

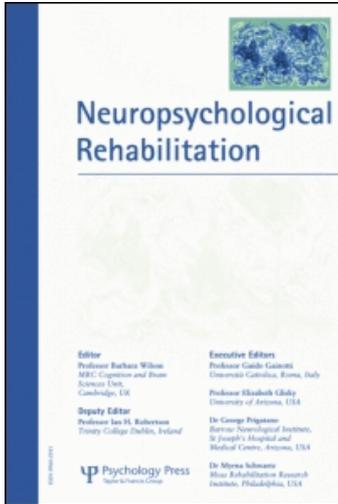
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### How intensive does anomia therapy for people with aphasia need to be?

Karen Sage<sup>a</sup>; Claerwen Snell<sup>a</sup>; Matthew A. Lambon Ralph<sup>a</sup>

<sup>a</sup> Neuroscience and Aphasia Research Unit (NARU), School of Psychological Sciences, University of Manchester, UK

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## How intensive does anomia therapy for people with aphasia need to be?

**Karen Sage, Claerwen Snell, and Matthew A. Lambon Ralph**

Neuroscience and Aphasia Research Unit (NARU), School of Psychological Sciences, University of Manchester, UK

The intensity of aphasia therapy has been a key clinical question. The aim of this case-series study was to compare the outcome of intensive and non-intensive therapy in the relearning of words for people with aphasia. Eight participants took part in a study comparing the intensity of delivery of the therapy. Participants received two courses of the same therapy (each lasting 10 sessions) delivered either intensively or non-intensively. Therapy consisted of confrontation naming with progressive phonemic and orthographic cues. Post-therapy assessments were carried out immediately after the study and one month later. Performance was also monitored during each therapy session. Immediately post-therapy, both types of therapy had improved naming accuracy considerably and there was no significant difference between the two interventions. One month later, seven out of eight participants showed a small yet significant difference in naming accuracy, favouring non-intensive over intense therapy. There were no differences in the learning patterns during the therapy sessions between the intensive and non-intensive therapies. For the majority of people with aphasia post-stroke, both intense and non-intense therapy for anomia leads to improved naming performance. Retention at one-month post therapy is relatively superior after non-intensive therapy.

**Keywords:** Aphasia; Anomia; Intensity; Therapy; Learning.

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Correspondence should be sent to Karen Sage, Neuroscience and Aphasia Research Unit (NARU), Zochonis Building, School of Psychological Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, UK. E-mail: karen.sage@manchester.ac.uk

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## BACKGROUND

An answer to the question of how intensive (or frequent) therapy needs to be to achieve the best outcome for people with aphasia after stroke is of great importance to the planning of speech and language therapy. Yet it has only been addressed on a relatively ad hoc basis. A recent meta-analysis covering studies between 1975 and 2002 (Bhagal, Teasell, & Speechley, 2003) selected eight studies which suggested that intensive therapy (defined as on average 8.8 hours per week for 11.2 weeks; average 98.4 hours total therapy) resulted in significant improvement in aphasia whereas lower intensity input (defined as 2 hours per week for 22.9 weeks; average 43.6 hours total therapy) compromised therapy outcomes. Criticism levied at this analysis (Marshall, 2008) questioned the selectivity of studies included, noting in particular the lack of studies demonstrating positive effects from less intensive treatments. In addition (see figures above), many studies included a confound in that the intensive condition often involved a greater amount of total therapy time. This unresolved debate demonstrates the need for a prospective investigation into the question of how intensive optimal treatment for aphasia needs to be.

The current study systematically investigated intensity in anomia therapy for people with aphasia to address the following questions: (1) What is intensive treatment in the context of anomia therapy? (2) Can a difference in naming accuracy be demonstrated between intensive and non-intensive therapies when total therapy input is controlled? (3) Which approach produces better retention of learned items? (4) Do intensive and non-intensive therapies produce a similar pattern of learning during therapy?

There has been no straightforward or consistent definition of intensive therapy in the field of aphasia. It has been defined either in terms of the number of hours per week (Hinckley & Craig, 1998) or, more generally, as “therapy that is delivered at a rate that is greater than usual” (Hinckley & Craig, 1998). In studies where the therapy was classified as “intensive”, the range varied between five (Denes, Perazzolo, Piani, & Piccione, 1996) and 25 (Hinckley & Craig, 1998) hours per week and the time period within which the therapy was delivered ranged from five days (Pulvermuller et al., 2001) to eight weeks (Poock, Huber, & Willmes, 1989). Where therapy input was classified as “non-intensive”, it has ranged from less than three (Hinckley & Craig, 1998) to five hours per week (Hinckley & Craig, 1998), with the therapy period ranging from six (Hinckley & Craig, 1998) to 24 weeks (Denes et al., 1996). Therefore, the range of what has been considered to be intensive therapy varies greatly, overlapping with what has been considered to be non-intensive elsewhere (Hinckley & Craig, 1998; Denes et al., 1996).

Some studies have suggested that intensive therapy was more effective/beneficial than non-intensive therapy immediately post-therapy and/or after

a period of time without therapy (Szaflarski et al., 2008; Bhogal et al., 2003). However, most studies compared intensive therapy either to no therapy at all (Poeck et al., 1989) or to a different kind of therapy (Pulvermuller et al., 2001), thus precluding them from concluding that intensity per se was the key element in their success. No previous study has compared the same treatment method over the same total number of treatment hours while varying only the intensity of delivery (Denes et al., 1996; Hinckley & Craig, 1998). In addition, no studies have investigated whether learning patterns differed across participants during the delivery of the intensive and non-intensive therapy since reports have focused on post-therapy performance only (Hinckley & Craig, 1998; Denes et al., 1996; Hinckley & Carr, 2005; Pulvermuller et al., 2001).

A recent addition to the debate has come from studies of constraint-induced aphasia therapy (CIAT) (Pulvermuller et al., 2001) for which intensity was a key principle; therapy was delivered for three to four hours every day for two weeks. Another principle of this therapy was that the aphasic individual practised the very task they found most difficult (i.e., speech) while other methods of communication (e.g., writing and gesture) were inhibited. CIAT was developed from ideas arising from constraint-induced movement therapy (CIMT) (Taub, Uswatte, & Pidikiti, 1999) which was originally devised as a treatment for upper limb paresis. Standard CIMT (Taub et al., 1999) constrained the unaffected arm (by placing it in a sling) and forced the use of the paretic arm for six hours a day over two weeks. Standard (i.e., intensive) CIMT has been compared to a less intensive (three hours per day) delivery (Sterr et al., 2002) but in this study both therapies were delivered for two weeks so that those who underwent the standard six hour treatment effectively received twice as much therapy as those undergoing treatment three hours a day. This factor alone (more treatment as opposed to more intensively delivered treatment) might have accounted for the observed advantage of the standard six hour group (Sterr et al., 2002). No CIMT studies reported on the performance of patients in the course of intensive versus non-intensive treatment. As with the aphasia studies, CIMT has either been compared against different types of treatment (Boake et al., 2007) or against different amounts of treatment in terms of total number of therapy hours (Sterr et al., 2002).

Research into motor skill learning in normal participants has controlled for some of these confounds. In these studies, the task and number of hours were kept constant whilst the learning schedule was varied (Mackay, Morgan, Datta, Chang, & Darzi, 2002; Moulton et al., 2006; Dail & Christina, 2004). However, the learning schedules used here were considerably different from those applied in aphasia therapy. For example, intensive learning varied from 20 minutes (Mackay et al., 2002) to one day (Dail & Christina, 2004) while non-intensive varied from 20 minutes with a 2.5 minute break every

five minutes (Mackay et al., 2002) to four weeks of one session per week (Moulton et al., 2006). The time to follow-up testing also varied from five minutes (Mackay et al., 2002) to one month (Moulton et al., 2006). When type of task and number of training hours were kept constant, there was either no difference between the intensive and non-intensive conditions immediately post-training (Moulton et al., 2006) or the non-intensive condition was shown to have an advantage (Dail & Christina, 2004). At follow-up, participants who underwent the non-intensive condition outperformed those from the intensive condition (Dail & Christina, 2004; Moulton et al., 2006).

While some of the methodological issues applicable to aphasia therapy have been addressed in studies of motor skill learning, it remains unclear how effective these learning schedules are to speech and language therapists providing aphasia therapy under standard NHS service provision. The goal of the present study, therefore, was to investigate the intensity of therapy by manipulating this factor whilst keeping the total number of hours, the treatments and the participants constant.

## MATERIALS AND METHODS

### Participants

Eight participants (2 females, 6 males; mean age 61.25 years,  $SD = 8.05$ ) with chronic aphasia (mean time post-onset 58.25 months,  $SD = 41.11$ ) following cerebrovascular accident (CVA) were recruited from local NHS speech and language therapy services and stroke clubs in North West England. All showed word finding difficulties with scores at least 2 standard deviations below the mean on both the Boston Naming Test (Goodglass, Kaplan, & Barresi, 2001) and the Graded Naming Test (Warrington, 1997). Participants were right handed, native English speakers and literate prior to their stroke. People with co-existing neurological problems, severe perceptual or cognitive deficits were excluded from the study. The study was approved under the NHS LREC procedure and informed consent was obtained from all patients. Participants underwent comprehensive language (see Table 1) and cognitive (see Table 2) assessment in order to examine whether an individual's therapy results could be attributed to their aphasiological and neuropsychological profile.

### Treatment

All participants underwent two courses of naming therapy delivered under two conditions (intensive vs. non-intensive). In both conditions there were 10 sessions of equal duration. The intensive condition was completed in

TABLE 1  
Background language results

<i>Participant</i>		<i>SM</i>	<i>ER</i>	<i>JM</i>	<i>SS</i>	<i>PR</i>	<i>JA</i>	<i>IH</i>	<i>SB</i>	<i>Normal Cut off</i>
<i>Test</i>	<u>Max</u>									
BNT	60	9 (1)	23 (2)	28 (3)	29 (4)	36 (5)	38 (6)	39 (7)	43 (8)	36 <sup>a</sup>
GNT	30	4 (1)	5 (2)	8 (3)	11 (6)	8 (3)	13 (7)	16 (8)	10 (5)	12.2 <sup>a</sup>
P&PT	52	33 (1)	47 (6)	46 (4)	42 (2)	47 (6)	46 (4)	42 (2)	<b>50 (8)</b>	49
PALPA 2	72	56 (3)	64 (4)	<b>71 (6)</b>	<b>68 (5)</b>	<b>68 (5)</b>	<b>72 (4)</b>	53 (2)	51 (1)	65
FAS		4 (1)	11 (7)	17 (8)	9 (4)	10 (6)	8 (3)	9 (4)	5 (2)	21.8
Category fluency		1 (1)	21 (6)	<b>36 (8)</b>	18 (4)	<b>30 (7)</b>	17 (3)	20 (5)	10 (2)	29.2
Synonyms judgements	96	*(n/a)	75 (5)	66 (4)	82 (7)	77 (6)	58 (1)	62 (2)	63 (3)	91
Cookie theft picture description wpm		1.2 (1)	24.6 (2)	<b>54.8 (6)</b>	<b>60 (7)</b>	<b>81.4 (8)</b>	34 (4)	36 (5)	31 (3)	53
PALPA 31 Reading (Img x Freq)	80	36 (1)	46 (2)	<b>79 (8)</b>	75 (6)	61 (4)	74 (5)	78 (7)	59 (3)	79
PALPA 9 Repetition (Img x Freq)	160	126 (7)	49 (1)	128 (5)	139 (8)	107 (4)	112 (3)	115 (5)	97 (2)	154 <sup>b</sup>
PALPA 36 Reading (length)	24	0 (1)	0 (1)	13 (7)	12 (6)	5 (4)	0 (1)	21 (8)	6 (5)	23
Fluency		NF	NF	F	F	F	NF	F	F	

BNT = Boston Naming Test (Goodglass et al., 2001); GNT = Graded Naming Test (McKenna & Warrington, 1983); TROG = Test for the Reception of Grammar (Bishop, 1989); P&PT = Pyramids and Palm Trees (Howard & Patterson, 1992); PALPA = Psycholinguistic Assessment of Language Processing in Aphasia (Kay, Lesser & Coltheart, 1992); Img = Imageability; Freq = Frequency; NF = non-fluent, F = fluent. Underlined and **emboldened** scores were within the normal range. Numbers in parentheses indicate participants within group ranking. n/a = not available.

<sup>a</sup>Normal cut off is age dependent all participants are below normal cut off for their age.

<sup>b</sup>Normal cut off for blocked presentation, mixed presentation was administered.

\*Unable to understand task.

TABLE 2  
Background cognitive assessments

<i>Participant</i>		<i>SM</i>	<i>ER</i>	<i>JM</i>	<i>SS</i>	<i>PR</i>	<i>JA</i>	<i>IH</i>	<i>SB</i>	<i>Cut off</i>
<i>Test</i>	<u>Max</u>									
TEA	7	4 (1)	<u>6 (2)</u>	<u>7 (3)</u>	<u>7 (3)</u>	<u>7 (3)</u>	<u>7 (3)</u>	<u>7 (3)</u>	<u>6 (2)</u>	6
TEA/D	10	0* n/a	0* (n/a)	<u>6 (5)</u>	<u>6 (5)</u>	<u>4 (3)</u>	2 (1)	2 (1)	<u>4 (3)</u>	3
Digit span forwards		2 (1)	2 (1)	<u>5 (7)</u>	4 (6)	3 (3)	3 (3)	<u>5 (7)</u>	3 (3)	5
Digit span backwards		0 (1)	<u>2 (3)</u>	<u>4 (7)</u>	<u>4 (7)</u>	<u>2 (3)</u>	0 (1)	<u>3 (6)</u>	<u>2 (3)</u>	2
Rey figure copy %ile	36	25 (5)	15.5 (1)	<u>32 (8)</u>	22 (3)	27 (6)	22 (3)	19 (2)	30 (7)	25–32 dependent on age
		<1	<1	<u>&gt;16</u>	<1	2.5	<1	<1	>16	
Rey figure immediate recall %ile	36	0 (1)	4 (3) 1	<u>24 (8)</u>	2 (2)	<u>18.5 (7)</u>	<u>15 (6)</u>	<u>5 (4)</u>	<u>11 (5)</u>	4–11 dependent on age
		<1		<u>90</u>	<1	<u>82</u>	<u>27</u>	<u>1</u>	<u>4</u>	
Rey figure delayed recall %ile	36	0 (1)	3.5 (3)	<u>21 (8)</u>	1 (2)	<u>14.5 (7)</u>	<u>11 (6)</u>	<u>6.5 (5)</u>	5.5 (4)	3–12 dependent on age
		<1	<1	<u>76</u>	<1	<u>54</u>	<u>7</u>	<u>2</u>	<1	
RCPM	36	24 (1)	24 (1)	31 (6)	29 (4)	30 (5)	32 (7)	27 (3)	35 (8)	
WCST	6	* (n/a)	<u>2 (1)</u>	<u>4 (5)</u>	<u>4 (5)</u>	<u>3 (2)</u>	<u>2 (1)</u>	<u>3 (2)</u>	<u>4 (5)</u>	1
RAVLT	15	0 (1)	6 (6)	2 (2)	9 (7)	2 (2)	2 (2)	5 (5)	9 (7)	13
RAVLT delayed recall	15	0 (10)	3 (6)	5 (8)	0 (1)	1 (5)	0 (1)	0 (1)	4 (7)	10
RAVLT recognition	15	0 (1)	12 (6)	12 (6)	<u>13 (8)</u>	8 (3)	8 (3)	6 (2)	9 (5)	13

TEA = Test of Everyday Attention (elevator counting task) (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994); TEA/D = Test of Everyday Attention (elevator counting task with distraction) (Robertson et al., 1994); RCPM = Raven's Coloured Progressive Matrices (Raven, 1962); WCST = Wisconsin Card Sort Task (Grant & Berg, 1993); RAVLT = Rey Auditory Verbal Learning Test (Schmidt, 1996).

Underlined and **bolded** scores were within the normal range. Numbers in parentheses indicate participants within group ranking.

\*Unable to understand task.

two weeks whereas the non-intensive condition spanned five weeks. Participants were randomised to undertake either the intensive therapy first (SM, PR, and ER) or the non-intensive therapy first (JM, IH, SS, SB, and JA). There was a gap of 5 weeks following the first therapy, during which no therapy occurred before the start of the second therapy. Post-therapy assessments were carried out immediately after each therapy and at one month post-therapy for each of the conditions.

Participants were asked to name 400 pictures on three separate occasions and, from this large baseline, three sets of 30 items (two therapy sets and one control set) were selected for each patient so as to match for baseline naming accuracy, Celex frequency (Baayen, Piepenbrock & Gulikers, 1995), syllable and phoneme length. During therapy sessions, each target picture was presented for naming. If no response was given within 10 seconds or the response was incorrect, progressive phonemic and orthographic cues were provided. A maximum of four cues were provided per picture (ranging from the initial phoneme to the full name). The next cue in the sequence was provided until the target name was produced by the patient or until the full name had been presented by the therapist. The next picture was then presented. The 30 items were presented in this way three times in each therapy session. A record of performance across all three naming attempts during the therapy sessions was recorded.

### Outcome measure

The outcome measure was the accuracy score on the therapy set ( $n = 30$ ), taken immediately after the therapy and one month later. For all post-therapy measures, the therapy and control items ( $n = 60$  items at each testing time) were presented in a random order. Analysis of naming accuracy during the therapy process used the first trial response from the three recorded.

### Statistical analysis

This study used a case-series design to enable data examination at both group and individual level. A  $3 \times 2$  ANOVA compared naming accuracy for intensive and non-intensive therapies at three time points (baseline, immediate, and 1 month). Post hoc *t*-tests determined the direction of any significant results. To establish whether there were performance differences over the duration of the two therapies (i.e., whether the learning patterns within the intensive and non-intensive conditions differed), a  $2 \times 10$  ANOVA was applied to the group data. Differences in individual's performance after intensive and non-intensive therapies were compared using  $\chi^2$ , whilst changes in individual performance on the sets over time (between baseline and post-therapy assessments) were carried out using the McNemar test.

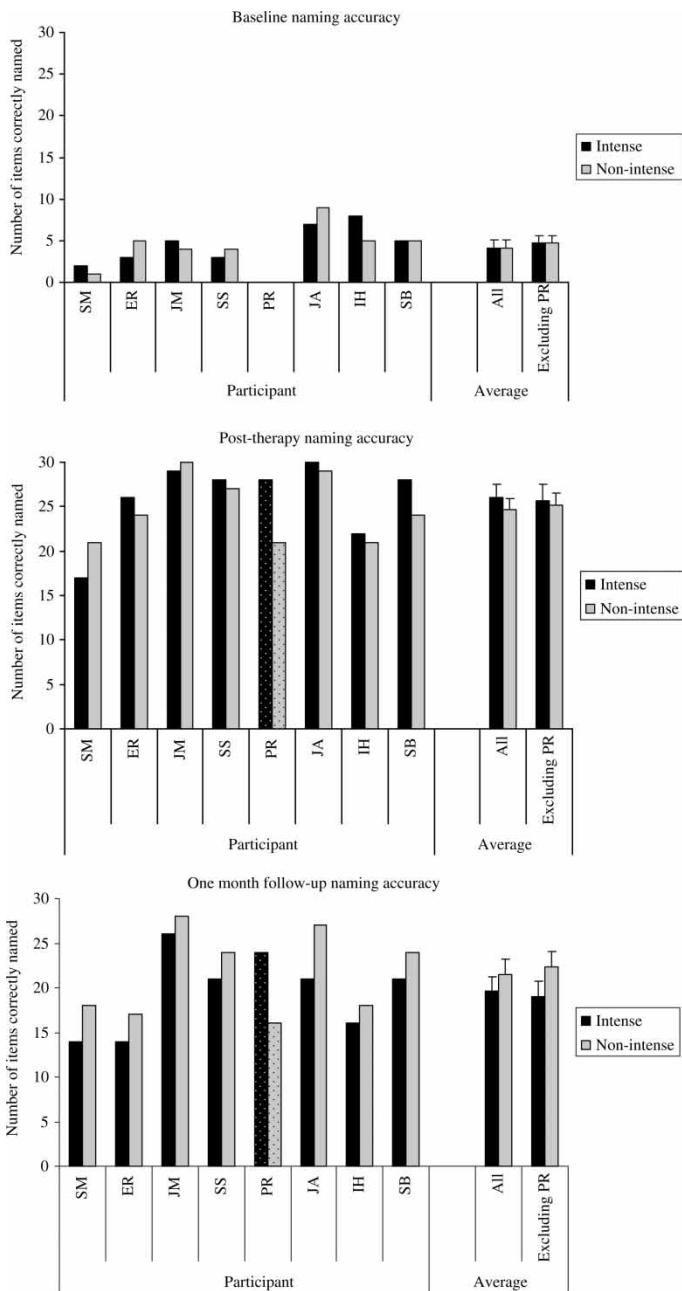
## RESULTS

Group results are presented first followed by individual participant results when these differed from the group performance. The results are provided in two sections: (1) post-therapy assessments, and (2) learning performance during the therapy. All participant results shown in the Figures are ordered by BNT (Goodglass et al., 2001) score (most severe on the far left, least severe on the right). For Figure 1a, 1b and 1c, the group mean and standard error are placed on the far right.

### Post-therapy assessments: Comparison of performance between the intensive and non-intensive therapy sets

The results for the control (untreated) and therapy items are reported separately for simplicity. Group and individual performances at each of the three time points are shown in Figure 1. The ANOVA confirmed that there was a significant effect of therapy – performance increases from baseline to post-therapy:  $F(2, 14) = 173.6, p < .001$ . There was no main effect of therapy type,  $F(1, 7) < 1$  and the interaction failed to reach significance,  $F(2, 14) = 2.96, p = .09$ . This pattern of results was the same, irrespective of which order the two therapies were delivered. When therapy order was added to the ANOVA, there were no interactions with time or therapy type,  $F(2, 12) < 1$ , and no three-way interaction,  $F(2, 12) = 1.2, ns$ . Analysis of individual performance revealed that seven of the eight participants showed no difference in accuracy on either therapy set both immediately post-therapy,  $\chi^2$  between 0.02 and 1.28,  $df = 1, p$  values between .26 and .89, and at one month post-therapy,  $\chi^2$  between 0.07 and 2.56,  $df = 1, p$  values between .79 and .11. However, one participant (PR) was significantly more accurate at naming items after intensive therapy both immediately,  $\chi^2 = 3.94, df = 1, p = .05$ , and at one month post-therapy,  $\chi^2 = 3.61, df = 1, p = .06$ . This result was masking the pattern for the remainder of the group which tended in the opposite direction. The group data were re-analysed, therefore, excluding PR. This revised ANOVA confirmed that the therapy increased naming from baseline to post-therapy, i.e., a main effect of time point:  $F(2, 12) = 139.8, p < .001$ , there was a borderline main effect of therapy type,  $F(1, 6) = 4.2, p = .09$ , and also a significant interaction,  $F(1, 6) = 8.1, p = .006$ . As can be seen in Figures 1b and 1c, this interaction arises from the fact that there was no significant difference in naming accuracy for the two types of therapy immediately after therapy: Figure 1b:  $t(6) < 1$ ; but there was a difference favouring non-intense over intense therapy at follow-up: Figure 1c:  $t(6) = 6.3, p = .001$ .

McNemar tests (summarised in Table 3) were carried out to determine whether participants were learning and retaining items. For intensively and non-intensively delivered therapy, individual performance was compared by



**Figure 1.** Naming accuracy on intense and non-intense therapy sets at baseline (1a), immediately post-therapy (1b), and at one month (1c). Two group averages are shown – one with and one without PR’s data included (see text).

TABLE 3

McNemar  $p$  value (one tailed) results for individual performance on intensive and non-intensive therapy between different time points (baseline and immediate assessment; baseline and one month assessment; immediate and one month assessments)

Participant	Intense			Non-intensive		
	Baseline– Immediate	Baseline– 1 month	Immediate– 1 month	Baseline– Immediate	Baseline– 1 month	Immediate– 1 month
SM	**	**	<i>ns</i>	**	**	<i>ns</i>
ER	**	**	**	**	*	*
JM	**	**	<i>ns</i>	**	**	<i>ns</i>
SS	**	**	*	**	**	<i>ns</i>
PR	**	**	<i>ns</i>	**	**	<i>ns</i>
JA	**	**	**	**	**	<i>ns</i>
IH	**	+	<i>ns</i>	**	**	<i>ns</i>
SB	**	**	<i>ns</i>	**	**	<i>ns</i>

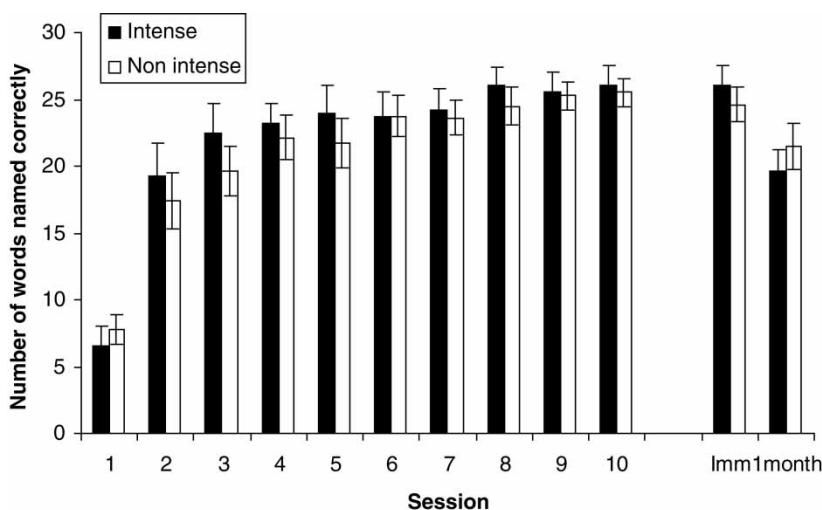
*ns* = not significant;  $+ .10 < p < .05$ ; \* $p < .05$ ; \*\* $p < .01$ .

examining changes in accuracy across baseline and immediately post-therapy, baseline and one month post-therapy and across the two post-therapy assessments (immediate and one month). For both therapy methods (intensive and non-intensive) all participants showed significant learning of items immediately after therapy (that is they were all able to name significantly more items after the therapy than they could at the start). For the non-intensive therapy all eight participants maintained that learning one month after therapy. For the intensive therapy, seven of the eight participants maintained that learning one month after therapy. IH was the only one not to show a significant difference between what he named at baseline and his accuracy one month post-therapy. When accuracy between the two post-therapy assessments was assessed, for the intensive therapy, three (ER: McNemar  $p = .008$ ; SS: McNemar  $p = .016$ ; JA: McNemar  $p = .008$ ) out of eight participants showed a significant drop in naming accuracy while for the non-intensive therapy, one of the eight (ER: McNemar  $p = .039$ ) showed a significant drop in naming accuracy.

With regard to the control items, there was a small but significant increase in naming accuracy from baseline ( $M = 3.75$ ), to immediately post-therapy ( $M = 8.5$ ) which was maintained at follow-up testing ( $M = 8.9$ ): main effect of time was significant,  $F(2, 14) = 10.1$ ,  $p = .002$ . There was, however, no effect of therapy type,  $F(1, 14) = 2.9$ , *ns* or an interaction,  $F(2, 14) = 3.1$ , *ns*.

### Performance during the two courses of therapy

Figure 2 (a & b) shows the group performance across the 10 therapy sessions as well as the post-therapy assessment scores. Figure 3 shows the eight



**Figure 2.** Mean (uncued) naming performance at the beginning of each therapy session.

individual participant data. Accuracy over the 10 therapy sessions for both the intensive and non-intensive conditions was analysed to investigate whether the pattern of learning exhibited by participants during the therapy periods varied and whether this variation could account for the superior accuracy, at the one month follow-up, for items learned non-intensively. The  $10 \times 2$  ANOVA revealed a main effect of time, confirming the gradual improvement in naming performance during therapy:  $F(9, 63) = 50.88, p < .001$ . There was no main effect of therapy type,  $F(1, 7) = 1.05, p = .34$ , nor an interaction,  $F(9, 63) = 1.24, p = .27$ . These results hold whether or not PR's data are included. In summary, the during-therapy performance closely matched the immediate post-therapy naming accuracy (with no effect of therapy type). Instead the difference only emerged as the therapy effect started to decline (as revealed by the one-month follow-up assessment).

## DISCUSSION

The aims of this study were to determine (1) whether the intensity of aphasia therapy affected the learning and/or retention of therapy items, and (2) how this related to the pattern of relearning during therapy. In order to explore this without confounds, all other variables were carefully controlled (including the type of therapy and the quantity of input). The sole experimental difference between the two conditions was whether therapy was delivered intensively (i.e., every day for two weeks) or non-intensively (twice a week for

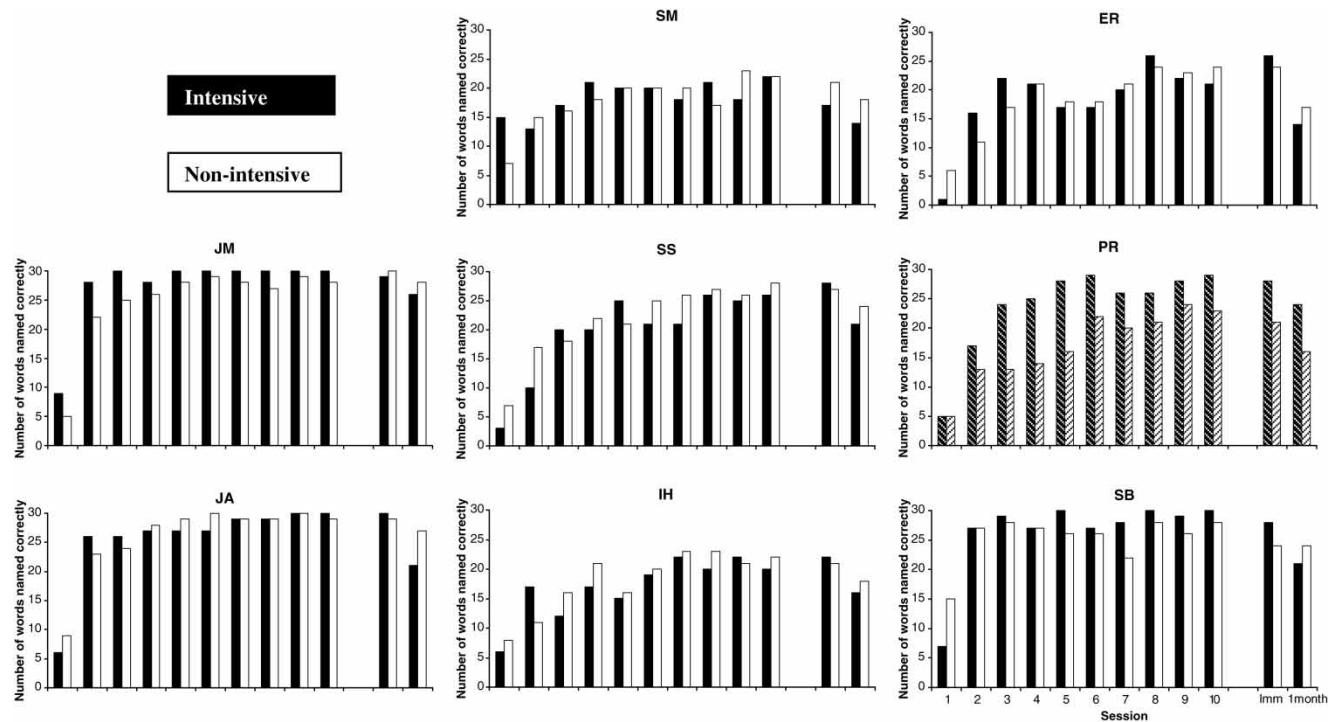


Figure 3. Individual naming performance across therapy sessions and at post-therapy assessments.

five weeks). Immediately post-therapy, there was no difference in naming accuracy between the two conditions. One month after therapy, accuracy was significantly better for the items learned non-intensively than for those learned intensively. Only one participant was better at naming following the intensive condition and he maintained this difference at follow-up. There may be a number of possible explanations for these findings and these will be addressed in turn.

Research into motor skill learning has explained an observed superiority for non-intensive learning regimes by suggesting that intensive learning induces “reactive impedance” (boredom, mental and/or physical fatigue) (Dail & Christina, 2004). Whilst this is a valid observation for motor learning (given that all learning sessions are crammed into a short time frame – see Introduction), for this study such an explanation is unsatisfactory as, even in the intensive condition, participants had a day between sessions. In addition, evidence for reactive impedance was not found. For example, performance across the 10 sessions did not decline or plateau over the latter half of therapy (compared to the non-intensive therapy) which might have been predicted had participants become bored or fatigued by the intensity of the therapy.

An alternative explanation of the better retention of material when learned non-intensively has come from studies on consolidation. These studies have investigated how deeply encoded an item became and how susceptible it was to interference. Non-intensive learning allowed for mental rehearsal between the therapy sessions which, in turn, allowed for deeper encoding (Moulton et al., 2006). Given that, in this study, there was greater opportunity to rehearse the training items in the non-intensive therapy because it was extended over five weeks rather than two, we might have expected a difference between the earlier and later learning profiles of the two conditions. The latter stages of learning in the non-intensive therapy would have shown stronger learning than the equivalent stages of the intensive therapy. The learning profiles did not show this advantage for the non-intensive therapy immediately after therapy.

Learning algorithms such as the Rescorla-Wagner theory (Anderson, 1995) in classical conditioning and the closely-related delta rule (Anderson, 1995) in connectionist modelling may provide a plausible explanation. In these learning algorithms, the difference between the learning goal (i.e., target performance) and the current (sub-optimal) performance is the core measure that guides the amount of learning at each step. If there is a large difference between behaviour and target performance then a considerable amount of learning is undertaken (large weight changes in a computational model) whilst only smaller changes are made as the observed performance converges with the target. This idea can be applied to the learning demonstrated in this therapy study. A key additional assumption is this; performance on any

particular naming trial is influenced by a combination of the accuracy of the underlying representation that supports naming and any remaining activation that persists in the system from one naming session to the next. It is known from studies of normal naming that repetition priming improves naming accuracy even over long intervals of days or months but the amount of priming reduces over this delay (Cave & Squire, 1992; Turenout, Ellmore, & Martin, 2000). This means that accurate naming on one session may persist over time and this priming will promote accurate naming next time. The amount of priming will be higher in the intensive therapy condition because the gap between sessions is smaller. However, amount of learning in the delta rule is governed by the difference between current activation (the combination of underlying representation and priming) and the target pattern. Therefore, large amounts of residual priming will actually reduce the difference and thus slow down changes to the underlying representation – which is critical for long-term effects.

This proposal would seem to explain two key aspects of the results. First, whilst there are significant differences between the intense and non-intense therapies, the effect is not a huge one. This would be in keeping with performance reflecting the additional, secondary effect of priming rather than changes to underlying representations per se. Secondly, it would also explain why the differences only emerge after a period of no therapy. Immediately after therapy, it is likely that the priming effect will still remain and this will reduce any underlying differences in naming performance because the intensely treated items have greater residual priming. Once a month has elapsed, however, a considerable amount of the repetition priming will have dissipated and thus the true underlying status of the long-term representations for naming will be revealed.

One participant preferred intensive learning and showed benefits immediately after therapy which were maintained at one month. PR was not an outlier on any of the language, cognitive or background assessments nor when test scores were grouped together to give overall semantic, phonological and naming scores. In fact he was middle ranking for most of these variables (see Tables 1 and 2). He also did not differ in terms of age, time post-onset, adjustment to aphasia, or social life. Given the small group size it remains unclear whether he was idiosyncratic and whether, in a larger study, other participants might also have shown a superior effect with the intensive therapy.

The current results have implications for clinical practice since they suggest that for this type of learning (anomia therapy) intensive input was not necessary. Whilst both types of therapy lead to significant improvements, this study suggests that less intensive input led to better long-term learning for most participants. If intensive therapy is necessitated by constraints in clinical service and provision then the positive message from this study is that this

will also be effective for most participants with aphasia. Further study is required to confirm whether the additional benefit of non-intense (“spaced”) therapy would hold consistently for the majority of participants with aphasia, for therapy in the acute stage of recovery and for different therapy tasks (e.g., auditory comprehension, reading, or sentence level deficits).

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