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CASE STUDY

External cueing systems in the rehabilitation of executive impairments of action

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Abstract

The use of a mnemonic cueing system (NeuroPage®) and a paper and pencil checklist in the rehabilitation of executive problems in a 50-year-old woman are described. Following a CVA 7 years earlier, the patient, despite intact general intellectual and memory functioning, had specific executive impairments of attention, planning, realizing intended actions, and also exhibited behavioral routines similar in form to obsessive–compulsive rituals. In a series of ABAB single-case experimental designs, the efficacy of 2 external cueing systems in prompting appropriately timed action is demonstrated. It is argued that the combination of external control and increased sustained attention to action were critical to the success of NeuroPage with this patient. Furthermore it is hypothesized that the checklist was effective in facilitating the patient's ability to foresee and recognize the consequences of her actions, which in turn had an impact on the probability of her changing those same actions. (*JINS*, 1998, *4*, 399–408.)

Keywords: NeuroPage, Dysexecutive syndrome, Frontal lobes, Attention, Rehabilitation, External aids, Single-case experimental design

INTRODUCTION

In 1982 Craine wrote, "Recognizing and then attempting specific remediation of frontal lobe dysfunction is of relatively recent origin, and has proved to be a rather difficult and frustrating task" (p. 239). Although this statement probably still remains largely true today, there have in the intervening years been a number of attempts at rehabilitating executive impairments of the sort that are typically associated with frontal lobe damage. As with most other areas of cognitive function there remains little evidence that lost functioning can be "restored," though recent small trials of the drug idazoxan (Sahakian et al., 1994) are promising in this respect and the "problem solving therapy" approach of von Cramon and colleagues (von Cramon et al., 1991; von Cramon & Matthes-von Cramon, 1992) also seems to provide some indication that executive skills can be retrained. However, as is typical in cognitive rehabilitation generally, treatment strategies for executive impairments have tended to focus on compensatory strategies of some sort, be they "internal" strategies such as the use of self-instructional training or "external" strategies such as in the use of notebooks, checklists, etc. For example, using a self-instructional technique, Cicerone and Wood (1987) enabled a head-injured man to improve his planning ability on a training task and also demonstrated some generalization to everyday life in terms of improved self-control. More recently Robertson et al. (1995) demonstrated that sustained attention (associated with right frontal lobe functioning) could be improved by the use of a self-instructional alerting procedure, which also had the effect of reducing the extent of unilateral spatial neglect in a series of 8 patients. Burke et al. (1991) describe six case studies of patients having problems with planning, self-initiation, and self-regulation that were improved by the systematic use of external aids such as notebooks and checklists.

In the present study the focus was on the use of external cueing–monitoring systems with a patient who had significant impairment in her ability to carry out tasks she intended to do. One of the classic descriptions of patients with frontal lobe lesions is that of Luria (1973), who character-

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ized such patients as having an impairment in their ability to translate verbal intention into action, noting that, "In these patients the verbal command remained in their memory, but it no longer controlled the initiated action and lost its regulating influence" (1973, p. 200). More recently Duncan (1986) using a similar framework to Luria characterized the impairments after frontal lobe damage as reflecting "a defect in goal based search, a failure to constrain the choice of action by its intended results" (p. 285). Baddeley and Wilson (1988) drew on the work of Rylander (1939) in characterizing the impairments shown by patients following frontal lobe lesions in terms of a "dysexecutive syndrome," which includes impairments in attention (being easily distractible), having difficulties grasping the whole of a complicated state of affairs, being able to work along routine lines but having difficulties in new situations. Baddeley (1986) has conceptualized the dysexecutive syndrome as arising from a deficit of the central executive component of working memory, which he has also equated with the Supervisory Attentional System in Norman and Shallice's model of frontal lobe functioning (see Shallice, 1988).

These models or conceptualizations of frontal lobe function (and dysfunction) all differ somewhat, and probably none can effectively capture *all* aspects of frontal lobe dysfunction. One area of functioning that each of the models would predict there to be problems with is prospective remembering or realizing delayed intentions. As the Luria and Duncan models predict, such patients may intend to act, but the intention is simply not translated into action. With similar functional consequences, the Baddeley and Shallice models predict that patients may start to do something, but be distracted before completing the task, they may do the task impulsively at an inappropriate time or in novel situations they may fail to plan ahead to establish appropriate intentions to act.

When it comes to rehabilitation of frontal lobe executive problems, on the basis of the models described above, it might be argued that an intervention ideally needs to provide some form of external prompt to action. It needs to reduce the likelihood of distraction prior to task completion, to prevent impulsive task completion at inappropriate times and to prompt planning at appropriate times. A system whose efficacy we have recently been involved in evaluating seems to be able to provide at least some of these components (see Wilson et al., 1997). The system is called NeuroPage® and is a mnemonic cueing system, developed recently by Hersh and Treadgold Inc., San Jose, California (see Hersh & Treadgold, 1994). The system utilizes radio paging technology and involves the patient wearing an ordinary alphanumeric pager. Reminders of things to do are entered on to a central computer using the NeuroPage software that automatically sends out the message *via* a modem to a paging company which then sends out the message to the patient's pager. The patient group for whom this system is primarily used are people with memory impairment. Such patients frequently rely on diaries or notebooks as memory aids, but these have the disadvantage of not providing proactive, timed reminders, and therefore rely on the patients remembering to look in their diaries and looking often enough so as not to miss things that must be carried out at particular times. Electronic diaries–organizers are available providing timed reminders *via* alarms, but these are frequently too complex for memory-impaired patients to learn how to use.

NeuroPage therefore offers a combination of sophisticated technology and ease of use as far as the patient is concerned. We hypothesized that NeuroPage would also be useful for patients with the sort of executive impairments of action associated with frontal lobe lesions discussed above, and in this paper describe its use with 1 such patient. A system such as Neuropage which is limited to providing specifically timed reminders, is not always appropriate, however, and in this paper we also describe the use of also a more basic paper-and-pencil checklist system.

CASE HISTORY

R.P. was 50 years old when she was referred to us as part of a larger study being carried out to evaluate the NeuroPage system. She had previously been a laboratory technician for a chemical company. In 1988 cerebral angiography revealed the presence of three aneurysms. Two of these, an anterior communicating artery aneurysm and another at the junction of the left internal carotid and the anterior choroidal artery, were surgically clipped and a third, on the right middle cerebral artery, was not treated. Although she did well for the first 18 hr postoperatively she then deteriorated and CT scanning showed evidence of ischemic damage to the anterior and medial part of the right frontal lobe extending superiorily to the right parasagittal region, and a further area of infarction in the medial part of the left frontal lobe. She was discharged from hospital at the end of 1988. Her husband reported that her main problems were that even though she could accurately say what she had to do, she needed to be prompted to do many things (e.g., take medication, go to her voluntary job), she was distractible (went to do one task, but was distracted by something else along the way), and was disorganized and did not plan ahead (for example, she had difficulties planning and organizing cooking family meals). An additional problem was that she spent an excessive amount of time in the bath (approximately $1\frac{1}{2}$ hr) every morning, preventing her from taking part in other activities. She also showed some obsessive–compulsive-type behavior such as counting (cars parked in the street near her house, cars passing on the road), though this behavior did not appear to have the same emotional quality as a true obsessive–compulsive disorder, since being prevented from counting (by distraction for example) did not seem to have any significant emotional consequences for her—as she simply started counting again. These problems had persisted for 7 years and her husband had given up his job to care for her.

Neuropsychological Functioning

Neuropsychological test data are provided in Table 1. R.P. has a WAIS–R full scale IQ that was identical to her pre-

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Table 1. R.P.'s Neuropsychological data

Test	Score
WAIS–R	
Full Scale IQ	98
Verbal IQ	94
Performance IQ	107
National Adult Reading Test (NART)	
Total errors	26/50
Estimated premorbid IQ	98
Spot the Word (scaled score)	7
Semantic Processing Test (scaled score)	8
Graded Naming Test	16/30 (between 10th and 25th percentile)
Rivermead Behavioural Memory Test	
Standardized Profile score (out of 24)	22 (control $M = 22.19$; SD 1.94)
Doors and People Test (scaled scores)	
People (verbal recall)	7
Doors (visual recognition)	11
Shapes (visual recall)	16
Names (verbal recognition)	12
Modified Wisconsin Card Sorting Test (Nelson, 1976)	
Categories	5 (Nelson controls $M = 5.0$)
Total errors	17 (Nelson controls $M = 9.2$, SD 8.5)
Perseverative errors	2 (Nelson controls $M = 5.2$, SD 3.9)
Verbal Fluency	
Letters (FAS 60s)	11 (*impaired*: predicted score, based on NART score = 38, discrepancy $p = <.05$)
Animals (60s)	12 (*impaired*)
Trail Making Test	
Trails A	58s (~25th percentile)
Trails B	132s (~25th percentile)
Behavioural Assessment of the Dysexecutive Syndrome	
Total Profile score	13/24
Age-Corrected Standardized score ($M = 100$, $SD = 15$)	73
Test of Everyday Attention (scaled scores)	
Map search 1	11
Map search 2	12
Elevator counting	Normal
Elevator counting with distraction	6
Visual elevator	5
Telephone Search	6
Telephone Search dual task	7
Lottery	4

morbid IQ predicted on the basis of the National Adult Reading Test score (Nelson & Willison, 1991). On the Rivermead Behavioural Memory Test (Wilson et al., 1985) she scored in the normal range and her overall score on the Doors and People test battery (Baddeley et al., 1994) was above average, though her score on the verbal recall subtest was a little weak, though still in the normal range. She was a little weak, but not impaired on the Modified Wisconsin Card Sorting Test (Nelson, 1974), a little slow on Trails A and B (Heaton et al., 1991), but was severely impaired on verbal fluency, producing a total of only 11 words for the letters *F*, *A*, & *S* (60s each letter). On the basis of Crawford et al.'s (1992) regression equation, her predicted verbal fluency score based on her NART error score of 26 was 38. A discrepancy between predicted and obtained scores on the verbal fluency task of more than 15 items is significant at the 5% level. Her performance on animal fluency is also impaired (see Lezak, 1995). On the Behavioural Assessment of the Dysexecutive Syndrome (Wilson et al., 1996) her score reflects her difficulty with planning and strategy application, and her scores on the Test of Everyday Attention (Robertson et al., 1994) reflect the presence of attentional impairment, particularly affecting sustained attention (Lottery task). In summary, R.P.'s general level of intellectual and memory functioning is normal on neuropsychological testing, but she appears to have

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selective impairments of executive and attentional functioning consistent with frontal lobe damage.

Relating her problems to the models of frontal lobe dysfunction described earlier, R.P. appears to be a striking example of the sort of patient described by Luria in that she fails to act, despite memory of the intention to act. However, this explanation does not seem to be sufficient to capture all of the problems she experiences. For example, sometimes she does act, but may be distracted prior to task completion or she may act impulsively, failing to plan appropriately. With regard to the latter set of problems the characterizations of frontal dysfunction provide by Baddeley (1986) and Shallice (1988) capture better the nature of these latter problems.

Identification of Target Behaviors for Intervention

We used a modified version of the Sunderland et al. (1983) memory questionnaire, in combination with discussion with both R.P. and her husband to identify a number of tasks she clearly failed regularly to do at the right time without prompting from her husband. From the list of actions generated from this process we selected a subset of tasks occurring relatively frequently that would also be possible to monitor throughout the course of the study. These included the following:

1. Taking medication (at 9:00 A.M. and 6:00 P.M.).
2. Watering plants: R.P. likes to have house plants, but frequently forgot to water them during the hot summer in which the study was carried out. On some occasions she remembered, but at inconvenient times, such as when her husband was about to serve dinner, which caused problems, especially as R.P. would insist on carrying out the task involving moving all the plants to the kitchen sink and standing them in water.
3. Washing underwear: R.P. has prosthetic underwear as a consequence of an earlier mastectomy. As she has only a small number of this particular piece of underwear, she needs to wash them regularly so that she always has clean underwear. She would occasionally forget to do this, which caused her great distress.

Data relating to the frequency of problems with each of the above tasks will be presented in relation to the NeuroPage intervention below. Two other tasks that were monitored were R.P.'s attendance at a voluntary job, and planning the evening meal. R.P. helped at a baby clinic weekly or biweekly, helping to weigh babies and doing other routine tasks. However she would occasionally forget to go, which, like her other failures of this sort, caused her much distress. Each afternoon, R.P.'s husband went to pick up their daughter from school. While he was away, R.P. would often start to get the evening meal ready, but would frequently do this in a poorly planned and disorganized way, starting all parts of the meal at the same time or combining foods that did not go well together or consuming food that was meant for dinner, for example, consuming all but a handful of strawberries intended for desert.

The problems identified above, characterized as situations in which R.P. failed to carry out appropriately timed actions, were treated with the NeuroPage, as described later. The other main problem identified by both R.P. and her husband was the length of time she spent in the bath in the mornings. This was frequently up to 80 or 90 min, which, added to the fact that she also took a long time with other aspects of the morning routine, meant that getting ready to go out could take up to 4 or 5 hr. This was preventing her from doing other things such as attending a day center for people with brain injury, despite her expressed desire to attend. It also meant that if there was something specific they needed to do outside of the house in a morning then her husband would have to get up extremely early in order to start the process of getting R.P. ready.

The bathing problem was treated by the use of a checklist and in the following sections we describe the treatment methods, experimental design and results, first for the NeuroPage study and then for the checklist intervention for the bathing problem.

Treatment Methods and Experimental Design: NeuroPage

An ABAB single-case experimental design was used to evaluate the impact of NeuroPage on the target actions identified (see Wilson, 1987 for a discussion of the use of single-case experimental designs in neuropsychological rehabilitation). Each target action was monitored during a 3-week baseline (A^1) phase; R.P. recorded the time she took her medication as soon as she had taken it (a time limit was set so that if she had not taken the medication within about 90 min of the allotted time, her husband reminded her) and the time in terms of minutes deviation from the allotted time was calculated. For the other target actions (watering plants, washing underwear) a simple record of whether or not she carried out the action at the time set was kept by her husband.

After the baseline phase was completed, the intervention (B^1) phase began and the pager was introduced to R.P. Reminders for the target actions were entered on to the central computer located in our department. We were careful to discuss with R.P. each of the target tasks to be certain that she agreed to all of them being included, since it is our experience that when the action is more for the benefit of a spouse–carer and the patient is indifferent about its inclusion then the reminder is often ineffectual. As well as the specific targets identified for the purpose of the evaluation study, other reminders were also entered for less frequently occurring things such as appointments, social events, etc. R.P. kept the pager for a period of 3 months and monitoring of the target actions continued throughout this period.

After 3 months the pager was withdrawn as part of a return to baseline (A^2) phase lasting 3 weeks, after which the

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pager was reintroduced (B^2). Monitoring of performance on each of the targeted actions continued throughout all four of the study phases.

Results: NeuroPage

Figure 1 shows the time deviation (in minutes) from the intended time for taking the 9:00 A.M. and 6:00 P.M. medication during the four phases of the study. Table 2 summarizes the results, showing mean deviation in minutes (ignoring the direction of deviation) for each of the four phases of the experiment, for each of the two target times. Figure 2 shows success or failure for the other target actions (washing of underwear and watering the plants) over each of the four phases of the study. It has been argued (see Morley, 1989) that if the results of an intervention are likely to be of any clinical significance then the effect of that intervention should be clear from a graphic presentation of the data, without the need for statistical analysis. It is clear from the data shown in the figures here that the pager had a marked effect on the probability of R.P. carrying out her intended actions at the appropriate time. One aspect of the data that does however warrant some statistical analysis is the apparent reduction in mean time deviation (from target time for medication) from the first baseline A^1 phase to the second return to baseline A^2 phase,

Table 2. Mean deviation (in minutes, ignoring sign) from target time for taking medication for 9:00 A.M. and 6:00 P.M. medication during each of the experimental phases

	Phase			
	A^1	B^1	A^2	B^2
Target time	Baseline	NeuroPage	Return to baseline	Return to NeuroPage
9:00 A.M.	41.09	3.52	21.75	0.75
6:00 P.M.	42.14	3.33	28.76	0.00

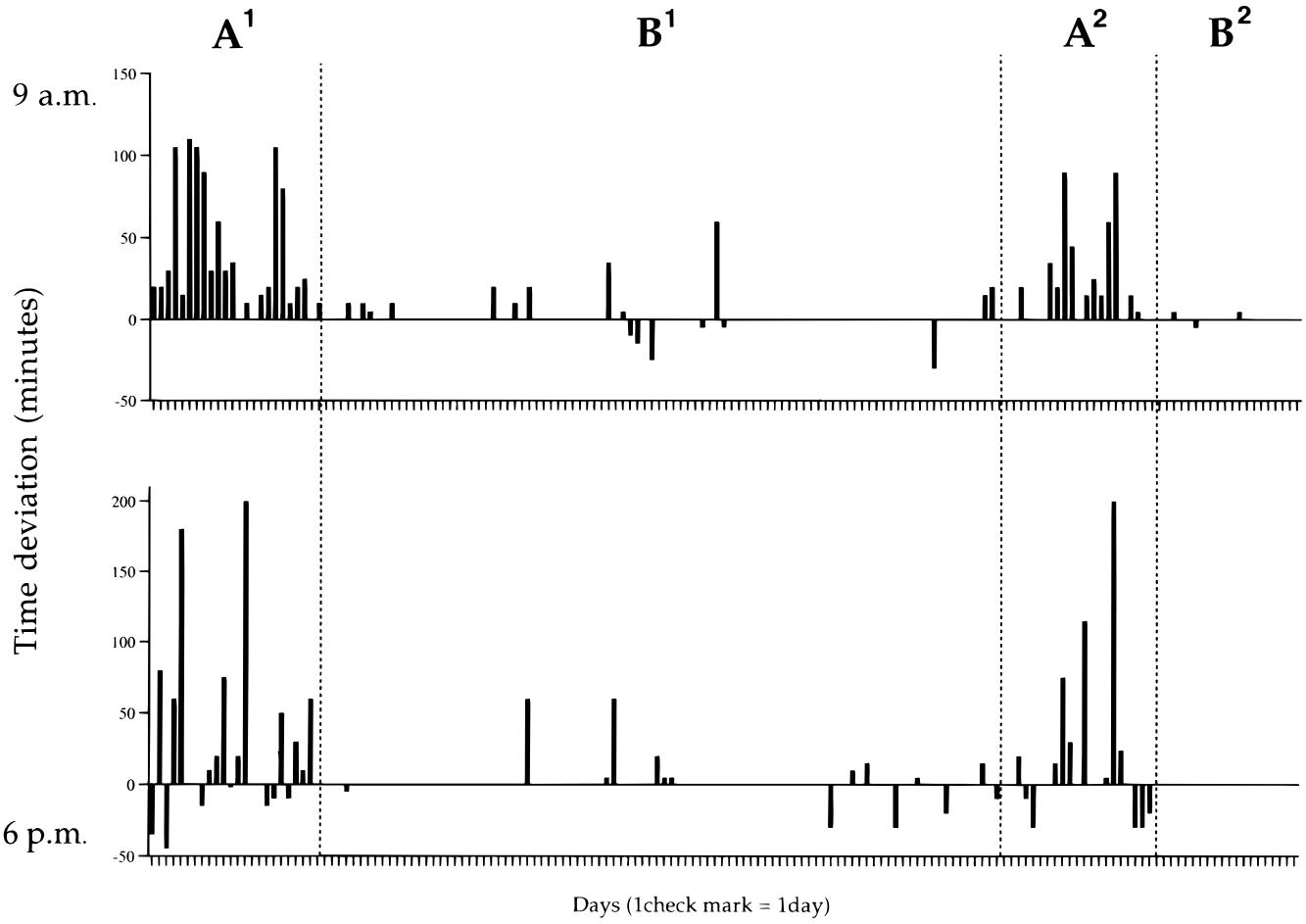

Fig. 1. Graph showing the deviation (in minutes) from the target time for taking medication, at 9:00 A.M. and 6:00 P.M. over the period of the four study phases: A^1 (*baseline*); B^1 (*NeuroPage introduced*); A^2 (*return to baseline*); B^2 (*reintroduction of NeuroPage*). Note that the absence of a line deviating from 0 min means that the medication was taken on time.

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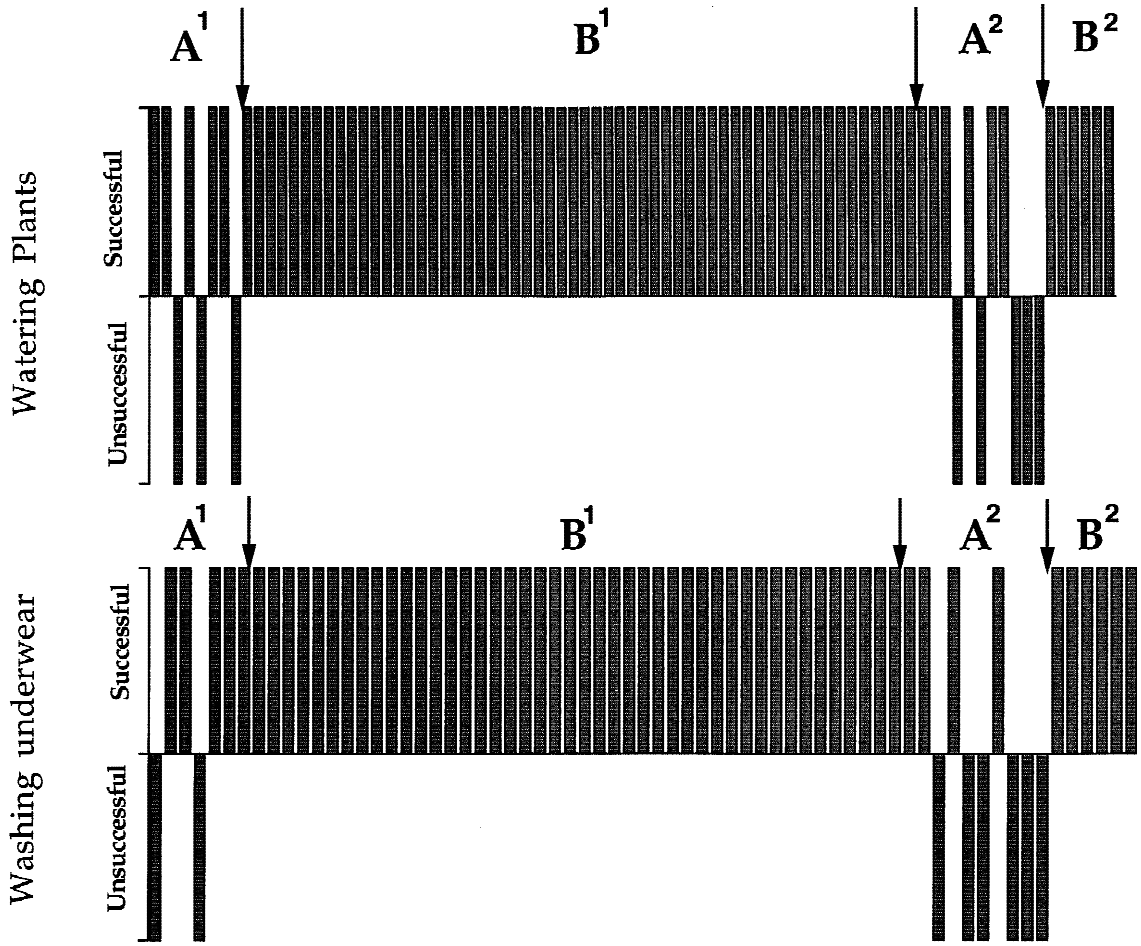

Fig. 2. Graph showing the success or failure of performing the two targeted actions; watering plants and washing underwear over the period of the four study phases: A^1 (*baseline*); B^1 (*NeuroPage introduced*); A^2 (*return to baseline*); B^2 (*reintroduction of NeuroPage*).

as illustrated in Table 2. A lag 1 autocorrelation analysis on data from each of the *A* phases indicated that there was no significant serial dependency in the data in any of the phases (9:00 A.M. A^1 phase $r = .290$, $p = .194$; 9:00 A.M. A^2 phase $r = .272$, $p = .280$; 6:00 P.M. A^1 phase $r = -.151$, $p = .508$; 6:00 P.M. A^2 phase $r = -.121$, $p = .615$), which meant that conventional *t* tests could be applied to the data (Herson & Barlow, 1976). A comparison of the 9:00 A.M. *A* phases (A^1 and A^2) failed to reach statistical significance ($t[40] = 1.901$, $p = .06$) and there was also no difference between the 6:00 P.M. *A* phases ($t[42] = 0.831$, $p = .41$).

R.P. also used the pager to remind her to attend her voluntary job and to instruct her to plan what needed to be prepared for the evening meal when her husband was out collecting their daughter from school. Reports from R.P.'s husband indicated that the pager was effective in both of these tasks. In particular, while she had the pager there were no occasions when she started preparing the evening meal without having planned what to do first.

Treatment Method, Experimental Design, and Results: Bathing

In relation to R.P.'s problem of staying in the bath for an excessively long period of time it became clear, following discussion with R.P. and her husband, that a significant part of the problem was an obsessive–compulsive-like ritual of having to wash each of 31 different body zones for a particular length of time. Initial monitoring of the time spent in the bath showed that this was almost always about 1 hr, 20 min, this time primarily determined by the fact that after this length of time R.P.'s husband would go to the bathroom and tell his wife to get out of the bath. R.P. said that she wanted to cut the time she spent in the bath down dramatically (her own target was 30 min), but despite this motivation she consistently failed to reduce the time. Although it was not appropriate to observe R.P.'s bathing routine (a procedure that might well have changed it anyway), through discussions with her it seemed likely that there were a number of factors causing her to take so much time over bath-

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ing. In particular it seemed that she would often lose track of where she was in her sequence of 31 body zones and therefore go back and wash areas she had already washed.

Following an initial period of simply monitoring the time spent in the bath (monitoring carried out by R.P.'s husband) a checklist of body areas was introduced for R.P. to use while bathing. R.P. was asked to use a pen to tick off each body area once it had been washed and move onto the next. It was hypothesized that this would prevent her from losing track of where she was up to in a sequence. It was also suggested to R.P. that the number of body areas be cut down from 31 to 9 (actually eight body areas and her glasses, which she always washed at the end of the sequence), on the assumption that this would also reduce the time taken. Figure 3 shows the record of time spent in the bath, the experimental design being an ABCAC design. During the baseline monitoring (Phase *A*) the time of 80 min was determined by the fact that after this length of time R.P.'s husband would go to the bathroom and tell R.P. to get out of the bath. It can be seen that the initial introduction of the checklist (Phase *B*) had little impact on R.P.'s times. At that stage, the time was still being recorded by her husband. Given R.P.'s impairments in planning and foresight we hypothesized that she was perhaps having difficulty relating her performance of the bathing routine to the overall time it was taking and its adverse consequences (such as not being able to take part in other activities). It was therefore decided to ask R.P. to use her checklist, but also to record the time taken at the end of each bath (Phase *C*). As Figure 3 shows, the intervention had a considerable impact on her times, which fairly rapidly reduced to around 40 min. After $3\frac{1}{2}$ months the checklist was removed to see if the improved times would continue (Phase *A*). However, over the period of the next month the times gradually increased again to their baseline levels. With the reintroduction of the checklist (Phase *C*) the times once again returned to a satisfactory level of around 40 min.

Discussion

For 7 years post-CVA, R.P. has had problems with the appropriately timed initiation of intended actions. Despite relatively preserved memory functioning, she frequently failed to carry out her intentions, set off to do one task, but became distracted before or during the task, or failed to plan before carrying out tasks and consequently made errors. The specific problem of spending too much time in the bath in the mornings seemed to be caused primarily by engaging in a stereotyped sequence of washing, with the additional problem of often forgetting where she was in the sequence and

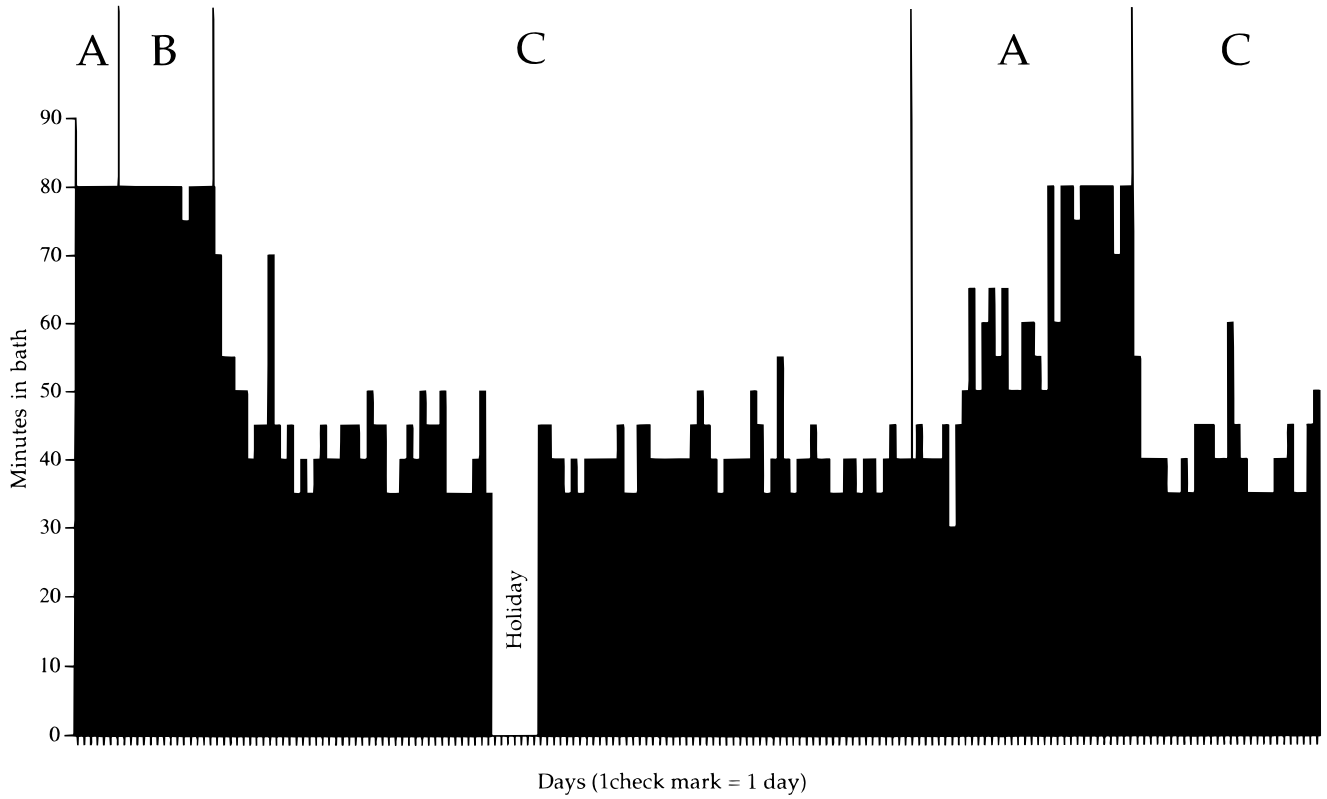

Fig. 3. Graph showing time spent in the bath over the five phases of the study: *A* (*baseline*); *B* (*checklist introduced*); *C* (*checklist plus R.P. puts time spent in bath in checklist*); *A* (*return to baseline*); *C* (*return to checklist plus putting time on checklist*).

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then going back to the beginning of the sequence once again. Both interventions described here, the NeuroPage and the bathing checklist, had a dramatic effect on R.P.'s functioning. The fact that she could get out of the bath in a reasonable time meant that she could attend the day center that she had previously been unable to get to on time. The fact that she could manage her own medication, deal with her plants, wash her underwear and go to her voluntary job, all without the need to be prompted by her husband, gave her more independence and at the same time relieved some of the pressure on him. Her husband frequently comments now that he feels considerably less burdened with the responsibility of always having to prompt R.P. to do things. Being able to return home after picking up their daughter from school and not find the kitchen in some chaos (since R.P. had a NeuroPage message telling her to *plan* the meal) was a considerable relief to R.P.'s husband.

A question raised by this study is why the NeuroPage was so effective when R.P.'s own self-generated intentions apparently failed to prompt the initiation of action at appropriate times. A further question is whether the results of this intervention provide evidence as to which of the theoretical models of frontal dysfunction described earlier might best account for R.P.'s problems. The description of her problems in combination with the neuropsychological analysis suggested that different aspects of her problems could be best explained by different models of frontal dysfunction and no single model seemed to account for all of the presenting complaints. Nevertheless, it is appropriate to ask whether her response to the two interventions offers further insight into the nature of the underlying cognitive deficit (or deficits).

R.P. noted that at times she "intends" to do something, but simply does not initiate the action and it was discussed earlier how this fits with a Luria–Duncan account of frontal dysfunction that emphasizes the verbal regulation of action. However, another hypothesis for this deficit is in terms of an attentional–arousal problem, which might suggest that her level of arousal is not sufficient to initiate action, but the bleeping of the pager increases her arousal level over some threshold thus enabling her to initiate an action and also to sustain her attention to that action once initiated. As noted earlier, one of the problems she had reported previously was that she would go to do one task, but get distracted along the way by something else. To our knowledge this never happened with the pager. Robertson et al. (1995) demonstrated that it was possible to improve sustained attention in a series of patients by the use of an alerting procedure that initially involved the tester banging a desk and saying loudly "attend" at random intervals; over the course of the intervention training period the patients learned first to say aloud to themselves "attend" and then to say it covertly to themselves. Teaching patients this technique brought about improvements in sustained attention, and also improved performance on tests of unilateral neglect. Robertson et al. argued that the arousal technique worked by enhancing the performance of a noradrenaline-based right frontal sustained attention system (having a modulating effect on the posterior spatial orientation system). For R.P. there is radiological evidence of a right frontal lobe lesion and also neuropsychological evidence of a deficit in sustained attention. We hypothesize that in the present case of R.P., the bleeping of the pager actually brought about an increase in attentional arousal, thus enabling the initiation of action to take place. The increased arousal also improved R.P.'s ability to sustain her attention over the time period required to carry out an action.

If the only critical aspect of the functioning of the pager was the bleeping, then it should have been possible to use a more simple alarm (such as a watch alarm) to alert R.P., since her memory for the intended actions was good. This would have provided a critical test of the "Lurian" explanation of her deficits in that if a simple alarm had a positive effect on her ability to control her actions then there might be less evidence for an explanation based on the importance of verbal control of action. However, R.P. was reluctant to do this since she felt strongly that, although when the pager goes off she usually knows what the message will say, actually having the text of the message presented was also important in enabling her to carry out the action. It seemed that the fact that the instruction to act came from an external source was important (though ultimately of course all the instructions included on the NeuroPage were generated by R.P. herself). This then provides support for the notion that the critical problem can be thought of in terms of a Luria–Duncan explanation relating to the verbal control of action. Another possibility of course is that each of the various models is useful in capturing different aspects of R.P.'s problems and that the Neuropage, with its combination of external verbal control and arousing bleeping actually acts on the different areas of deficit simultaneously.

With regard to the bathing problem, R.P.'s behavior had many of the characteristics of an obsessive–compulsive ritual. Recent theoretical accounts of obsessive–compulsive disorder (OCD) have argued that there may be an underlying neuropsychological impairment present in OCD, and in particular an impairment in memory for performed actions (see Tallis, 1997). Because people with OCD may fail to remember accurately whether an action has actually been performed, they feel a lack of confidence in whether the action has indeed been performed and therefore experience the need to check and recheck. Could this hypothesis account for R.P.'s behavior? One of the ways in which R.P.'s behavior seems to differ from that of someone with OCD is that a failure to complete the ritual does not provoke an anxiety response. It was noted earlier that R.P. also has counting rituals, such as counting cars parked in the street or cars that pass by when R.P. and her husband are out. Once again however, both she and her husband reported that there was no anxiety response if she was prevented from counting, for example if she is distracted by engaging in conversation. She simply started counting again later. It seems therefore that her behavior is more like an habitual or stereotypical behavioral routine triggered in particular situations. De-

spite the lack of anxiety associated with the rituals, it could still be the case that an OCD-type impairment in R.P.'s memory for actions is what causes her problems in the bath. However, another possible explanation is that the impairment in the ability to sustain concentration means that she becomes distracted, loses track of where she is, and so starts the sequence over again. Her poor planning–problem-solving skills clearly contribute to her inability to adopt a more practical solution (than starting over again) when she does lose track. The aim of providing R.P. with the checklist was simply to provide her with a way of keeping track of where she was in her routine and to cut down the number of separately specified body areas involved, in order to reduce the time spent washing. So although the checklist was not bringing about an increase in arousal and sustained attention (and hence reducing distractibility) in the way it was hypothesized the NeuroPage was doing, it might instead be conceptualized as compensating for an attentional deficit, in that when R.P. was distracted she could nevertheless still pick up her washing routine at the appropriate point in time. However, the introduction of the checklist did not actually reduce the time spent in the bath, which might suggest that neither an account in terms of an OCD-type impairment in memory for actions nor a sustained attention deficit are good explanations of this particular problem. What seemed to bring about the reductions in time was when R.P. started to place the time spent in the bath on the daily record sheet. Since the record sheet covered 1 week, R.P. could see the time she had spent in the bath each previous day. Throughout the course of the baseline monitoring period R.P. expressed a strong motivation to reduce the time spent in the bath. The presence of the time for previous days on the checklist seemed to increase further her motivation and, perhaps more importantly, we hypothesize, it provided her with a more concrete representation of the relation between her actions and the consequences of her actions (i.e., the time spent). Given the fact that R.P. had difficulties with planning and foresight we had hypothesized that part of the problem may have been an inability to relate her actions to their consequences, and it did seem to be the case that the presence of the time on the checklist facilitated this process. If recording the time was the most important factor, then simply doing this and not using the checklist of body areas might have been equally effective in keeping the time down. However we were not able to test this hypothesis because when the second baseline period was over (during which the time had returned to around 1 hr, 20 min and was once again disrupting the lives of R.P. and her husband), both R.P. and her husband were keen to return to the previously successful formula of the checklist plus time recording.

In conclusion, in this paper we have demonstrated the efficacy of two external aids, the NeuroPage and a checklist, for treating what we have conceptualized as executive impairments of action in a woman with frontal lobe damage. External aids such as these, more typically associated with rehabilitation of memory functioning, are clearly useful in the rehabilitation of executive functioning impairments. In particular the NeuroPage system may have a role not simply as a mnemonic reminder, but as an alerting device that may improve both initiation and sustained attention, and thus enable successful task completion in people who would otherwise be likely to be distracted before carrying out an intended task.

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