Single case experimental design study of Carer facilitated Errorless Learning in a patient with severe memory impairment following TBI

ARTICLE *in* NEUROREHABILITATION · JANUARY 2007

Impact Factor: 1.12 · Source: PubMed

5 AUTHORS, INCLUDING:

Loretta Campbell
Belfast Health and Social Care Trust
2 PUBLICATIONS **54** CITATIONS
SEE PROFILE

Frederick Colin Wilson
Belfast Health and Social Care Trust
38 PUBLICATIONS **378** CITATIONS
SEE PROFILE

John Mccann
Belfast Health and Social Care Trust
24 PUBLICATIONS **335** CITATIONS
SEE PROFILE

Rosalind Rogers
Ulster University
3 PUBLICATIONS **54** CITATIONS
SEE PROFILE

NeuroRehabilitation 22 (2007) 1–9
IOS Press

Single case experimental design study of Carer facilitated Errorless Learning in a patient with severe memory impairment following TBI

Loretta Campbell[a,*], F. Colin Wilson[b], John McCann[c], George Kernahan[d] and Rosalind Gray Rogers[e]
[a]*Occupational Therapy Department, Department of Rehabilitation Medicine, Royal Victoria Hospital, Belfast Health and Social Care Trust, Belfast, Northern Ireland, UK*
[b]*Regional Acquired Brain Injury Unit, Musgrave Park Hospital, Belfast Health and Social Care Trust, Belfast, Northern Ireland, UK*
[c]*Department of Rehabilitation Medicine, Royal Victoria Hospital, Belfast Health and Social Care Trust, Belfast, Northern Ireland, UK*
[d]*School of Nursing, University of Ulster, Jordanstown, Northern Ireland, UK*
[e]*School of Communication, University of Ulster, Jordanstown, Northern Ireland, UK*

Abstract. *Objectives:* To investigate if errorless learning applied by carer(s) in an everyday setting can reduce the frequency of everyday memory problems following severe traumatic brain injury (TBI).
Research design: Multiple baseline single case experimental design.
Methods and procedures: A patient with severe memory impairment, six years post TBI was recruited via an outpatient neurorehabilitation clinic. ABA analysis was conducted using daily frequency counts of everyday memory problems as an index of change.
Experimental intervention: Errorless learning delivered by the patient's carer, aimed at reducing the occurrence of identified everyday memory problems. The carer was guided in treatment implementation by an Occupational Therapist.
Main outcomes and results: Incidence of frequently occurring memory lapses was significantly reduced ($p < 0.001$) and this was maintained at 3 months post intervention.
Conclusion: This study highlights the potential clinical value of errorless learning with self-generated cues applied by carers within an everyday setting.

Keywords: Memory rehabilitation, errorless learning, family & carers, brain injury

1. Introduction

Memory impairment is one of the most significantly disabling and frequently observed deficits following brain injury [10]. The resulting everyday problems can have a profound impact not only on the individual's ability to succeed in rehabilitation but ultimately in their ability to achieve independent living and social re-integration [9,17]. In addition, memory impairment also impacts significantly on those caring for individuals following brain injury [19]. Clearly, the management of memory impairment is an important issue within neuro-rehabilitation, which continues to present challenges to both carers and professionals.

*Address for correspondence: Occupational Therapy Department, Department of Rehabilitation Medicine, Royal Victoria Hospital, Belfast Health and Social Care Trust, Belfast, BT12 6BA, Northern Ireland, UK. Tel.: +44 28 90634322; E-mail: loretta.campbell@belfasttrust.hscni.net.

ISSN 1053-8135/07/$17.00

Early research considered that impaired memory functioning could be restored. However, the supporting literature is limited and currently poorly supports the 'restorative' approach [17]. The alternative approach focuses on managing the resultant 'cognitive' disability by learning new information and the use of compensatory techniques. The compensatory approach broadly involves the use of external strategies such as environmental aids and internal strategies (e.g. mnemonics and visual imagery). It is widely considered to be the most effective approach [20]. In addition to this shift in approach, a number of broad themes have begun to emerge within the literature.

Increasingly, memory research has moved from the laboratory into everyday settings and focuses on everyday memory problems encountered by individuals with brain injury. Likewise, the importance of ensuring ecologically valid treatment applied to the specific memory problems encountered by the individual with brain injury is now increasingly recognised. Ownsworth and McFarland [13] observed that successful methods are 'acceptable to the patient', taking into consideration their lifestyle, level of cognitive functioning and stage of recovery and are applied to particular memory problems. Cicerone et al. [3] in an extensive literature review of the effectiveness of cognitive rehabilitation after TBI and Stroke recommended that treatment should always be directed towards everyday functioning gains.

More recently, Mateer [12] emphasised the 'collaborative' nature of management involving all those involved in the individual's life. Kime, Lamb and Wilson [10] in their study, emphasised the importance of family as well as rehabilitation professionals practising techniques with the brain-injured individual. Fleming et al. [7] provided an example of family involvement in a compensatory training programme for prospective memory, which facilitated generalization into home and community settings. In an earlier study McKinlay and Hickox [11], specifically considered the role of family members and suggested that relatives could act as 'co-therapists' in training brain injured individuals to employ memory strategies within their everyday setting. They caution however that rehabilitation professionals should be sensitive to the complexities of family relationships. Not all family members might feel that they can provide input at this level and their intervention may be counter productive or contribute to, as oppose to alleviating caregiver strain.

In the related area of Alzheimer disease research, a recent study considers the impact of intervention on carers. Clare et al. [4] conducted an errorless learning memory rehabilitation programme. In this, the patient's carer, while not the 'primary therapist' played an active role in the practice of techniques and generalised use to other situations. This 'generalisation' was achieved without any reported increase in depression, anxiety or caregiver strain. These preliminary findings suggest that, at least among some Alzheimer disease (AD) patients and their family members, that it is possible to apply professionally guided strategies with limited involvement from healthcare professionals. However, to date, within the field of neuro-rehabilitation, the role of carers, in the application of memory techniques, such as errorless learning has received limited attention.

Learning without error (Errorless learning [EL]) is viewed as having significant potential in the management of severe memory impairment after brain injury Bier, Vaniear and Meulemans [2]. Indeed Kessels and De Haan [8] reviewing the effects of errorless learning and vanishing cues in amnesic patients, observed a statistically significant effect for the use of errorless learning over vanishing cues. Notwithstanding, the theoretical basis underpinning the effect of errorless learning remains unclear. Evans et al. [6] suggested that errorless learning only acts on implicit memory functioning, which concurs with Baddeley and Wilson [1] theoretical position. However Hunkin et al. [5] proposed that errorless learning utilises an individual's residual explicit memory. Tailby and Haslam [16] have argued that both implicit and explicit processes may be used when learning information under errorless learning conditions or that, learning responses may differ according to the individual's cognitive profile.

In practice, errorless learning operates on the principle that the individual should be prevented from making mistakes whilst learning. This may be achieved using a range of strategies, such as dividing the task into sub components, using one piece of information at a time, guiding learning using methods such as vanishing cues and spaced retrieval [19]. Furthermore, Wilson [19] also suggests that teaching only one piece of information at a time may improve results. Bier [2] emphasises the importance of ensuring that instructions should not refer to information that has already been learnt, but instead facilitate automatic recall. Consequently, the patient should not have to retrospectively search for learnt information. Tailby and Haslam [16] described a method for improving the application of errorless learning. They argued that by actively involving the patient in encoding information, that as a result, learning performance is enhanced. This is based on the observation that recall is improved if information is

learnt in a semantic context and therefore this technique aims to utilise intact semantic memory following brain injury. However, they reported that it was unclear if the gains observed were due to the use of elaborative cues or the self-generation of responses or to a combination of both.

This case study attempts to investigate the use of errorless learning applied by a carer within the home environment in order to manage specific everyday memory problems with an individual following severe traumatic brain injury. A multiple baseline by intervention experimental design was employed with three-month post intervention follow-up.

2. Method

2.1. Patient

Twenty four year old single male (JT), now six years post-traumatic brain injury as a result of a road traffic accident is presented. Initial CT (brain) scan indicated left side tempo-parietal subdural haematoma with underlying cerebral hemisphere swelling and midline shift. At seven days post injury JT underwent left temporal lobectomy due to cerebral oedema and multiple infarcts. He had a right hemiplegia and also sustained right femur and ankle fractures. JT received nine months in-patient neuro-rehabilitation and a further three months as an outpatient. JT was recruited to the study via a neuro rehabilitation review clinic. He was living at home with his parents and brother. He was independent with personal activities of daily living (ADL), but dependent on his family for support with most domestic and extended ADL tasks. He attended a vocational rehabilitation programme twice a week. His mother (M), agreed to be the key family member implementing the intervention at home.

2.2. Assessment

Initial informal discussion with JT and his parents indicated that his memory was the most limiting factor to achieving independence in many functional tasks e.g. 'He forgets where we have arranged to meet in the supermarket' or 'He forgets when he has arranged to go out with a friend'. Consequently, JT required constant reminders and supervision throughout the day. Nevertheless, JT demonstrated awareness of these difficulties and a willingness to address them. Formal brief cognitive assessment was conducted including Wechsler Abbreviated Scale of Intelligence (WASI) [18] and Rivermead Behavioural Memory Test (RBMT) [21]. JT's estimated current IQ was within average range. However he scored 0/12 when assessed on RBMT, indicating severe memory impairment.

In addition, a number of self-report questionnaires were completed pre and post intervention with JT and his mother (M).

- Caregiver Strain Index (CSI) [14] Completed by M. A score of 7 or above is considered to indicate a significant level of strain.
- Hospital Anxiety and Depression Scale (HADS) [15]. Completed by M and JT, the scale provides separate scores for anxiety and depression out of a maximum of 21. Cut off points of 8, 11 and 15 indicate mild, moderate and severe disturbance respectively.
- Dysexecutive Questionnaire from the Behavioural Assessment of Dysexecutive Syndrome (BADS) [22] rates both the patients and their carer's perception of their executive functioning. (Mean carer score – 32.85, S.D – 15.98. Mean self score – 27.2, S.D – 14.4).

Results are presented in Table 3, within the results section.

3. Procedure

Following assessment, JT and his parents were asked to identify daily memory failures. They reported that JT carried a notebook with him much of the time, however rarely wrote in it and only did so if prompted. Whilst this is not an everyday memory problem but rather a failure to use an aid for such problems, it was considered to be one of the most potentially useful 'memory failures' to address. In addition, they also reported that JT never remembered to walk his dog and always required prompting do so.

Daily outcome measures were then established for each problem:

1. Did the problem occur to day? Yes or No
2. How many prompts were required to achieve the set task.

With problem one (Use of the notebook) 8 data points were pre-established for each day to record whether or not the problem took place. The data points were on an hourly basis between 11am and 6pm (or 4pm and 11pm on the days in which JT attended his vocational

Table 1
Prompting given for Notebook Entry

Prompt level	Prompt Description
Level 1	Mobile phone 'beep' noise
Level 2	Mobile phone message ' write in notebook'
Level 3	Verbal reminder 'now JT, write in your notebook'
Level 4	Physical/verbal reminder – take out notebook and pencil for JT and say 'Now JT, write in your notebook'

programme). The data points were mutually agreed with JT and his mother as realistic points during the day, at which he would make a notebook entry and the intervention could be implemented. In the case of problem two (Walking the dog), he had only 1 data point per day. This was at set-time (4.30pm).

The intervention programme consisted of errorless learning applied by the carer using self-generated patient responses. The therapist facilitated the elicitation of patient generated prompts to ensure successful achievement with each problem. These formed the system of prompts, which would ultimately ensure that JT successfully performed both tasks. For example, JT initially suggested that his mother would bring him the dog lead and provide a verbal prompt to ensure that he walked the dog. This suggestion was then developed with both JT and his mother into levels of predominantly verbal prompting, (using his choice of wording), applied to ensure that he would walk the dog each day at 4.30pm.

Tables 1 and 2 outline the level of prompting given for problems 1 and 2 respectively.

Daily data sheets were used by M to record the occurrence of the problem at each data point and the level of prompting required.

If JT did not move to write in his notebook with the initial prompt level, M introduced the next level of prompting (levels 2 to 4) until writing in the notebook was achieved.

M used the minimal level of cue required to ensure that JT walked the dog. Moving down through the levels from 1 to 5 as required.

During baseline period (A1), the frequency of both memory problems, were simultaneously monitored. The study involved multiple baseline with staggered intervention. Having established a stable baseline for problem one (10 days), intervention period (B) commenced, using a forward chaining approach using the prompt system outlined in Table 1. The planned intervention facilitated by the Occupational Therapist was a dynamic process involving both patient and carers. Training in implementation of the technique and the agreed prompt levels was provided to M. This consisted of a face-to-face education session on errorless learning of verbal instruction and role-play. In addition, M was also provided with a written information sheet detailing brief information on errorless learning in general and on the levels of prompting and how to implement each stage. M agreed to ensure that the intervention was carefully implemented. At no point, during the study was it indicated to M or any other family, what the anticipated outcome measures were. JT was effectively blinded to the intervention during carer education sessions. Once task completion had become established and JT had begun to perform the task on a consistent basis before external prompting was applied, it was jointly agreed by M and the therapist to enter the post intervention period (A2). No additional cues were given during this period by the family.

Table 2
Prompting given to exercise family dog

Prompt level	Prompt Description
Level 1	'JT it is 4.30 it is time to exercise Bob'
Level 2	'JT it is 4.30 it is time to exercise'
Level 3	'JT it is 4.30 it is time to'
Level 4	'JT check the time'
Level 5	M looks at her watch, in view of JT

Intervention for problem two (walking the dog) only commenced when outcome measures for problem one (period A2) were established. The same errorless learning technique was applied, with the level of required prompts outlined in Table 2. In this case, however a backward chaining approach was employed. In essence backward chaining is a behavioural technique, which involves teaching an entire fixed sequence of behaviours, one step at a time, commencing with the last step in the sequence and teaching backwards once the preceding step has been acquired to the first step.

Throughout the study, M had access to support from the therapy team. She was provided with contact telephone details and encouraged to ring at any stage if guidance was needed. In addition, regular phone contact was maintained by the Occupational Therapist to provide reinforcement and guidance in use of the technique. M returned the daily checklists by post on a regular basis enabling the Occupational Therapist to mon-

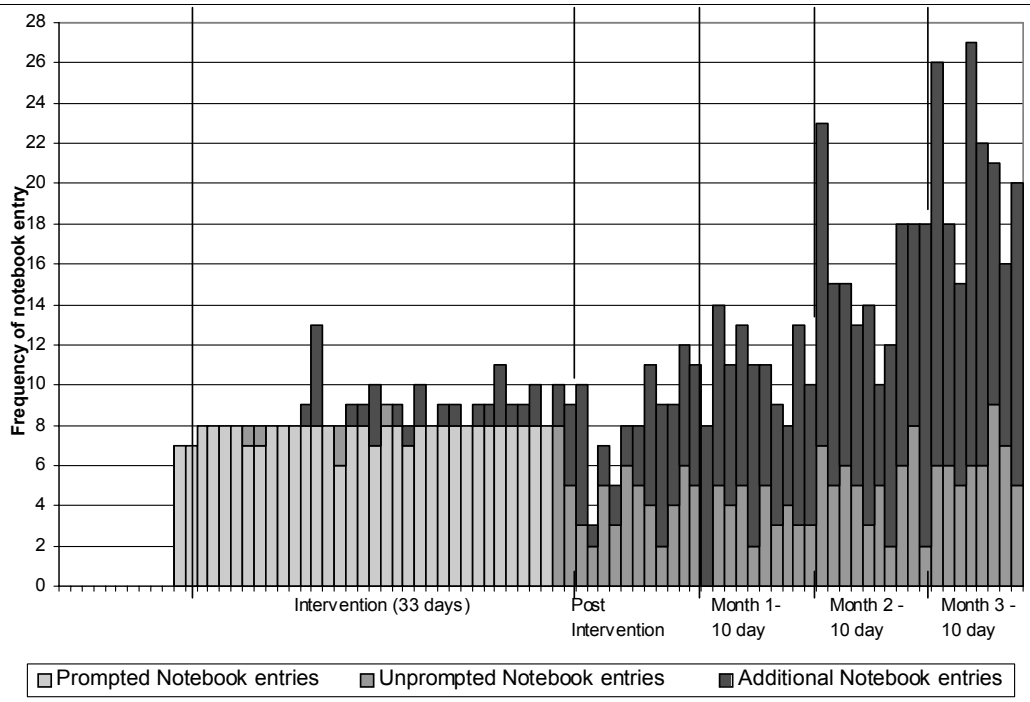

Fig. 1.

itor progress. The Therapy team met with JT and his parents once every 2–3 weeks at key stages e.g. when moving onto the next period. This was to ensure that the programme was properly implemented. At these meetings, JT's notebook entries were reviewed and collated and qualitative feedback given. At the end of the study, JT's notebook entries were cross-referenced with the daily checklists.

4. Results

Figure 1 illustrates the frequency of notebook use by JT throughout each period of the study. During the baseline period (A1: 10 days), the notebook was not used. During the intervention period (B), mean daily notebook use = 8.1. JT also began to use the notebook on a number of occasions independently (mean daily use = 1.7) and by day 12 of intervention spontaneously outside of the set times. On return to baseline (A), JT continued to use his notebook unprompted (mean daily use = 8.0). This spontaneous use extended (mean daily use = 22 at 3 months post-intervention). A significant change in notebook usage from baseline-3month follow-up ($p < 0.001$) was observed.

Figure 2 demonstrates the level of prompts provided during the intervention period. Initially third level cues (verbal prompts) were required to achieve notebook entry. However, generally a mobile phone message cue (level two prompt) was sufficient. Indeed, by day 11, JT had completed 3 consecutive days with only level two prompts. A further level of prompt (phone 'beep' – general alerting cue) was introduced. This was introduced, as it was considered too early to completely withdraw all prompts. It was the only level of prompting required during the final 7 days of intervention.

Figure 3 illustrates that JT did not walk his dog at any time during the 44-day baseline period. He did however during the intervention period when prompted and continued to do so during return to baseline and at each of the follow up periods without any further prompting. Finally, the level of prompts during the intervention period steadily reduced from level 1 (full verbal reminder) to level 5 (discrete non-verbal cue). By day 28 JT required level 5 prompt only and he had begun to occasionally walk the dog without any prompts (day 18).

4.1. Assessments

DEX questionnaires completed by JT pre and post intervention did not indicate significant changes in his insight regarding cognitive, emotional or behavioural deficits. Of note however, M's DEX carer's rating (pre

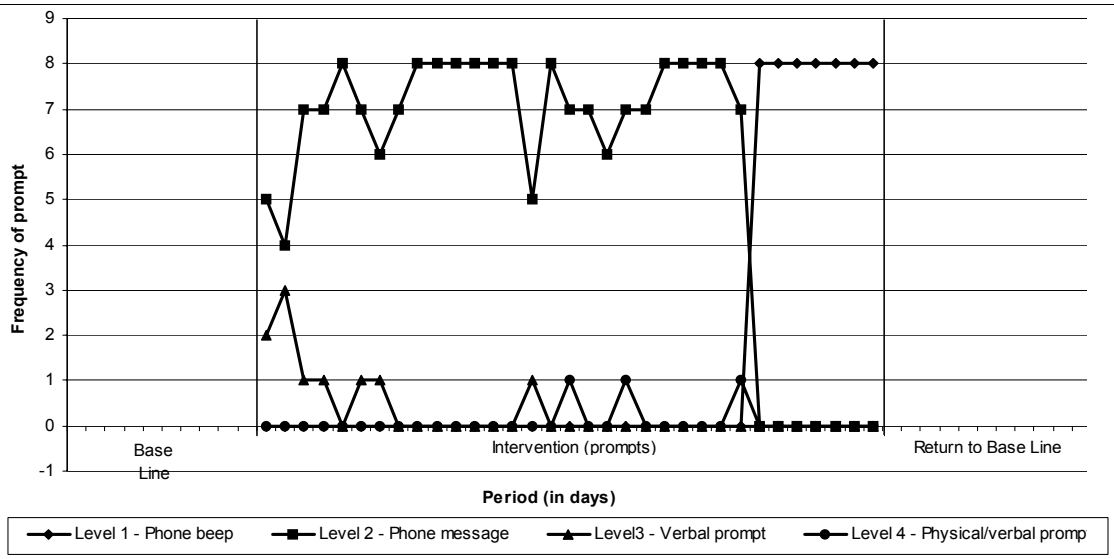

Fig. 2.

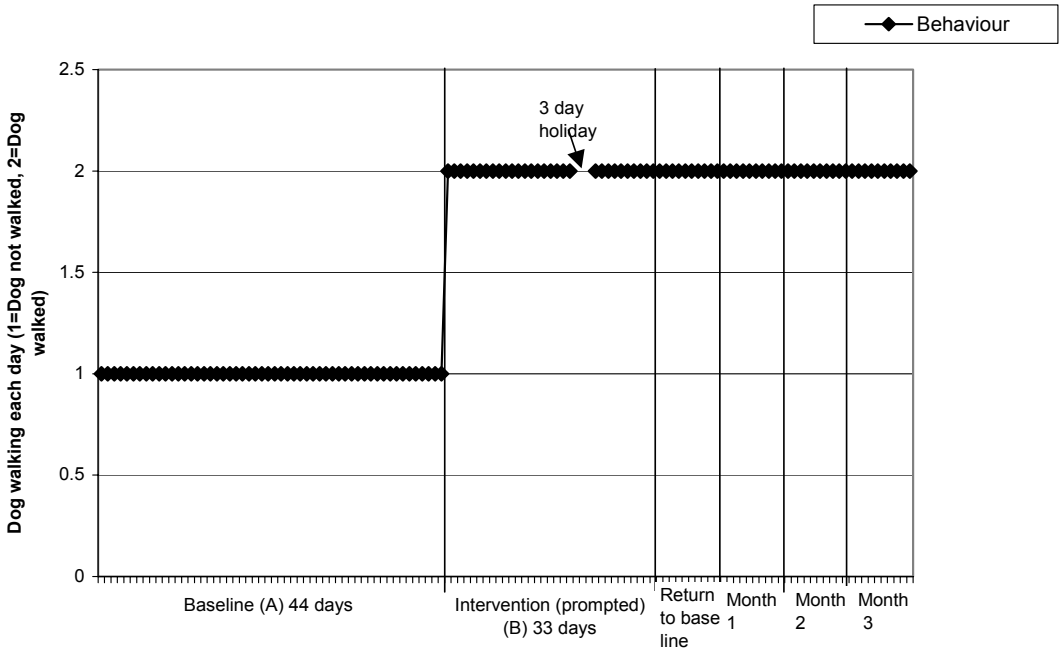

Fig. 3.

to post change of 29 to 9) indicates an alteration in M's rating of perceived level of executive dysfunction.

The score of 9 for HADS-A recorded by M, pre intervention indicates a mild level of anxiety. Whilst post intervention, this was not seen to be evident (HADS-A = 2).

The initial Caregiver Strain Index score was 'negative' for stress (2/13) and did not alter at the cessation of the follow-up period, (1/13). Table 3 provides further details of the self – report rating scale assessments.

Finally, JT, as already reported scored 0/12 in the initial Rivermead Behavioural Memory Test. Post intervention his level of memory impairment was, as anticipated unchanged (Score 1/12).

Table 3
Self-report rating scale assessments

Measure	Subject	Rater	Pre intervention	Post intervention
HADS-A	JT	JT	2	3
HADS-D	JT	JT	1	0
HADS-A	M	M	9	2
HADS-D	M	M	3	0
CSI	M	M	2	1
DEX	JT	JT	11	16
DEX	JT	M	29	9

4.2. Patient and family commentary

M declined to record her experiences in a notebook but instead preferred to give her comments verbally. Therefore, carer's experience of the programme was limited to comments recorded during phone and face-to-face contact with the therapy team. Initially JT's parents reported, JT 'forgets important daily things' and in relation to notebook use, 'he always has to be prompted to use his notebook. He carries it but never initiates using it'. By day 11, M reported 'JT now always carries his notebook'. During follow up meetings, Dad (D) reported 'at rest JT is inclined to read over his notebook'. JT reported 'I don't ask my Mum or Dad, what I have been doing . . . I use my notebook'. M and D both reported that they were 'surprised and pleased' with the results, that they felt even if JT did not receive any further input that this approach, had 'potential' for them to apply. M reported 'it shows that someone like JT without a memory can use a notebook and diary'. At each point of contact, the therapist checked whether or not there was any negative impact of the programme on either JT or his carer. None were reported. M commented 'it does need patience', but that recording outcomes was helpful and that 'it gave you a focus' with programme implementation. No reported change in the mother – son relationship was noted. Both M and D were clearly motivated and committed to the programme.

4.3. Functional gains

JT has expanded use of his notebook beyond the intervention period. Following discussion with the Occupational Therapist (LC), facilitated self-generated responses were elicited. Initially JT developed a 'things need to do' page for each day in his notebook and suggested using a yellow elastic band to highlight this page. He resisted suggestions of using a diary instead preferring to use a calendar, alongside his notebook. Eventually he decided himself to move onto using a diary. At 18 months post intervention, he now carries a diary as well as a notebook successfully using the diary as an aid to prospective memory and to plan everyday activities. He continues to use a notebook to 'track' daily events. Finally, JT continues to remember to walk his dog on a daily basis without prompts.

4.4. Discussion

This study highlights the successful implementation by a carer of an errorless learning approach, to manage everyday memory problems in an individual with severe memory impairment post brain injury. Three-month follow-up demonstrated maintenance of the established intervention gains well beyond the cessation of errorless learning intervention.

As a family member acted as the sole implementer of the intervention on a daily basis, gains were achieved without intensive or lengthy input from neurorehabilitation professionals. Furthermore, in terms of ecological validity, direct family involvement enabled the intervention to be provided within the patient's everyday environment. Indeed it could be argued that less professional input, would have been required had the intervention not been part of research study. Clearly, the potential for family members to act as 'co-therapists', which has previously been referred to within the literature [11], exists. Indeed family members and/or carers often provide a level of supervision and are willing if not very keen to receive professional support to manage memory problems. It could be argued that they are often the people best placed to implement this type of intervention. Following appropriate assessment of suitability in terms of carer adjustment and carer burden as well as ongoing support and guidance from rehabilitation professionals, a significant impact in terms of day-to-day memory functioning could result from an errorless learning approach, such as the one described.

The therapist played a pivotal role in initially establishing the programme and in facilitating active patient involvement. In the study the patient played an active role in self generating his own prompt levels e.g. JT

chose the prompts to use, to remind him to use his notebook and the wording of the sentence to be used to cue him to exercise his dog. This may have contributed to the success of the intervention and supports the view that practical application of errorless learning can be enhanced by active patient participation, in this case through self-generated memory prompts. JT also chose how to expand use of his notebook and the tools he would use to do so, for instance using a calendar. This further reinforces the view that patients should be facilitated in selecting memory aids, which are specifically appropriate for that individual [7]. Although it is acknowledged that not all individuals will be able to participate to this degree in an errorless learning intervention.

With notebook use, a forward chaining approach was applied. This did create some difficulties. The main difficulty was the inability to predict with certainty the precise level of prompting necessary to ensure that the memory failure did not occur. In this case study the initial prompt was considered to be too significant to withdraw completely and therefore an additional prompt (phone beep) was introduced before completely withdrawing the prompts. A backward chaining approach was used to manage walking the dog. This was found to afford greater control of the prompting and to facilitate a tailored approach. It appears to be the chaining approach of preference in this instance. Of note, once the learning had become established, JT demonstrated expanded notebook use post intervention, this is indicative of a habitual response pattern. Likewise, in the case of walking the dog, once learnt the established behaviour became part of a daily routine. Nonetheless, it is argued that without the errorless learning approach, a habitual response pattern would not have been established given JT's severe memory impairment.

5. Study limitations & clinical practice generalisation

Practically, this study has some limitations. The intervention places a number of demands on the carer in terms of comprehension of the technique and also ability to commit to its implementation. In this instance, explanation of the technique was found to be relatively straightforward. Not all carers could however be assumed to be capable of grasping the methodology with ease. In the initial stages close contact was maintained to ensure correct implementation. However, as the programme proceeded, JT mother (M) began to initiate when she felt JT was ready to move onto the next level of prompt and felt confident in applying the technique independently. She also initiated educating other family members, ensuring that the programme was adhered to correctly. Implementation of the technique was also facilitated by the fact that M did not work outside the home, which meant that much of the day was spent in daily activity with JT and his father (D). Ongoing commitment to the programme was aided by the tangible gains made within the first 1–2 weeks. Successful outcomes were achieved with less than 5 weeks of intervention for both identified problems. It could be argued that in a case where the results are not as significant it may be difficult to maintain commitment. Clare et al. [4] noted similar findings in relation to the impact on the caregiver of adopting such a role and in this case study, the carer's role was expanded even further without any negative impact being noted. However this may not have been the case if significant and ongoing carer emotional distress was present.

6. Insight and engagement

JT's awareness of his memory problems was also a significant positive contributing factor. While no significant formal assessment was undertaken, he did articulate some awareness of his memory problems and a willingness to address them. A programme of self-awareness training such as that described by Fleming et al. [7] may be useful in instances where poor self-awareness is an issue. This study looked at problems that occurred on a daily basis and intervention could therefore be applied in a consistent manner. Other memory problems may occur with less frequency but be equally disabling. It cannot be assumed that errorless learning can be applied in all cases e.g. failure to recall details of a phone conversation or where patient insight and motivation is severely impaired.

In terms of validity, the fact that this study relied on the carer to record the daily outcome measures could be perceived as a potential source of bias. In an attempt to manage this risk in the case of the notebook training, notebook entries were cross-referenced with the daily outcome measures. To minimise testing effect M was also advised to ensure that JT was unaware that his responses were being recorded. This was not, however, considered to be a significant threat to validity given JT's ongoing severely impaired memory.

Clinically this case study has a number of potential implications. It illustrates the practical application

of errorless learning and the use of self generated patient cues in the management of memory problems post brain injury. In addition, it demonstrates the application of EL beyond the clinic setting and the potential for successful application by appropriately trained and supported 'significant others'. The implications of this case study may be enhanced through the use of a larger case series multiple baseline design. This study also provides preliminary support for the application of errorless technique(s) within wider non-clinical settings such as residential settings or vocational rehabilitation centres. Finally, research is warranted which examines the precise role of the therapist in facilitating the use of errorless learning as well as the under-pinning mechanisms of patient-generated cues, which could further assist in refining clinical delivery.

Acknowledgements

The authors would like to thank JT and his parents for their dedication to this study and the support of the Royal Victoria Hospital Occupational Therapy Department.

References

[1] A. Baddeley and B.A. Wilson, When implicit learning fails: amnesia and the problem of error elimination, *Neuropsychologica* **32** (1994), 53–68.

[2] N. Bier, M. Vanier and T. Meulemans, Errorless learning: A method to help amnesic patients learn new information, *Journal of Cognitive Rehabilitation* **20** (4) (2003), 12–18.

[3] K.D. Cicerone, C. Dalhberg, K. Kalmar, M. Langenbahn, J.F. Malec, T.F. Bergquist, T. Felicetti, J.T. Giancino, J.P. Harley, D.E. Harrington, J. Hervog, S. Kneipp, L. Laatsch and P.A. Morse, Evidence – Based Cognitive Rehabilitation: Recommendations for Clinical Practice, *Arch Phys Med Rehabilitation* **81** (2000), 1596–1615.

[4] L. Clare, B.A. Wilson, G. Carter and J.R. Hodges, Cognitive Rehabilitation as a component of early intervention in Alzheimer's disease: a single case study, *Aging and Mental Health* **7**(1) (2003), 15–21.

[5] N. Hunkin, E. Squires, A. Parkin and J. Tidy, Are the benefits of errorless learning dependent on implicit memory? *Neuropsychologia* **36** (1998), 25–36.

[6] J.J. Evans, B.A. Wilson, U. Schuri, J. Andrade, A. Baddeley, O. Bruna, T. Canavan, S. DellaSala, R. Green, R. Laaksonen, L. Lorenzi and I. Taussik, A comparison of "Errorless" and "Trial and Error" Learning Methods for Teaching individuals with acquired memory deficits, *Neuropsychological Rehabilitation* **10**(1) (2000), 67–101.

[7] J.M. Fleming, D. Shum, J. Strong and S. Lightbody, Prospective memory rehabilitation for adults with traumatic brain injury: A compensatory training programme, *Brain Injury* **19**(1) (2005), 1–10.

[8] R.P.C. Kessels and E.H.F. de Haan, Implicit learning in memory rehabilitation: A meta-analysis on errorless learning and vanishing cues methods, *Journal of Clinical and Experimental Neuropsychology* **25**(6) (2003), 805–814.

[9] H.J. Kim, D.T. Burke. M.M. Dowds and J. Georges, Utility of a microcomputer as an external memory aid for a memory impaired head injury patient during in-patient rehabilitation, *Brain Injury* **13**(2) (1999), 147–150.

[10] S.K. Kime, D.G. Lamb and B.A. Wilson, Use of a comprehensive programme of external cueing to enhance procedural memory in a patient with dense amnesia, *Brain Injury* **10**(1) (1996), 17–25.

[11] W. McKinlay and A. Hickox, How can families help in the rehabilitation of the head injured? *Journal of Head Trauma Rehabilitation* **3**(4) (1988), 64–72.

[12] C. Mateer, Neuropsychological Rehabilitation. Abstract from Effectiveness of Rehabilitation for Cognitive deficits, Cardiff University Conference September 2002. http://www.cf.ac.uk/psych/ercd/speak/abstracts/wilson.html.

[13] T.L. Ownsworth and K. McFarland, Memory remediation in long term acquired brain injury: two approaches in diary training, *Brain Injury* **13**(8) (1999), 605–626.

[14] B.C. Robinson, Validation of a caregiver strain index, *Journal of Gerontology* **38** (1983), 344–348.

[15] R.P. Snaith and A.S. Zigmond, *The hospital anxiety and depression scale*, NFER – Nelson, Windsor, 1994.

[16] R. Tailby and C. Haslam, An investigation of errorless learning in memory – impaired patients: improving the technique and clarifying theory, *Neuropsychologia* **9** (2003), 1230–1240.

[17] R.L. Tate, Beyond one-bun, two-shoe: recent advances in the psychological rehabilitation of memory disorders after acquired brain injury, *Brain Injury* **11**(12) (1997), 907–918.

[18] D. Wechsler, *Wechsler Abbreviated Scale of Intelligence*, The Psychological Corporation, San Antonio: TX, 1999.

[19] B.A. Wilson, Management and remediation of memory problems in brain injured adults, in: *Handbook of Memory Disorders*, A. Baddley, B.A. Wilson and F. Watts, eds, John Wiley and Sons, Chichester, 1995, pp. 452–479.

[20] B.A. Wilson, Memory rehabilitation in brain – injured people, in: *Cognitive Neurorehabilitation*, D.T. Stuss, G. Winocur and I.H. Robertson, eds, Cambridge University Press, Cambridge, 1999, pp. 333–346.

[21] B.A. Wilson, J. Cockburn and A.D. Baddeley, *The Rivermead Behavioural Memory Test*, Thames Valley Test Company, Bury St Edmunds, 1985.

[22] B.A. Wilson, N. Alderman, P.W. Burgess, H. Emslie and J.J. Evans, *Behavioural Assessment of the Dysexecutive Syndrome*, Thames Valley Test Company, Bury St. Edmunds, 1996.