the problem solving process, a number of co-ordinated even more basic cognitive processes are required, including, for example, attentional skills in order to notice that a problem exists, episodic and semantic memory for a referential reserve of potential actions, working memory to hold in mind and evaluate alternative solutions, in addition to mood and motivation factors (Dritschel, Kogan, Burton, Burton, & Goddard, 1998; Evans, 2001; Evans, Williams, O’Loughlin, & Howells, 1992). In this context, breakdown can take place in one or more stages and processes. For instance, patients may be impulsive if they are impaired in the ability to plan, but are intact in their ability to translate intention into action. By contrast, another patient may be able to create a plan and solution to a problem but not be capable of translating an intention into action, leading to initiation difficulties (and descriptions such as inertia or adynamia).

In summary, according to this model, problem-solving depends upon three broad processes: (1) “on-line monitoring” or awareness of problem existence, and monitoring/evaluation of plan implementation; (2) development of a plan of action; and (3) initiation and implementation of action or translation of intention into action. Relevant to the present study, the use of a problem-solving framework can potentially provide an effective way to structure and evaluate rehabilitation treatment for people with a dysexecutive syndrome.

**Intervention approaches to the dysexecutive syndrome**

The main treatment approaches to the dysexecutive syndrome described in the literature can be classified as interventions with the aim of: (1) restoring or re-training executive functions; (2) compensating for executive impairments through the use of internal or external strategies; (3) promoting modification of the environment or behaviour by working with carers, family and friends and behaviour modification techniques; and (4) pharmacological treatments. At the present time, evidence for the effectiveness of interventions in each of these areas is rather limited. Perhaps the most substantial body of

Von Cramon et al. (1991) developed a problem solving therapy (PST) group programme, with the aim of enabling patients to be more effective in breaking down problems, adopting a slowed down, controlled and stepwise processing approach in contrast to the more usual impulsive approach. Drawing on the work of d’Zurilla and Goldfried (1971) the aim of the group programme was to enhance skills in each of the separate stages of problem solving through the use of tasks and exercises that require or make demands on skills involved in each of the stages. Von Cramon et al. (1991) compared a group of patients who received PST with a control group who received memory therapy, finding that the PST group improved to a greater extent on tests of problem solving, although no evidence was presented in relation to generalisation to everyday functioning. Similarly Rath et al. (2003) compared outcome for 27 patients who undertook a similar form of problem solving training with a control group of 19 patients who received “conventional” therapy. They found greater improvement for the problem solving training group on measures of problem-solving and a role-play of a practical problem solving scenario that was rated by independent raters.

Another treatment approach that has shown some promise is goal management training (GMT; Robertson, 1996). This technique was derived from Duncan’s (1986) concept of goal neglect and involves training patients to develop a mental checking routine (using the metaphor of checking a mental blackboard), combined with a strategy of very clearly defining a goal to be achieved, learning the steps required to achieve the goal and then regularly checking progress as part of the mental checking routine. Levine et al. (2000) described some preliminary evaluation of this approach with positive results and the training has recently been shown to be effective in healthy older adults (Levine et al., 2007).

The attention and problem solving group approach

Recently, Evans (2001, 2005) described an attention and problem solving (APS) group programme, which was loosely adapted from a combination of Von Cramon et al.’s (1991) problem solving therapy and Robertson’s (1996) goal management training. The APS group was developed as one component of a holistic rehabilitation programme (Wilson et al., 2000) and runs over a period of 8 to 10 weeks, twice weekly for about an hour each session. The aim of the initial sessions is to address attentional difficulties and the latter ones to introduce and practise the use of a problem solving framework (PSF). The PSF has a format of a paper-based checklist with
an associated exercise template (see Figures 1 and 2). The main aim of the group is to encourage participants to adopt a systematic approach to identifying ways of solving problems (preventing a more impulsive approach) and managing/monitoring goal achievement through development of a mental checking, goal management routine. Within the group programme, specific components of executive functioning are targeted as follows:

**Problem awareness (meta-cognitive processes), monitoring and evaluation.** One aim of the treatment is to increase insight and awareness of how difficulties impact on everyday tasks. For this, clients and staff work on self-monitoring sheets (for recording problems as they occur in day-to-day life), receive education about the nature of the brain injury and consequences on behaviour and carry out a series of exercises simulating

### Attention and Problem Solving Framework

- **What do I want to do?**
  - **What is the task?**
  - **What’s the problem?**

  **STOP: THINK**
  - Define/clarify the main goal
  - *What am I trying to achieve?*

- **Is there really only one solution?**
  - Yes
  - No

  **Identify the possible solutions**
  » Think flexibly and broadly

- ** Decide on your solution**
  » Weigh up the pros and cons of each solution

- **Plan the steps involved**
  » Think about the sequence and timing
  » What strategies will I use

- **Carry out the plan, monitor progress and adjust plan**
  » Am I still on track? Is my solution working?

  **Overall evaluation**
  » Was it a success, what went well, what went badly?

**Figure 1.** Attention and problem solving framework template.
the different types of attentional demands (sustained, selective, and divided attention). Tasks that also make demands on planning and goal management (e.g., practical forms of multiple elements tasks) are also used. In part the aim of these programme components is to develop meta-cognitive skills. Subsequently, clients are trained on specific internal and external strategies for managing attention difficulties, including using the GMT concept of checking the mental blackboard, time management strategies, environment modification, cue cards, and watch alarms.

**Developing a plan.** A major focus within the group programme is on teaching clients to replace impulsive or inappropriate responses with more
effective planning skills, based on the steps illustrated in the PSF (see Figure 1). A major focus of this work is on teaching a “STOP: THINK!” strategy, a form of self-instruction that is aimed at encouraging clients to interrupt impulsive action when faced with a problem or goal to achieve. Practice at using the PSF is given with both hypothetical and real life problems, incorporating goal management training with application of the PSF. When using the PSF, patients are encouraged to generate a range of possible solutions to problems presented, using divergent thinking, and to create strategies for managing the implementation of plans using attention strategies, memory aids, etc. In the final stage of the programme, clients are asked to plan and perform a day activity away from the centre using the PSF.

**Initiating and implementing a plan.** Some patients have difficulty in translating intention into action or initiation problems. Within the group programme patients learn to compensate for such difficulties using electronic reminder systems (e.g., watch alarms, pagers), often in conjunction with external memory aids such as diaries, checklists, etc. and are encouraged to adopt daily routines in order to cope with difficulties related to unstructured and unpredictable situations.

There has been no formal evaluation of the APS group approach, as yet. There are considerable difficulties, related to the issue of experimental control, in investigating individual components of a holistic rehabilitation programme. The aim of the current study was therefore to investigate, outside of a holistic rehabilitation environment, the effectiveness of the APS treatment approach in a group of patients with executive impairments using two experimental control groups, in a cross-over design. Cicerone et al. (2006) highlighted the pressing need to address the question of whether rehabilitation that targets impairments in specific executive function domains is effective in changing both the specified impairments and associated activities and participation. This study aimed to do this by examining the impact of a targeted intervention approach, using traditional measures of executive functioning and measures aimed at reflecting participation in everyday activities, with a group of people with clearly documented frontal lobe damage.

**METHOD**

**Participants**

In the current study, 30 participants with lesions in the frontal lobes took part, all of them recruited from the outpatient service of the Neurology Department, Hospital das Clinicas, University of Sao Paulo, Brazil. There were 16 participants with left frontal lesions (LF) and 14 with right frontal lesions (RF).
Among them, 23 had undergone neurosurgery for the removal of a tumour (9 cases of meningioma and 14 cases of low grade astrocytoma) and 7 had suffered a mild TBI from a road traffic accident resulting in a mainly frontal lobe lesion. The site of the lesions included the orbitofrontal cortex (OFC, \(n = 9\)), dorsolateral prefrontal cortex (DLPFC, \(n = 8\)) and orbitofrontal combined with dorsolateral prefrontal cortical lesions (OFC/DLPFC, \(n = 13\)). Seven patients were on anti-convulsive medication. The average time since injury or surgical procedure was 2.4 years (\(SD = 1.04\)). The 15 male and 15 female participants were aged between 25 and 60 years (mean 41.7; \(SD = 9.72\)). The number of years of education ranged between 5 and 16 years (mean 9.17; \(SD = 2.88\)). Employment status was categorised as follows: Full-time employment/study (\(n = 3\)); part-time employment/study/volunteer work (\(n = 8\)); unemployed (\(n = 19\)). All participants reported no prior involvement with a neuropsychological rehabilitation programme. A number of neuropsychological measures were administered before and after the interventions in order to characterise the patients and to measure the impact of the group programme. Inclusion criteria included having a deficit in at least one measure of executive functioning and evidence that everyday functioning was significantly affected by the cerebral lesion (e.g., inability to return to previous work/study activity, impulsivity, apathy, etc.) determined by an independent professional (neurologist, neurosurgeon or other health care professional). None of the patients had a prior history of psychiatric disorders or neurodegenerative conditions. The study had ethical committee approval by the Hospital das Clinicas, University of Sao Paulo, Brazil and all participants and their carers signed an informed consent.

Procedure

Design

A counterbalanced, cross-over experimental design was used. The 30 participants were allocated into three groups (G1, G2 and G3), each with 10 subjects. Allocation to group was pseudo-random in that initial allocation to groups of half of the participants was random, with the second half allocated in order to ensure that groups were matched for age, education, time since injury and performance on the main baseline neuropsychological tests (see Table 1).

Following baseline assessment (Assessment 1) by three examiners, Group 1 received the attention and problem solving (APS) intervention. The APS group received 10 weekly sessions of attention and problem solving training provided by two neuropsychologists. The group ran once a week for an hour and a half each session. Following baseline assessment (Assessment 1), Group 2 received an information and education (IE) intervention. The IE
control group received an educational material in a booklet format with information about brain injury, cognitive, behavioural and social consequences and suggestions for cognitive exercises using the mental blackboard and problem-solving framework with the only instruction to read the booklet as carefully as possible and try to apply the exercises suggested, at home. Following baseline assessment (Assessment 1), Group 3 received any usual treatment, such as physiotherapy, when needed, but did not receive any specific cognitive rehabilitation intervention (as this was not part of usual treatment). Following the first intervention period, all patients were reassessed (Assessment 2). Then, Groups 2 and 3 received the APS intervention. After this, all patients were again reassessed (Assessment 3). Six months after the end of the APS intervention, patients were reassessed for a final time (Follow Up).

**Assessment procedures**

A number of neuropsychological tests and a questionnaire examining dysexecutive syndrome (DEX) were administered to all participants at the three baseline assessments and at follow up (see Table 1). In addition, participants carried out a functional task (Modified Multiple Errands Task), described below, developed and piloted for this study, in order to investigate generalisation of strategies to real-life situations. For each assessment the following neuropsychological measures were administered:

**Assessment 1 (Baseline).** FSIQ (WASI), Digit Span (WMS-III), Warrington Recognition Memory for Words and Faces (Camden Memory Tests), Logical Memory I and II and Visual Reproduction I and II (WMS-III), Wisconsin Card Sorting Test (WCST), Verbal Fluency (FAS), Virtual Planning Test (VIP; Miotto and Morris, 1998, which assesses planning, sequencing and organisation of daily life activities in the laboratory), Digit Symbol (WAIS-III), the DEX Questionnaire from the Behavioural Assessment of
the Dysexecutive Syndrome (BADS), and the Modified Multiple Errands Task (see below for a description of this task).

Assessment 2. Digit Span (WMS-III), Warrington Recognition Memory for Words and Faces, Logical Memory I and II and Visual Reproduction I and II (WMS-III), WCST, FAS, VIP, Digit Symbol, DEX and Modified Multiple Errands Task.

Assessment 3. WCST, FAS, VIP, DEX and Modified Multiple Errands Task.

Follow up (6 months later). WCST, FAS, VIP, DEX and Modified Multiple Errands Task

Modified Multiple Errands Task (MMET)

This task was adapted from the Multiple Errands Task of Shallice and Burgess (1991). Participants were taken to a local shopping precinct and asked to carry out a series of activities requiring planning, strategy, sequencing and monitoring of behaviour and spend a limited amount of money given in advance. The activities were written on an instruction card given to them, which they could consult throughout the activity. For baseline 2 and 3 they were taken to a novel nearby area and asked to carry out similar activities. At follow up they carried out the same tasks in the same environment as in baseline 1. The instructions for the functional task were as follows: “We would like you to perform a number of activities in the next 15 minutes. They will be written in this card given to you so you can consult them at any time. You will receive a piece of paper, a pencil and 1.50 (local money), which you will have to use according to the instructions and return all materials to the examiner at the end. Make sure you understand all tasks before starting and once you begin you are allowed to speak to the examiner only when designated in the instructions.”

In order to carry out all activities, the participants had to plan in advance how they would go about and select the specific shops among the various ones in the street to perform the tasks. If they just followed the order of the tasks written in the instruction card they would not have enough time to complete all tasks. This is because the shops to be entered according to the sequence in the instruction card were located at a distance from each other of approximately 30 metres. In addition, the first shop of the instruction card was at the end of the street next to the final position where the subject should be at the end of the task. The second shop according to the instruction card was at the beginning of the street where the subject started the task. This means that if participants followed exactly the order of the instruction card they would end up walking long distances and not be able to complete all
**TABLE 2**

Neuropsychological test results for each group at Assessment 1, 2, 3 and follow up, six months after the intervention

<table>
<thead>
<tr>
<th>Test</th>
<th>Assessment 1</th>
<th>Assessment 2</th>
<th>Assessment 3</th>
<th>Follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G1</td>
<td>G2</td>
<td>G3</td>
<td>G1</td>
</tr>
<tr>
<td>Intellectual Functions (WASI)¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIQ</td>
<td>97.2 (5.73)</td>
<td>96.5 (6.43)</td>
<td>98.5 (7.34)</td>
<td></td>
</tr>
<tr>
<td>Memory Functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Span (%)</td>
<td>29.0 (14.49)</td>
<td>24.5 (9.3)</td>
<td>29.8 (15.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Recognition² (%)</td>
<td>30.0 (10.54)</td>
<td>28.8 (16.4)</td>
<td>40.0 (22.1)</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face Recognition² (%)</td>
<td>35.0 (17.48)</td>
<td>29.5 (16.06)</td>
<td>41.5 (23.2)</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical Memory I³ (%)</td>
<td>32.5 (12.53)</td>
<td>31.5 (10.55)</td>
<td>38.1 (19.6)</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical Memory II³ (%)</td>
<td>29.0 (11.25)</td>
<td>30.5 (8.64)</td>
<td>35.5 (18.0)</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Reproduction I³ (%)</td>
<td>30.8 (9.23)</td>
<td>30.7 (16.1)</td>
<td>36.8 (18.9)</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Reproduction II³ (%)</td>
<td>30.0 (10.80)</td>
<td>30.4 (16.12)</td>
<td>36.3 (18.2)</td>
<td>32.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Executive Functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCST⁴ Categories</td>
<td>3.0 (0.79)</td>
<td>3.0 (0.74)</td>
<td>3.0 (0.95)</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Table continued)
<table>
<thead>
<tr>
<th>Test</th>
<th>Assessment 1</th>
<th>Assessment 2</th>
<th>Assessment 3</th>
<th>Follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G1</td>
<td>G2</td>
<td>G3</td>
<td>G1</td>
</tr>
<tr>
<td>FAS</td>
<td>25.0</td>
<td>23.0</td>
<td>25.0</td>
<td>26.00</td>
</tr>
<tr>
<td></td>
<td>(4.85)</td>
<td>(4.6)</td>
<td>(5.9)</td>
<td>(3.30)</td>
</tr>
<tr>
<td>VIP(^5) (Max. Total = 16)</td>
<td>11.0</td>
<td>9.0</td>
<td>9.0</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>(1.89)</td>
<td>(1.22)</td>
<td>(1.5)</td>
<td>(2.67)</td>
</tr>
<tr>
<td>Information Processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Symbol (%)</td>
<td>25.1</td>
<td>22.9</td>
<td>29.1</td>
<td>24.5</td>
</tr>
<tr>
<td>DEX Questionnaire(^6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient (Total)</td>
<td>51.9</td>
<td>49.3</td>
<td>51.9</td>
<td>51.30</td>
</tr>
<tr>
<td></td>
<td>(5.13)</td>
<td>(5.23)</td>
<td>(6.5)</td>
<td>(5.10)</td>
</tr>
<tr>
<td>Independent (Total)</td>
<td>52.5</td>
<td>49.3</td>
<td>52.9</td>
<td>41.3</td>
</tr>
<tr>
<td></td>
<td>(4.95)</td>
<td>(4.9)</td>
<td>(9.6)</td>
<td>(10.1)</td>
</tr>
<tr>
<td>MMET (Max. Total = 10)</td>
<td>8.0</td>
<td>8.0</td>
<td>7.0</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>(0.92)</td>
<td>(0.85)</td>
<td>(1.5)</td>
<td>(0.63)</td>
</tr>
</tbody>
</table>

Results are expressed by means and standard deviation for each group.

\(^1\)WASI: Wechsler Abbreviated Scale of Intelligence

(Full Scale IQ based on Vocabulary and Matrix subtests scores)

\(^2\) The Camden Memory Tests

\(^3\) WMS-III: Wechsler Memory Scale –III

\(^4\) Wisconsin Card Sorting Test

\(^5\) Virtual Planning Test

\(^6\) BADS: Behavioural Assessment of the Dysexecutive Syndrome
tasks in the time available. For successful performance of the task, subjects had to plan ahead the sequence of tasks and create the strategy of starting a task with the shop nearest to the start position. To achieve this, they would have to quickly explore the area before deciding which task should be carried out first and then plan subsequent steps.

Scoring the MMET. One point was given for each activity undertaken correctly (up to a total of 10 points). An error could occur for the following reasons: (1) non-completion of an activity, either because of lack of time or performing a different task; (2) execution in a wrong order (e.g., returning the materials before using them); (3) rule break (e.g., talking to the examiner about irrelevant information, inappropriate conversation with people in the precinct, spending money over the budget or buying other items).

Attention and Problem Solving (APS) Rehabilitation Group

This group approach was based on that developed for the Oliver Zangwill Centre for Neuropsychological Rehabilitation (see Evans, 2001) which was itself adapted from von Cramon’s PST (von Cramon et al., 1991) and from the GMT (Levine et al., 2000). The group ran over a period of 10 weeks, meeting once a week for 90 minutes. The first four weeks of the programme focused on attention. Each session had a similar format and included presentation of educational information on attention (forms of attention, anatomy) and problems with attention that may arise after brain injury. Tasks were used to illustrate different forms of attention (selective, sustained, divided attention). Internal and external strategies for managing attention were introduced to the participants. One key concept emphasised was the mental blackboard as a metaphor for thinking about attention/working memory. In relation to this idea, participants were also instructed in the use of goal management techniques derived from GMT. The following weeks had a similar format, but with a focus on problem solving. Participants were introduced to the problem solving framework (Figure 1) which presents the stages in the problem solving (and goal management) process. Tasks were used to illustrate stage in the problem solving process. Participants were also provided with a problem solving template (Figure 2). They were instructed in the use of this template and practised the use of this framework using hypothetical problems at first and then practical real-life examples from their own current experiences. The aim of the practice was to encourage participants to internalise the steps in the process. During each session, two professionals were present, one to deliver the information and teach participants how to use the various strategies and the other to monitor each person’s behaviour. Further details of the programme content of each session are available from the corresponding author.
RESULTS

The data for the three groups for many of the measures used did not conform to a normal distribution and therefore a non-parametric approach was taken for the analyses. Chi-square and Kruskal Wallis tests were used for the comparison of all three groups together across the various measures and the baseline assessments. Subsequently, each separate group was analysed independently comparing the performance of the subjects across the three assessments and follow up. The follow-up assessment, carried out six months later, included only 25 participants. Four participants were not located due to change of address and one participant died due to a systemic infection.

Pre-intervention

At Assessment 1, before any treatment, the results showed no significant difference between the participants in terms of Full Scale IQ (WASI), Short-Term Memory (Digit Span), Recognition Memory (Warrington), Free Recall (Logical Memory and Visual Reproduction, WMS-III), Executive Functions (WCST, FAS, MMET), Information Processing (Digit Symbol WAIS-III) and the Dysexecutive Questionnaire (DEX). In addition, there was no difference in age, time since injury and education. There was however a difference in baseline performance on the Virtual Planning Test (VPT; $H = 7.07$, $df = 2$, $p = .029$), with Group 1 having significantly higher scores than the other two groups.

Post-intervention

To examine changes over time and the impact of the intervention, change-scores were calculated for each of the measures. We examined whether there were changes on the background neuropsychological measures of memory and information processing, the tests of executive functioning and on the ratings of patients and carers of everyday problems with executive functioning (DEX questionnaire).

Background cognitive functions

There was no significant change in performance on any of the measures of recognition and recall memory and information processing between Assessment 1 and Assessment 2.

Measures of executive functioning

There were no significant differences between the three groups in changes between Assessment 1 and Assessment 2 for WCST ($H = 0.344$, $df = 2$, $p = .564$).
p = .842) or FAS (H = 2.04, df = 2, p = .361). In fact all three groups showed an improvement between Assessments 1 and 2 on the WCST, although G3’s change did not quite reach significance (G1, T = 0, Z = −0.27, p = .023; G2, T = 0, Z = −2.449, p = .014; G3, T = 0, Z = −1.890, p = .059). On FAS, G1 and G2 did not show any difference between Assessments 1 and 2, but scores for G3 improved (G1, T = 0, Z = 2.0.27, p = .023; G2, T = 20, Z = 2.2.449, p = .014; G3, T = 0, Z = −2.754, p = .006).

On the VIP test, there was a trend towards a significant difference between the groups (H = 5.59, df = 2, p = .061), with G1 showing a greater change than G2 (U = 17.0, Z = −2.562, p = .01), but no difference from G3 (U = 41.5, Z = −0.655, p = .512), with G2 and G3 also showing no significant difference from each other (U = 34.5, Z = −1.218, p = .223). All three groups showed a significant increase in performance on the VIP from Assessment 1 to Assessment 2 (G1, T = 0, Z = −2.588, p = .010; G2, T = 0, Z = −2.549, p = .011). On the MMET there was a significant effect of the intervention with an overall significant difference between the groups in terms of improvement in performance from Assessment 1 to Assessment 2 (H = 8.466, df = 2, p = .015). Post-hoc analysis showed that G1 improved more than G2 (U = 17.5, Z = −2.63, p = .009) and G3 (U = 20.5, Z = −2.33, p = .02). There was no difference in change scores for G2 and G3 (U = 47, Z = −0.252, p = .853).

Examining changes from Assessment 2 to Assessment 3 (after the intervention for groups 2 and 3), there were significant differences in change scores for the WCST (H = 6.301, df = 2, p = .043), VIP (H = 13.258, df = 2, p = .001) and MMET (H = 8.209, df = 2, p = .017), but not for FAS (H = 0.072, df = 2, p = .965). Looking at each group separately, there were no further changes from Assessment 2 to 3 for G1. For G2 there was no change in performance on FAS, but there was an improvement in performance on the WCST (T = 0.0, Z = −2.24, p = .025), the VIP (T = 0.0, Z = −2.694, p = .007) and the MMET (T = 0.0, Z = −2.121, p = .034). For G3 there was no change in performance on FAS or WCST, but there was an improvement in performance on the VIP (T = 0.0, Z = −2.684, p = .007) and the MMET (T = 0.0, Z = −2.392, p = .017).

There were no changes on any of the executive functioning measures between Assessment 3 and the Follow Up assessment.

Dysexecutive Questionnaire (DEX)

The DEX was used as a means to assess changes in the participants’ behaviour related to executive dysfunction. This scale has an independent
(carer) version and self-rating version. Both versions were administered at assessments 1, 2, 3 and follow up.

For the independent rater version, there was no difference between the groups at Assessment 1 ($H = 3.142, \text{df} = 2, p = .208$), but there was a difference between the groups at Assessment 2 ($H = 6.715, \text{df} = 2, p = .035$). Analysing change scores, there was a significant difference between the groups in terms of changes from Assessment 1 to 2 ($H = 18.257, \text{df} = 2, p < .001$). Examining each group separately, the results showed that G1 demonstrated a significant reduction in the number of symptoms attributed by the carer at assessment 2 ($Z = 2.80, p = .005$) while G2 and G3 showed no reduction in symptoms. Analysing change scores from Assessment 2 to 3, there was a significant difference between the groups ($H = 10.263, \text{df} = 2, p = .006$). For G1 there was no change ($T = 9, Z = -1.634, p = .102$). However, both G2 and G3 demonstrated a reduction of symptoms following the intervention ($G2, Z = -2.09, p = .036; G3, Z = -2.25, p = .025$). Although there was evidence of symptom reduction post-intervention, the total DEX scores remained elevated compared to the control levels reported by Wilson, Alderman, Burgess, Emslie, and Evans (1996), presumably reflecting a continuing significant level of functional disability despite some apparent improvement as a result of the intervention.

For the self-rated DEX questionnaire, there were no differences in total scores between the groups at any of the assessment points. Critically, there was no evidence of difference in change scores between the groups from Assessment 1 to 2 ($H = 4.533, \text{df} = 2, p = .104$), although looking at each group separately revealed that there was no change from Assessment 1 to Assessment 2 for G1 and G3, but there was an increase in scores for G2 ($T = 7, Z = 2.106, p = .035$).

There was a difference between the groups in change scores from Assessment 2 to 3 ($H = 12.231, \text{df} = 2, p = .002$) and looking at the groups separately, for G1 there was a significant reduction of symptoms between Assessment 2 and Assessment 3 ($T = 0.0, Z = -2.812, p = .005$). For G2 and G3 there was no change post-intervention or subsequently.

Lesion effects

The patient groups were divided according to the side of the lesion (RF = 14 and LF = 16), size ($<4.5 \text{ cm}^2, n = 13; >4.5 \text{ cm}^2, n = 17$) and site (OFC = 9, DLPFC = 8 and OFC/DLPFC = 13) and their performance compared on the main measures at Assessment 1, using Kruskal-Wallis for the analyses. There were significant differences between the groups on the following measures: side of lesion for FAS ($CS = 4.22, p = .040$) with LF being more impaired; size of lesion for the DEX patient ($CS = 4.58, p = .032$), DEX independent ($CS = 4.03, p = .025$), VIP ($CS = 4.54,$}
and MMET (CF = 4.22, \( p = .040 \)), with patients having lesions more than 4.5 cm\(^2\) showing the greater impairment. There was no significant difference when comparing side, site or size of lesion and improvement in performance as a result of participation in the group (i.e., comparing changes in scores from pre- to post-intervention).

**Return to occupational activities**

Employment status before treatment was as follows: full-time employment/study (\( n = 3 \)); part-time employment/study/volunteer work (\( n = 8 \)); unemployed (\( n = 19 \)). At follow up assessment, 6 months after G2 and G3 received the APS intervention, employment status was: full-time employment/study (\( n = 6 \)); part-time employment/study/volunteer work (\( n = 14 \)), unemployed (\( n = 5 \)). As mentioned earlier the remaining five patients were not included in the follow up assessment (four patients changed their addresses and one patient died).

**DISCUSSION**

The current study investigated the effectiveness of the APS treatment approach to executive impairments in patients with frontal lobe lesions using a cross-over design with two control groups. The design of the study allowed for an evaluation of the treatment through three baseline assessments and a follow up six months later. The 30 participants were divided into three groups, each with 10 patients (G1, G2 and G3) and the APS treatment was compared to two intervention procedures, an information/education (IE) approach and traditional rehabilitation (TR).

Firstly, the participants’ performance was analysed in terms of whether there was an improvement in cognitive performance after the intervention on measures of executive functions, memory and information processing. There was no difference between the groups pre- or post-first intervention on measures of memory or information processing. Overall, there was little evidence of improvement on the more traditional measures of executive functioning as a result of the intervention. On the WCST there was evidence of improvement in all three groups. The most likely explanation for this would seem to be a practice effect arising from task familiarity – although we cannot be sure that all three “interventions” did not have some effect, it seems unlikely that any increase in performance in G3 was a result of intervention as they received at that time only physical therapy. For the VIP there was a trend towards a significant difference between the groups in terms of changes in scores between Assessment 1 and 2, although this did not reach significance. Here again there was evidence of an increase in performance in all three groups. Although the intervention group showed the greatest
improvement in functioning, the level of improvement was only significantly greater than one of the control groups (information and education), but not the other (treatment as usual). One piece of evidence that the intervention may have had an effect on the VIP performance is that between Assessment 2 and 3 (when the two control groups underwent the group intervention). G2 and G3 improved further their performance on the VIP, but G1 showed no change. One interpretation of this result is that there was a practice effect operating between Assessment 1 and 2, with G1 gaining additional benefit from the intervention. Then between Assessment 2 and 3, there is no additional practice effect evident (because G1 did not change further) and the improved performances of G2 and G3 are thus attributable to the intervention. The strongest evidence for an effect of the intervention came from the more functional multiple elements task (MMET) and from the ratings of carers on the Dysexecutive Questionnaire. For both of these measures there was improvement after the implementation of the APS programme in all three groups. However, despite this improvement, the results showed that there was still evidence for the presence of a significant degree of executive impairment, with scores on the DEX still in the elevated range.

The improvement on the MMET suggests that the three groups were able to improve their ability to carry out novel real-life situation tasks particularly after the APS programme was implemented. Our interpretation of how participants improved their performance was through adopting a simple strategy of exploring the precinct first before deciding on the best task to start with depending on which shop was located near the start position. This strategy reflects a more planned and efficient approach to the task and contrasts with a more impulsive or unplanned one (e.g., starting the test entering the first shop described in the instruction card) that characterised pre-intervention performance. A strong emphasis was placed in the group training on the STOP: THINK element of the problem-solving framework. Von Cramon et al. (1991) similarly emphasised that a key focus of their problem solving training was on the management of impulsivity.

An issue that is relevant to all cognitive rehabilitation studies is the relationship between training tasks, outcome measures and functioning in everyday “real-life”. Some interventions are focused on teaching a task-specific skill or strategy where the aim is to improve performance on a specific functional task. In this case the patient is trained on the specific task, hopefully improves performance on that task in everyday life and no generalisation to other situations is expected. The study by von Cramon and Matthes-von Cramon (1995) in which a physician who had executive dysfunction after a head injury was trained to use a checklist to improve his performance in undertaking and reporting on pathology examinations was a good example of this approach. His performance in the work situation improved, but there was no evidence of improvement on other measures of
planning. However, if an intervention is aimed at improving cognitive functioning with the aim that performance will be improved in a variety of everyday situations (that all make demands on the trained cognitive function), then it is important in evaluating the efficacy of the treatment that at least some of the outcome measures are not tasks that have been specifically trained as part of the intervention. In the present study there was evidence of improvement as a result of participation in the group on the VIP and the MMET. These tasks were not specifically trained as part of the group intervention. There was, as would be expected, overlap in the demands made by these tasks and some of the practical tasks used in the group to teach planning and goal management skills. For example in the group, participants had to plan an outing for the group where they were encouraged to stop and think about what was required, consider options for the outing, choose an option, plan the details and implement that planned outing. Furthermore, participants were supported in applying these strategies to difficulties arising for them in their daily lives. In this way the aim was explicitly to train participants to generalise strategy use to new situations. As already discussed, perhaps the clearest example of this was prompting use of a STOP: THINK strategy, which participants were encouraged to apply in everyday life. Therefore, although the VIP and MMET were not specifically practised as part of the training programme, it seemed that participants were able spontaneously to transfer use of strategies to these situations. Nevertheless one should still be cautious about the extent to which participants transfer skills to actual everyday life given that tasks such as the VIP and MMET are at least broadly similar in form to the sort of tasks used in the group. It was important therefore to have at least some other measure of transfer of training to everyday life and this was provided by the DEX questionnaire.

The DEX questionnaire examines behavioural, cognitive, personality and motivational changes associated with the dysexecutive syndrome and results showed that there was a significant change over time in the way the carers or relatives rated the participants’ performance. There was a reduction in the number of items rated as happening “very frequently”. Of relevance of course is the fact that relatives were not blind to intervention condition and the possibility that ratings are influenced by expectations of change or indeed by a desire to please the researchers cannot be ruled out. By contrast to the ratings from relatives, no significant changes were observed in terms of the participants’ self-rating scores. One interpretation of these findings is that as a result of participation in the group, insight did improve, and at the same time, and possibly in part as a result of improved insight, participants were better at applying planning and problem solving strategies. In this case, although one might expect self-rating DEX scores to increase, as a result of greater insight, because functioning is better as a result of strategy application, so scores might not increase or might even decrease. In other
words, pre-treatment, participants may have an unrealistically low rating of everyday problems, after the intervention that same rating level is in fact a more realistic evaluation of functioning. Von-Cramon and colleagues (1991) also noted that a proportion of patients deteriorated on tests after treatment possibly due to an increased awareness of the complexity of their problems.

Current neuropsychological assessment tools are not specifically designed to identify which stage of the problem-solving process might be impaired. The view of the clinicians running the intervention groups, based on the standardised and functioning test performance, questionnaire scores and observation of the patients in the group setting was that the most common area of deficit was in the planning phase, or, using Shallice and Burgess (1996) terminology, the phase in which a temporary new schema is developed. Although there were patients with poor initiation and with poor monitoring, the most striking difficulties were in the ability to generate alternative solutions to problems. This phase of the process might be said to be the most complex, making demands upon a range of underlying cognitive processes and hence most vulnerable to disruption. For instance, most patients had difficulties with divergent thinking when creating alternative solutions to problems such as providing an important document to a medico-legal interview in order to obtain another period of sickness leave from work despite the proper knowledge of it or how to make sure all the lights in the house would be turned off before going out. Nevertheless, after a number of sessions working on alternative solutions to various problems with the APS framework, the majority were able to generate appropriate solutions to other problems as demonstrated by what they wrote on their template sheets (see Figure 1).

There was an association between size of lesion and performance on some, although not all, measures of executive functioning. Patients with lesions larger than 4.5 cm² showed the greatest deficits on the VIP, MMET and DEX. This finding is consistent with a few studies showing that large lesions in the frontal lobes, especially more than 5 cm² can produce greater impairment (Goldstein, Bernard, Fenwick, Burgess, & McNeil, 1993; Goto et al., 2003; Leimkuhler & Mesulam, 1985). Tests such as the VIP and MMET are relatively complex and hence it makes sense that as lesion size increases, the range and severity of impairments are likely to increase, which will be reflected by poorer performance on complex multi-component tests. Similarly, the DEX questionnaire was designed to reflect the very wide range of potential symptoms of frontal lobe dysfunction and as lesion size increases one would expect an increase in the range and severity of symptoms endorsed. Laterality of lesion showed an effect only on the FAS verbal fluency task. However, site of lesion did not produce any significant differences in performance on tests used. It seems likely that this latter finding
may also be the result of the fact that most of the measures used are complex and rely on multiple aspects of executive functioning for successful performance. Hence a range of different impairments may impact on performance on such measures. From the perspective of ecological assessment of everyday executive functioning this is perhaps not critical. However it does raise the question as to whether it is possible to design assessment procedures that are able not only to predict performance on complex everyday tasks, but also identify component processes that may be selectively impaired, and hence could be specifically targeted by rehabilitation interventions. In the present study, there was no relationship apparent between side, site or size of lesion and relative benefit from the intervention. It might be argued however that such a relationship might not be expected as the treatment group programme addresses a wide range of aspects of attention and executive functioning in a “catch all” manner. Hence it could be said that whatever the problem, some aspect of the treatment programme will help and so one would not expect a specific relationship with particular impairments or indeed the side/site/size of the lesion. The ideal would be of course to be able to identify specific impairments and apply targeted rehabilitation interventions that have effects that generalise to everyday functioning. Sturm et al. (2002) presented preliminary evidence that attention training aimed at specific attention systems selectively improved the targeted domain of attention functioning, although evidence of generalisation to everyday life was not presented. Similar evidence does not exist for the broader concept of executive functioning. Many of the patients who present in rehabilitation settings, particularly those with head injury, do not of course have very circumscribed lesions nor highly selective cognitive impairments. For most therefore, a treatment intervention that covers a broad range of cognitive functions and focuses on improving functioning on complex everyday tasks seems entirely appropriate. Nevertheless, it also seems reasonable to assume that programmes that include individually evaluated component interventions that are derived from clear theoretical models of executive functioning are likely to be the most effective, as long as there is also a focus on everyday functioning.

In summary, the main results showed some evidence for the effectiveness of a treatment approach to the dysexecutive syndrome, namely the APS treatment. There was also an indication of a degree of generalisation to real-life activities. However, these findings should be interpreted as preliminary results, from which we should be cautious in drawing conclusions. There are several methodological limitations associated with this study, some of which should be addressed in future studies. Firstly, the sample might be said to consist of participants with only mild to moderate levels of executive impairment and future studies might usefully examine a broader range of patients in order to clarify for which patients the intervention might be
helpful. Although the person who carried out the assessments was not involved in the treatment interventions, she was not blind to group membership, which is a significant weakness of this design. It is impossible to run strict double blind studies, but future studies should adopt a single blind evaluation where possible. In the present study we compared the experimental condition with a treatment as usual condition and an information and education condition. The latter was chosen to investigate the possibility that simply providing structured information about improving problem solving might be effective. If it had proved to be as effective as the intervention group then it would have provided a much more cost-effective approach to rehabilitating executive difficulties. The limitation of this approach is that the possibility that some more general effect of contact with therapists is responsible for the improvement in performance cannot be ruled out. The use of wait-list controls has been common in this type of research (Fox, Martella, & Marchand-Martella, 1989; Medd & Tate, 2000; Tiersky et al., 2005) and does avoid the ethical issue of giving participants a “treatment” which is considered unlikely to have a significant effect on the problems with which they are presenting. Despite these limitations, the study goes some way to bridge the gap between the identification of executive deficits specifically related to problem solving, planning, initiation, monitoring and behaviour regulation and the implementation of a targeted intervention at these deficits having functional outcome as the main goal of treatment.

REFERENCES


Manuscript received October 2007
Revised manuscript received June 2008
First published online August 2008