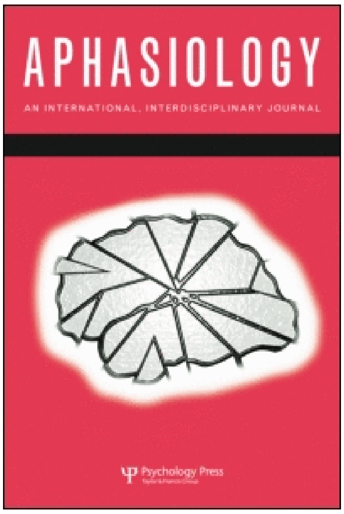

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Errorless and errorful therapy for verb and noun naming in aphasia

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Errorless and errorful therapy for verb and noun naming in aphasia

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Background: The aphasiological literature has provided an extensive body of research on verb impairments but many fewer verb therapy studies. Verbs display particular complexity at various levels of linguistic analysis: phonological, morphological, semantic, and syntactic. Verb impairments can arise at any of these processing levels as well as from cognitive sources. Verb-naming therapies may therefore be relatively more vulnerable to errors, which could reduce their effectiveness. Errorless learning has been used with positive results for noun therapies.
Aims: Given the high linguistic and cognitive demands of verb processing, this study investigated whether errorless therapy would be more effective for verb naming than more traditional hierarchical cueing (relatively errorful) therapy.
Methods & Procedures: Nine participants with word-finding difficulties as a part of their chronic aphasia took part in the study.
Outcomes & Results: For the dependent variable of naming accuracy, as in previous studies, we found that errorless therapy was as effective as errorful therapy for both verb and noun naming. Three participants with most severe aphasia showed significantly greater gains in noun as opposed to verb naming. The remaining participants exhibited comparable gains in both nouns and verb naming. There was no lasting generalisation from treated to untreated therapy items. The prediction that errorless therapy would be more effective for verb naming was not upheld; errorless and errorful approaches were as effective as one another.
Conclusions: An errorless-learning approach to verb and noun naming was a time-efficient therapy, and one that was as effective as an errorful/hierarchical cueing method in improving naming accuracy, for a range of participants with varying naming skills and types of aphasia.

Keywords: Errorless learning; Verb naming; Noun naming; Aphasia; Cueing.

There have been a limited number of published verb therapy studies in the aphasiological literature, yet the theoretical literature on verb impairments has provided a rich set of findings about the nature of verbs which could directly inform therapy studies (Conroy, Sage, & Lambon Ralph, 2006). There have been challenges, however, in

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attempting to devise theory-driven verb therapies. First, in comparison with nouns (which serve as the usual focus of attention in naming therapy studies), verbs display greater complexity at various levels of linguistic analysis: phonological, morphological, semantic, and syntactic (Black & Chiat, 2003). This means that verbs tend to be inherently more difficult as therapy targets for many people with aphasia. Second, verb impairments have been shown to arise from one or many linguistic and cognitive sources. These have included semantic, syntactic, and phonological processing deficits as well as cognitive sources such as executive dysfunction (Silveri, Salvigni, Cappa, Della Vedova, & Puopolo, 2003) or impairments in "thinking for speaking" (Marshall & Cairns, 2005). The principal aim of this study, therefore, was to replicate and extend previous uses of errorless learning to target verb as well as noun naming. Accordingly, we review briefly below the previous literature on verb therapies (which have more often targeted verbs within phrase production rather than single naming as in this study) and then previous interventions that have utilised an errorless approach.

There has been a tendency in the literature for verb therapies to be directed to participants with non-fluent aphasia while noun therapies have often been directed to those with both fluent or non-fluent aphasia (Conroy et al., 2006). Traditionally, agrammatic (i.e., severely nonfluent) aphasia has been associated with relatively poorer verb than noun production. The opposite pattern (noun < verb production) has been associated with fluent aphasia sub-types such as anomic and Wernicke's aphasia. However, a recent large group study (Luzzatti et al., 2001) found that relative performance in noun and verb naming corresponded only loosely with aphasia classification. While non-fluent aphasic speakers showed a tendency to perform more poorly with verbs, some did not. The picture was more mixed with fluent aphasia, where there was a tendency, albeit weaker, to perform worse with nouns. An earlier seminal paper by Berndt and colleagues examining relative patterns of noun verb naming across different aphasia subtypes had also found relative verb impairments in both nonfluent (agrammatic) and fluent (Wernicke's) aphasia (Berndt, Mitchum, Haendiges, & Sandson, 1997). Relative noun impairments were noted in the context of severe anomia. The key point arising from this literature is that noun–verb dissociations are only relative and so verb therapies are needed for many people with aphasia, irrespective of classification.

Verb-naming studies have either compared verb against noun therapies (Pashek, 1998; Raymer et al., 2007; Wambaugh, Doyle, Martinez, & Kalinyak-Fliszar, 2002; Wambaugh et al., 2001) or examined the effects of verb therapy on related skills such as sentence production (Edwards, Tucker, & McCann, 2004; Marshall, Pring, & Chiat, 1998; Mitchum & Berndt, 1994; Raymer & Ellsworth, 2002). All of these studies found little or no generalisation from treated to untreated verbs. Three studies concluded that verb therapy was beneficial for their participants with regard to sentence production (Edwards et al., 2004; Marshall et al., 1998; Raymer & Ellsworth, 2002), while one did not (Mitchum & Berndt, 1994). A further distinct group of studies has focused on verb and argument structure therapies (Fink, Martin, Schwartz, Saffran, & Myers, 1992; Murray & Karcher, 2000; Schneider & Thompson, 2003; Webster, Morris, & Franklin, 2005). These differed from verb-naming studies in that they trained production of verbs and key nouns in sentences; in other words, the verb and its argument structure. A recent study examined the effects of verb training through sentence production therapy including direct treatment of specific verb forms to ensure correct grammatical expression of tense and person agreement

(Bastiaanse, Hurksmans, & Links, 2006). Encouragingly, this study reported positive therapy gains on related subtests of an aphasia battery and, more importantly, on measures of functional verbal communication. Finally, the effects of gesture facilitation as a treatment method for verb naming has also been investigated based on the purported link between semantic knowledge for verbs and actions (Druks, 2002). Positive treatment effects have been reported with gesture-plus-verbal facilitation proving more effective than verbal facilitation only for verb naming in one participant (Pashek, 1998), and as effective for verb naming as semantic-phonologic treatment in four participants (Rodriguez, Raymer, & Gondalez Rothi, 2006). Although these therapy studies have reported positive results, they are often either single-case studies or based on a small number of participants with aphasia. The present study used a case-series methodology, which permitted observation of changes within individual participants as well as across the group allowing us to say something about the extent to which more general conclusions can be drawn from the findings (Conroy et al., 2006).

Potential treatment implications have emerged from theoretical accounts of verb impairments. The notion of minimising errors in the therapy process has been investigated recently in noun-naming studies (Fillingham, Sage, & Lambon Ralph, 2005a, 2005b, 2006). Given the relatively high cognitive and language demands of verb processing, minimising errors during therapy could be particularly helpful. For example, verb naming has been shown to demand greater cognitive processing with respect to selecting between competing items, in particular at the conceptual and morphological levels. At the conceptual level, it has been argued that nouns (particularly object names) have a relatively "tight fit" between their word form and meaning but, because verbs depict actions, processes, events, and states involving temporal relations, they have a "looser fit" between word form and the meaning they represent (Black & Chiat, 2003). At the morphological level, fMRI studies have shown that verbs evoke more activation in the left inferior frontal gyrus than nouns (Tyler, Bright, Fletcher, & Stamatakis, 2004). Tyler et al. noted that the left ventrolateral prefrontal cortex is associated with tasks involving selecting between competing items and attributed the differential activation in this region to the greater morphological complexity in verb processing. At the phonological level, verbs show more complexity than nouns on at least three factors:

1. Stress pattern: English bisyllabic nouns have a strong tendency to place stress on the first syllable, while bisyllabic verbs tend to have second-syllable stress (e.g., window vs depart). This difference has been found to influence processing in normal participants (Mattys & Samuel, 2000) and some people with aphasia (Nickels & Howard, 1999). In some homophonic pairs, stress pattern is the distinguishing feature between the verb and nouns forms (e.g., to reject vs a reject; to refuse vs the refuse).
2. Duration: Nouns tend to be of longer duration than verbs even in homophonic pairs, e.g., coach and coach (Sorenson, Cooper, & Paccia, 1978).
3. Syllable length: Nouns tend to contain a greater number of syllables than verbs (Kelly, 1992).

These cognitive and linguistic factors led us to the prediction, to be investigated in the present study, that verb naming during therapy tasks may be more prone to error (relative to nouns) with the result that verb therapies may be hampered as a direct consequence. Therefore, errorless techniques in therapy may be particularly helpful in verb-naming therapies.

Errorless learning has had a history of successful application to learning across a wide range of both clinical and non-clinical domains (Fillingham, Hodgson, Sage, & Lambon Ralph, 2003). Most notably, there has been a substantial literature describing errorless learning techniques in the rehabilitation of memory impairments (Baddeley & Wilson, 1993; Clare et al., 2000; Komatsu, Mimura, Kato, Wakamatsu, & Kashima, 2000; Tailby & Haslam, 2003; Wilson, Baddeley, Evans, & Shiel, 1994; Wilson & Evans, 1996). The advantage for errorless learning found with amnesic patients has been related by some researchers to intact implicit learning mechanisms that cannot distinguish between errorful or correct responses and reinforce both types of response (Page, Wilson, Shiel, Carter, & Norris, 2006); although counter-arguments have also been proposed (Squires, Hunkin, & Parkin, 1997). A related idea can be found in the computational neuroscience literature: if learning and relearning are considered in terms of Hebbian reinforcement mechanisms then the formation of language-related representations can be shown to be vulnerable to errorful learning sequences in both computational models and neurologically intact participants (McCandliss, Fiez, Protopapas, Conway, & McClelland, 2002; McClelland, Thomas, McCandliss, & Fiez, 1999).

These studies suggest that even normal, adult language systems can benefit from an errorless learning environment and thus it seems plausible to consider the hypothesis that this technique may be beneficial for people with aphasia, particularly for demanding word types (e.g., verbs) or sentence construction. In recent years there have been a growing number of studies investigating the efficacy of errorless learning for aphasia therapy, particularly for aphasic word-finding (noun) difficulties. A series of studies by Fillingham and colleagues found consistently that errorless therapy was as effective as traditional hierarchical cueing (errorful) therapy (Fillingham et al., 2005a, 2005b, 2006). Other contemporaneous studies found that errorful therapy may be more effective in some cases (Abel, Schultz, Radermacher, Willmes, & Huber, 2005). Direct comparison between these studies reveals that there were differences in the therapy methods and that these might be the root of the variation in results. Fillingham et al. used a relatively "pure" form of errorless learning by presenting participants with object pictures together with both their phonological and orthographic word forms, and requesting immediate repetition (with the participants selected to have minimal repetition impairment). Even this technique was not completely pure, as a few errors inevitably occurred. In contrast, Abel et al. compared increasing cues in therapy (hierarchical cueing, starting with the more minimal cue first) against decreasing cues (starting with whole word repetition but reducing the quantity of cues through therapy, thereby allowing more errors to emerge). Abel et al. predicted that decreasing cues might have been more beneficial for participants with severe naming disorders in that it prevented them from producing such frequent errors. However, their results showed no participant improving in the decreasing cues only condition, some who showed positive effects with both increasing and decreasing cues, and several participants who showed positive effects with increasing cues only. This led Abel et al. to conclude that "patients with aphasia do not seem to be hampered by their own errors" (p. 845).

Given these slightly divergent results, one of the aims of the present study was to take a new case-series of participants with aphasia and to compare errorless and errorful therapies in an attempt to replicate the results from Fillingham et al. In addition to object naming we extended the study to include action naming, given that the theoretical literature indicates that verbs may be more demanding both cognitively and linguistically (see above). Given the lack of overall differences reported in the Fillingham et al. errorless versus errorful therapy studies on noun naming, we aimed to contrast the two types of therapies more strongly, through an extended form of hierarchical cueing with trial and error naming to promote the rate of errors in this (errorful) condition (see Method). Based on the points that emerged from the literature review (above), we predicted the following:

1. Errorless therapy would be as effective in improving naming accuracy for nouns (in line with Fillingham et al.) but would show significantly *greater* effects for verb naming accuracy, given the higher processing demands for verbs.
2. Verb naming overall, i.e., regardless of type of therapy, would result in lower accuracy scores than noun naming.
3. That verb naming during therapy tasks may be more prone to error (relative to nouns) with the result that verb therapies may be hampered as a direct consequence.
4. Improvements in verb-naming accuracy would be more vulnerable than noun naming to the effects of withdrawal of therapy. In order to distinguish short- from longer-term effects from therapy, we assessed naming accuracy at an early time point post-therapy (1 week) and then again after a period of no intervention (5 weeks later).

METHOD

Participants and baseline naming ability

Nine participants with chronic aphasia including word retrieval impairment took part in a case-series study. Participants varied in their aphasia symptoms, severity, and time since CVA. All were monolingual English speakers. Participants were recruited from NHS Speech and Language Therapy services within Shropshire, England. Inclusion criteria were devised to ensure the errorless therapy would be viable and also to eliminate the likelihood of spontaneous recovery. Participants had to be at least 6 months post CVA, with no other history of significant neurological illness such as, for example, dementia or multiple sclerosis. Normal or corrected hearing and vision were required. With regard to language skills, two factors were considered: degree of (noun and verb) naming impairment; and word repetition skills. For the former, noun and verb picture items were taken from the Object and Action Naming Battery (Druks & Masterson, 2000). These were 20 nouns and 20 verbs, with each set matched for significant variables including frequency, imageability and visual complexity (see Appendix). Participants were required to achieve a score between a minimum of 10% (4/40) and a maximum of 90% (36/40). On the word repetition task, which consisted of the first 20 items in PALPA 9 (Kay, Lesser, & Coltheart, 1992), participants were required to score at least 75% correct. This was in order to ensure that the errorless therapy, which required reliable word repetition skills, would be viable and relatively error-free for all participants.

Table 1 summarises the participants' age, gender, handedness, number of years education, occupation, and months since CVA. Table 1 shows participants' baseline naming score from the Boston Naming Test/ BNT (Goodglass, Kaplan, & Barresi, 2001). The BNT was administered without its cueing system, purely as a screen of anomia severity. This showed a range of naming ability on a continuum from severe to mild impairment across the case-series. Table 1 also contains baseline naming scores on the set of matched nouns and verbs and a description of the participants'

TABLE 1
Description of participants, naming score, description of aphasic symptoms

Participant	*KP*	*PM*	*RP*	*PO*	*JT*	*IH*	*MD*	*DR*	*WE*
Age	75	42	71	60	84	62	48	65	65
Gender	female	female	male	male	female	female	female	male	female
Handedness	right	right	right	right	right	right	right	right	right
Number of years education	10	13	12	13	16	12	13	13	16
Occupation	Administrator	Secretary	Farmer	Business Manager	Teacher	Housewife	Hairdresser	Engineer	Teacher
Months post onset of CVA	50	46	13	7	10	11	136	31	56
Baseline naming of matched noun verb set (20 N, 20 V)	V = 3 *N* = 1	V = 3 *N* = 2	V = 6 *N* = 4	V = 10 *N* = 8	V = 12 *N* = 8	V = 14 *N* = 14	V = 12 *N* = 9	V = 18 *N* = 16	V = 16 *N* = 12
Baseline naming (BNT: max = 60)	0	3	8	24	28	29	34	35	40
Error type on BNT:									
Semantic	0	4	2	2	12	4	6	1	8
Phonological	0	6	8	2	4	0	8	1	0
No response	60	43	40	31	13	27	10	20	10
Unrelated	0	0	2	0	0	0	2	1	2
Description of aphasia	Fluent anomic	Non fluent	Non fluent	Fluent Jargon	Non Fluent	Non Fluent	Non Fluent	Fluent anomic	Agrammatic

BNT = Boston Naming Test (Goodglass et al., 2001).

aphasic symptoms in connected speech. There were no significant differences for any individual participant between these matched sets (all $\chi^2 < 1.04$, $p > .30$). As a group, however, there was a naming superiority for verbs (mean = 14.22, *SE* = 2.06) compared to nouns (mean = 12.0, *SE* = 1.84), which did reach statistical significance (Wilcoxon matched-pairs test, $p = .01$). This finding (that all participants showed similar degrees of naming impairment when tested on matched verbs and nouns) was particularly striking. The participants varied in their aphasic symptoms (e.g. fluency) and so, in light of the theoretical literature linking relative strength and weakness in naming across these word classes to aphasia subtypes (see Introduction), we might have expected to see more variation in verb/noun differential naming ability.

Background assessment

Participants completed comprehensive linguistic and cognitive assessment, the results of which are shown in Tables 2 and 3, respectively.

Assessment of participants' language skills focused on single-word processing skills in the domains of naming, phonology, and semantics.

Naming. The following tests were used:

1. The Boston Naming Test (Goodglass et al., 2001) without cueing.
2. The Object Action Naming Battery (Druks & Masterson, 2000) was used as a measure of verb and noun retrieval.
3. A subset of verbs and nouns from the Object Action Naming Battery, consisting of 20 verbs and 20 verbs matched for key psycholinguistic variables, particularly word frequency, imageability and visual complexity (see Appendix), was used to assess *relative* strengths in verb versus noun naming. The results for this subset were extracted from participants' naming of all of the items in the Object Action Naming Battery.

Phonology. Word and non-word reading and repetition tasks from the PALPA test battery (Kay et al., 1992) were used to assess the integrity of participants' phonological representations:

1. Imageability by frequency word reading (PALPA 31);
2. Non-word reading (PALPA 36);
3. Auditory word repetition: Imageability by frequency (PALPA 9);
4. Auditory non-word repetition (PALPA 9).

Semantic memory and comprehension of nouns and verbs. The three-picture version of the Pyramids and Palm Trees Test (Howard & Patterson, 1992) was used. This test required participants to match pictures on the basis of semantic relatedness; e.g., for a *pyramid*, the participant should select a *palm tree* and not a *fir tree*.

1. The three-picture version of The Kissing and Dancing Test (Bak & Hodges, 2003). This test resembles the Pyramids and Palm Trees Test in its format but uses action instead of object pictures. The participant is required to match actions on the basis of semantic similarity; e.g., for *kissing*, the participant should select *dancing* and not *running*.
2. A synonym judgement test (Jefferies, Patterson, Hopper, Corbett, Baker, & Lambon Ralph, 2008) was used to detect milder forms of semantic impairment.

TABLE 2
Results of language assessments across participants

Participants:		*KP*	*PM*	*RP*	*PO*	*JT*	*IH*	*MD*	*DR*	*WE*	
Assessments:	max										normal range
NAMING											
Objects (OANB) % correct	162	15 (9%)	25 (15%)	52 (32%)	96 (59%)	96 (59%)	125 (77%)	109 (67%)	145 (89%)	125 (77%)	n/a
Actions (OANB)% correct	100	6	7	11	29	36	36	55	62	59	n/a
PHONOLOGY											
Word Reading	80	28	9	20	63	46	71	57	74	77	79–80
Nonword Reading	24	1	0	0	3	0	13	8	18	22	n/a
Word Repetition	80	55	**<u>79</u>**	67	**<u>78</u>**	74	76	75	66	**<u>80</u>**	78–80
Nonword Repetition	80	34	69	40	58	48	56	68	41	72	n/a
SEMANTICS											
P & P	52	42	39	42	47	40	**<u>52</u>**	48	**<u>52</u>**	46	49–52
K & D	52	44	47	38	47	37	**<u>51</u>**	44	**<u>50</u>**	41	48–52
Syn Judgement	96	73	11	59	67	65	90	66	82	73	91–96
N V Comp	100	90	72	78	90	77	**<u>100</u>**	99	99	95	100
SWPM	40	**<u>39</u>**	26	**<u>38</u>**	**<u>40</u>**	**<u>37</u>**	**<u>40</u>**	**<u>36</u>**	**<u>40</u>**	**<u>38</u>**	35–40
WWPM	40	**<u>37</u>**	23	34	**<u>40</u>**	26	**<u>40</u>**	**<u>38</u>**	**<u>39</u>**	**<u>40</u>**	35–40

OANB = Object Action Naming Battery; all phonology subtests taken from PALPA; P & P = Pyramids and Palmtrees Test; K & D = Kissing & Dancing Test; Syn Judgement = Synonym Judgement Test; N V Comp = Noun Verb Comprehension Test; SWPM = Spoken Word to Picture Matching; WWPM = Written Word to Picture Matching; n/a = not available. <u>Underlined</u> and **emboldened** scores were within the normal range.

TABLE 3
Results of cognitive assessments across participants

Participants:		*KP*	*PM*	*RP*	*PO*	*JT*	*IH*	*MD*	*DR*	*WE*
Assessments:	Max									
CMT (pictures)										
Score	30	25	28	28	30	26	28	28	30	29
%tile		4.7	**13**	**38.8**	**100**	7.1	**15.7**	**15.7**	**100**	37.8
CMT (words)										
Score	25	13	21	20	19	17	25	23	25	20
%tile		<2.8	1.9	**13.9**	3.1–6.3	2.8–11.1	**100**	**31.3**	**100**	6.3
Rey Copy										
Score	36	23	26	36	34	18	35	34	36	28
%tile		<1	<1	**>16**	**>16**	<1	**>16**	**>16**	**>16**	2–5
Rey Imm Recall										
Score	36	3	5	11	11	6	22	19	20	7
%tile		1	<1	**31**	**12**	**24**	**86**	**38**	**86**	4
Rey Delayed Recall										
Score	36	6	7	7	11	48	22	16	21	73
%tile		4	<1	5	**10**		**88**	**16**	**92**	
WCST: no of categories										
Score	6	2	1	2	5	0	2	6	3	3
%tile	>16	**>16**	2–5	**>16**	**>16**	11–16	6–10	**>16**	**>16**	**>16**
WCST: items to 1st cat										
Score		11	17	20	4	84	18	3	16	10
%tile	>16	**>16**	6–10	**>16**	**>16**	**>16**	11–16	**>16**	**>16**	**>16**
TEA: elevator counting										
Score	7	7	4	6	5	4	5	6	7	7
TEA: elevator counting distractions										
Score	10	2	0	1	7	3	1	4	5	2
%tile		5	1	1	**10–25**	5–10	1	5–10	**10–23**	5
Self assessment of naming										
%	100	**100**	90	74	66	80	**100**	**100**	**100**	**100**

CMT = Camden Memory Test; Rey Copy = Rey Complex Figure Test – Copy subtest; Rey Imm Recall = Rey Complex Figure Test – Immediate Recall subtest; Rey Delayed Recall = Rey Complex Figure Test – Delayed Recall subtest; WCST = Wisconsin Card Sorting Test; TEA = Test of Everyday Attention. **Emboldened** scores were within the normal range.

This test required participants to match words (presented in written and spoken form) on the basis of semantic relatedness; e.g., for *rogue*, the participant should select *scoundrel*, and not *polka* or *gasket*. Probe, target and foils within each trial are matched for frequency and imageability, and these factors are varied across trials to produce an orthogonal manipulation of the two variables (high vs low frequency; low, medium, and high imageability);

3. The Noun Verb Comprehension Test is an adapted version of a comprehension test supplementary to the Object Action Naming Battery (Druks & Masterson, 2000). This spoken word-to-picture matching test contains 50 noun and 50 verb targets. Target items are presented alongside four semantic-related and one unrelated pictures (e.g., UMBRELLA: *raining*, *roof*, *hat*, *bucket*, or *plug*; POURING: *kettle*, *dripping*, *stirring*, *dropping*, or *yawning*);

4. Spoken word to picture matching (PALPA 47) (Kay et al., 1992). This test consists of five items in an array: one target, one close semantic distractor, one distant semantic distractor, a visually related distractor, and an unrelated distractor. For example, for the target *stamp*, the distractors in the same order are *envelope*, *pen*, *picture*, and *paint*;
5. Written word to picture matching (PALPA 48) (Kay et al., 1992). This test consists of the target as a written word and five surrounding pictures. The targets and distractors are the same as for the spoken version (PALPA 47).

Assessment of participants' cognitive skills included measures in the domains of memory, executive, and attention skills and self-monitoring.

Memory.

1. The picture and written word subtests from the Camden Memory Tests (Warrington, 1996). In the picture version participants looked at a set of composite scenes and decided whether each one had been taken by an amateur or professional photographer. Participants then looked at a set of three photographs and decided which one they had previously seen. For the written word recognition task participants read written words appearing on a set of cards, one word per card. Participants then decided which words they had already seen from sets of multiple word lists.
2. Copy, immediate, and delayed recall parts of the Rey Complex Figure Test (Meyers & Meyers, 1995). This test required participants to copy a complex geometric figure, then to draw this figure from memory 5 minutes later and then again 30 minutes later.

Executive and attention skills.

1. The Wisconsin Card Sorting Test (Grant & Berg, 1993) was used to assess aspects of executive functioning such as cognitive flexibility and problem solving. This test examined participants' ability to formulate rules with which to match cards on the basis of shape, colour, or number, and then to shift to different rules as the test progressed. We looked at two measures: number of items to first category, which was the number of guesses a participant made before they had worked out the "rule" for matching cards; and the number of categories obtained, which was the number of times the participant both worked out and maintained the application of a matching rule. This latter measure can be particularly useful in detecting perseveration where a participant has worked out one rule successfully but cannot shift from this as required.
2. Two subtests from the Test of Everyday Attention (TEA) (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994) were used: "elevator counting" which requires sustained attention and "elevator counting with distraction" which requires divided attention. Elevator counting requires participants to listen and count a set of tones at random time intervals from 1 to several seconds apart. Elevator counting with distraction requires participants to listen to sets of tones but to count only the low-pitch ones while ignoring the high-pitch ones. Written numbers were provided in both tasks to avoid problems in verbal number naming.

Self-monitoring skills. We assessed participants' reliability in judging the accuracy of their own naming by asking them to judge their own response as correct or incorrect.

TABLE 4
Self-monitoring of naming

Participants:		*KP*	*PM*	*RP*	*PO*	*JT*	*IH*	*MD*	*DR*	*WE*
Assessments:	max									
% correct in self assessment	100	100	90	74	66	80	100	100	100	100
Correct		10	13	25	59	51	39	52	80	73
Commission errors		34	45	30	28	33	15	22	10	18
Trials on which self assessment made		44	58	50	87	84	50	62	90	91

Percentage correct and number of items on which self-monitoring was carried out.

A subset of nouns (50) and verbs (50) from the Object Action Naming Battery (Druks & Masterson, 2000) was used for this task. Participants rated those items for which they made a response (correct or commission error). Table 4 shows the number of items (out of 100) on which each participant made their self-monitoring decisions.

PARTICIPANT PROFILES AND SUMMARY OF ASSESSMENT FINDINGS

The assessment findings provided us with profiles of linguistic and cognitive functioning through which to describe our study participants. In the scores obtained from the Object Action Naming Battery (see Table 2), three participants (KP, PM, & RP) showed similar degrees of naming impairment across these sets. The other six participants, who were less severely naming impaired, exhibited markedly lower accuracy scores for action as opposed to object naming (e.g., IH 125/162 objects vs 36/100 actions named), although, of course, these sets are not matched for various confounding psycholinguistic factors. Perhaps most importantly for this study, this assessment demonstrates that all the participants in this case-series had verb naming impairments in addition to those for nouns—and thus both word types were legitimate targets for therapy.

On the phonology subtests, all participants scored over 50% on word repetition, which was unsurprising given that 75% accuracy was required for entry to the study on a 20-item screen. KP was the most markedly impaired in word repetition at 55/80, as well as on the nonword repetition task where she scored 34/80. All the other participants scored at least 50% on the nonword repetition task. On the word-reading task, only participants IH, DR, and WE were near to the normal range. Similarly, with the exception of IH, DR, and WE, all other participants exhibited considerable impairment on the nonword reading task.

Within the domain of semantics, all participants scored more highly on these tasks reflecting better processing in this domain. IH, DR, and WE were within or very close to the normal range scores on many of the tasks. With the exception of PM, all participants were within the normal range on the spoken word-to-picture matching task.

The cognitive assessment data are summarised in Table 3. Within the domain of memory, participants IH and DR were at ceiling on the Camden Memory Test words subtest, with MD at the 31st centile and all other participants below the 14th centile. PO and DR scored at ceiling on the pictures subtest of the same memory assessment, with WE and more strikingly RP at the 38th centile, with the remaining participants below the 16th centile. The scores for the Rey Complex Figure were limited for KP, PM, & JT with visuospatial copying scores below the 1st centile and only slightly higher for WE. The remaining participants reproduced accurate versions of this abstract figure. MD and DR scored highly in both the immediate and delayed recall parts of the Rey test (above the 86th centile in each case). The remaining participants scored below the 16th centile for both.

Lastly, within the domain of executive-attentional skills, the easiest task here for these participants was the self-assessment of naming, which provided a measure of self-monitoring of speech. Six participants scored at or near ceiling, while the other three also scored highly (RP: 74%; JT: 80%), with PO, who displayed jargonistic Wernicke's-type speech output, scoring lowest at 66%. All participants showed relatively poor skills in problem solving and ability to shift set in the Wisconsin Card Sorting Test, with scores between the 2nd and 16th centiles for both measures. Similarly, participants were towards the bottom of the normal range in their results for the Test of Everyday Attention divided attention subtest in which two participants scored between the 10 and 23rd centiles, and all others below the 10th centile. Performance overall was better on the sustained attention subtest (albeit with a limited possible range of scores from 0 to 7), with three participants scoring at ceiling and the lowest score at 4/7 (JT).

THERAPY METHODS

Following assessment, participants received therapy in their own homes. Assessments and therapies were administered by the same clinician (the first author) and the sessions were digitally audio-recorded to allow for verification of results. Both errorless and errorful therapy for noun and verb targets were carried out in parallel, i.e., both therapies were implemented in all therapy sessions. The alternative to this parallel-administration design was sequential administration of the separate therapies. Parallel administration has many practical benefits including reducing the period of time over which therapy is delivered, during which participants can lose motivation, and also minimising the likelihood of any unpredicted events (e.g., illness, absence) affecting one therapy type and not the other.

Verb and noun therapy targets

The primary outcome measure in the study was naming accuracy. Three sets of target items were selected for each participant. Items that a participant had consistently failed to name three times were selected from the naming assessments, particularly the Object & Action Naming Battery (Druks & Masterson, 2000) as this details the psycholinguistic properties of the words in this battery very comprehensively. There were pros and cons to selecting items that participants consistently failed to name at baseline as therapy items. On the negative side, this method might allow "regression to the mean" (Bland & Altman, 1994) such that accuracy for these items was more likely to change in a positive direction. Under these circumstances, if control items showed significant improvements one could not then be sure whether this represented true generalisation of naming skills from treated to untreated items or regression to the mean. On the positive side, taking consistently failed items as therapy targets gave us a zero baseline and allowed clearer comparison of the relative effects of different therapies on naming accuracy, which was our main aim in the study.

A total of 120 failed items were collated for each participant. Where a participant had not failed a sufficient number of the items from the Object & Action Naming Battery, items from other naming tests were used: the action naming subtest from the Verb and Sentence Test: VAST (Bastiaanse, Edwards, Maas, & Rispens, 2003) for verbs and the Boston Naming Test for nouns (Goodglass et al., 2001). These 120 failed items were divided into three sets, each consisting of 40 words: 20 nouns and 20 verbs. Set A were the targets for errorless therapy, set B for errorful therapy, and set C was reserved as a control set. The sets were matched for significant variables such as length (number of phonemes), imageability, frequency, and word class. However, it was not feasible to match nouns and verbs within each set on these variables, given the systematically lower imageability scores for verbs. There is in fact very little overlap in terms of imageability between nouns and verbs and much of the overlap that does exist is already represented within the matched subset from the Object Action Naming Battery (which was used as a baseline measure of noun and verb naming ability, see above).

Errorless therapy

The errorless therapy consisted of presenting an object or action picture along with the name in written form, which was also spoken by the therapist. The participant was asked to repeat this spoken word twice, asked to listen to it again, and then to repeat it a further three times. For example, if the target object picture was *mirror*, the therapist said, "This picture shows a *mirror*, (PAUSE), can you say *mirror*? (RESPONSE) And again. (RESPONSE). The picture shows a *mirror*, can you say that three times?" For an action picture target such as *fishing*, the therapist said, "This picture shows *fishing*, (PAUSE), can you say *fishing*? (RESPONSE). And again. (RESPONSE). The picture shows *fishing*, can you say that three times?" The target word was produced five times per picture presentation. In instances where the participant response was not an accurate production of the target word (i.e., an error crept into the error-reducing therapy) the therapist would then say: "No. Let's try again. This picture shows . . ." The 40 items (20 nouns, 20 verbs) in the errorless therapy set were presented twice in each session, 10 naming attempts per session. Over 10 sessions (conducted twice weekly), this amounted to 100 production attempts of each item over the 5 weeks of therapy.

Errorful therapy

As noted in the Introduction, we aimed to amplify the differences between the two therapies over that obtained by Fillingham et al. (2005a, 2005b, 2006) by encouraging error production in the errorful therapy through extended hierarchical cueing (encouraging more guesswork than in previous studies). A five-stage cueing hierarchy was therefore devised, which included semantic and phonemic cues. In this way the two therapies were matched for the number of naming attempts per administration (i.e., five attempts). In the case of errorless learning, the majority if not all of the naming attempts would be correct because the name was provided by the therapist and repeated by the participant (see above). In the case of the errorful therapy, the five naming attempts were a mixture of incorrect responses (following insufficient cueing) and some correct responses. In this way the exposure to the treatment items was matched for both interventions but errorful:errorless ratio of responses was manipulated following the original errorless learning studies of Wilson and colleagues (Baddeley & Wilson, 1993; see above).

Cue 1. This cueing hierarchy commenced with presentation of an object or action picture, accompanied by a broad semantic cue and a request for the participant to name the item. An example of a broad semantic cue would be "[PIANO] this is a type of musical instrument". An example of a broad semantic cue for an action picture would be "[BOUNCING] as in basketball". For naming an action picture, the participant was asked to describe what was happening, in one word. For some pictures the instruction would be rephrased as "what is he/ she doing?" The present continuous verb form -ing was the target. If a participant named the picture correctly at this point after the first cue, they were asked to repeat the correct word four more times only.

Cue 2. At the second stage of cueing, descriptions of the object or action were then offered, providing a more specific semantic cue (e.g., [PIANO] "we play the keys", [BOUNCING] "making the ball go up and down"). If a participant named the picture correctly at this point after the second cue, they were asked to repeat the correct word three more times only.

Cue 3. The third cue comprised both the first grapheme as well as the initial phoneme, provided by the therapist. Where a target word started with a consonant cluster, the full onset was provided both graphemically and as a phonemic cue. If the participant named the item at this point, they were asked to repeat the word twice more only. If not, the next level of cue was given.

Cue 4. The next cue consisted of the onset plus vowel (CV or CCV) of the target word, presented again in both written and spoken forms. In bi- and multi-syllabic words, CVC or CCVC cues were given. All target verbs were in the present continuous "-ing" form and so were either bi- or multi-syllabic, e.g., "walking". Typically, this level of cueing would result in the item being named correctly, in which case the participant was asked to repeat this word just once more.

Cue 5. If the item was not named correctly, however, the full target word was given to the participant with the request to say it once only.

To match the errorless therapy, the errorful therapy also consisted of two cycles through the set of items in a session, resulting in 10 naming attempts per session and 100 per therapy programme. The errorless and errorful therapies were delivered in parallel, i.e., two cycles of each therapy set in each session (although counterbalanced in terms of order of presentation within sessions).

Post-therapy assessments

Post-therapy naming of the verbs and nouns in all three sets was assessed at 1 week post-therapy (immediate results) and then 5 weeks later (follow-up results). Scoring was simply administered on a correct/ incorrect basis using the target name, or occasional legitimate alternative name (items were selected to have very high name agreement), listed in the assessment materials from which these items were selected, see above. In terms of statistical analyses of the data, we used a three-way ANOVA to examine group effects between the factors of type of therapy (errorless or errorful), word class (noun or verb), and assessment point (immediate or follow-up). McNemar tests were carried out to test at the level of the individual, i.e., in order to examine the differences between baseline scores and naming accuracy scores at the immediate post-therapy assessment point, between baseline scores and naming accuracy scores at the follow-up post-therapy assessment point, and between immediate and follow-up post-therapy naming accuracy assessment points. Chi-squared tests were used to analyse the categorical data with respect to differences between errorless versus errorful therapies, and nouns versus verbs for individual participants.

RESULTS

We first analysed the data at the group level and then tested for the same effects in each individual participant's data. The post therapy data (immediate and 5-week assessment) were analysed with a three-way, repeated-measures ANOVA (the factors being treatment type, word class, and time of testing). Since there was little change in the control data and there were clear changes in the treatment sets, the control data were not included in the analysis. The ANOVA showed three main effects and no significant interactions; all $F(1, 8) < 3.22$, $p > .11$. There was a main effect of post therapy time point for testing, global mean immediate post therapy naming score = 14.7/20 vs follow-up naming test, mean naming = 12.3/20: $F(1, 8) = 18.0$, $p = .003$; a main effect of word type, global mean noun performance = 14.6 vs mean verb performance = 12.4: $F(1, 8) = 6.2$, $p = .04$; and a borderline effect of therapy type, global mean naming after errorless learning = 14.1 vs errorful learning = 12.9: $F(1, 8) = 4.9$, $p = .06$.

The individual participant results, summarised in Table 5, are described in four sections following the factors (significant) included in the group ANOVA:

1. Overall therapy effects for treated and untreated words at both post-therapy assessment points.
2. Results for errorless and errorful therapies.
3. Results for verb versus noun naming.
4. In addition, we assessed the rate of naming errors in the two types of therapy and across word classes during therapy.

Overall therapy effects for treated and untreated words at immediate and follow-up assessments

The group ANOVA revealed a main effect of assessment time: following improvements from baseline (because of the item selection process, all naming was at zero at baseline, see above) to immediately post therapy, the ANOVA confirmed a significant drop back in naming accuracy at the 5-week follow up assessment. Figure 1 summarises the overall therapy effect for each participant and the group as a whole (collapsed across therapy and word type) at immediate and 5-week assessments (baseline is not shown given that it was zero for all participants). For all results, the participants have been ordered according to baseline naming accuracy, with the most severely impaired on the left and least impaired on the right. All participants made highly statistically significant improvements from baseline in their naming of treated items at both assessment points, immediate and follow-up (McNemar

TABLE 5
Post-therapy naming results

			Max	*KP*	*PM*	*RP*	*PO*	*JT*	*IH*	*MD*	*DR*	*WE*	*Mean*
Time of assessment	Group type	Word class type											
Immediate post-therapy	EL total	N & V combined	40	14	18	27	35	34	39	37	38	37	31.00
	EF total		40	17	12	23	33	28	31	34	38	34	27.78
	Control total		40	4	4	3	5	3	4	4	3	2	3.56
	EL & EF combined	Verbs	40	8	12	19	33	30	35	37	37	34	27.22
		Nouns	40	23	18	31	35	32	35	34	39	37	31.56
	Control	Verbs	20	1	1	1	2	1	3	2	1	1	1.44
	V & N	Nouns	20	3	3	2	3	2	1	2	2	1	2.11
	EL	Verbs	20	5	8	11	17	17	20	19	18	18	15
	EL	Nouns	20	9	10	16	18	17	19	18	20	19	16
	EF	Verbs	20	3	4	8	16	13	15	18	19	16	12
	EF	Nouns	20	14	8	15	17	15	16	16	19	18	15
Follow-up post-therapy	EL total	N & V combined	40	13	10	17	35	27	33	30	35	28	25.33
	EF total		40	17	9	23	32	20	30	26	35	21	23.67
	Control total		40	3	0	0	3	2	3	2	3	1	1.89
	EL & EF combined	Verbs	40	11	6	13	33	24	29	29	36	19	22.22
		Nouns	40	19	13	27	34	23	34	27	34	30	26.78
	Control	Verbs	20	1	0	0	1	0	2	1	1	0	0.67
	V & N	Nouns	20	2	0	0	2	2	1	1	2	1	1.22
	EL	Verbs	20	4	3	6	18	13	16	15	18	12	12
	EL	Nouns	20	9	7	11	17	14	17	15	17	16	14
	EF	Verbs	20	7	3	7	15	11	13	14	18	7	11
	EF	Nouns	20	10	6	16	17	9	17	12	17	14	13

Post-therapy naming results immediately after therapy and at follow-up for each therapy and control items. Verb and nouns results immediately after therapy and at follow-up for each therapy and control items.

EL= Errorless therapy, EF= Errorful therapy, N = nouns, V = verb, Max = maximum score / total number of items in each category.

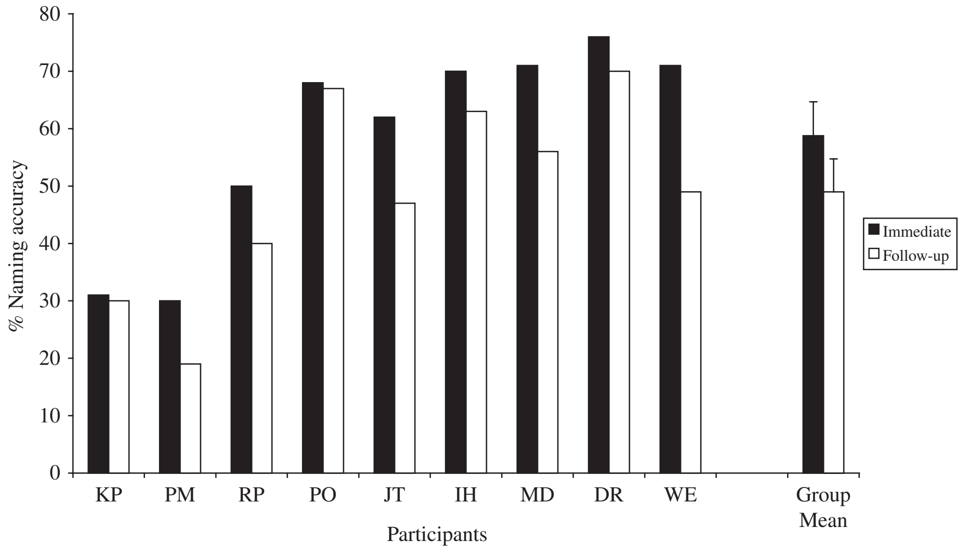

Figure 1. Overall therapy effect for each participant and group at immediate and 5-week assessments.

1-tailed, $p = .001$ for each participant). All participants showed decreases in naming accuracy between the two assessment points, which was statistically significant for five participants (PM: McNemar 1-tailed, $p = .02$; JT: McNemar 1-tailed, $p = .006$; MD: McNemar 1-tailed, $p = .001$; DR: McNemar 1-tailed, $p = .03$; and WE: McNemar 1-tailed, $p < .001$).

Participants' naming of the control items improved minimally: between two and five items at the immediate post-therapy assessment. For one participant (PO), his gain from zero pre-therapy to five immediately post-therapy was a statistically significant change (McNemar 1 tailed $p = .03$). This participant presented with fluent jargon aphasia and our impression was that he became more attuned to the pragmatics of the naming task (i.e., where he was encouraged to search for one single word to encompass the object or action feature depicted rather than a prolonged jargonistic explanation). This strategy seemed to account for his significant, albeit limited, improvement in naming control items. At the follow-up assessment there was no statistically significant gain in naming of control items for any participant.

Errorless vs errorful therapies

Naming accuracy after each type of therapy (collapsed across word type and testing time) is shown in Figure 2. The group-level ANOVA had revealed a borderline difference favouring errorless over errorful learning. At the individual level, while there was a trend towards a greater benefit for errorless therapy for seven of the nine participants (1-week post therapy assessment), this individual difference was only statistically significant for one participant, IH ($\chi^2 = 5.53$, $df = 1$, $p = .02$). At the 5-week post-therapy assessment, 5/9 participants showed a numerical naming advantage for errorless > errorful but none of these differences were statistically reliable.

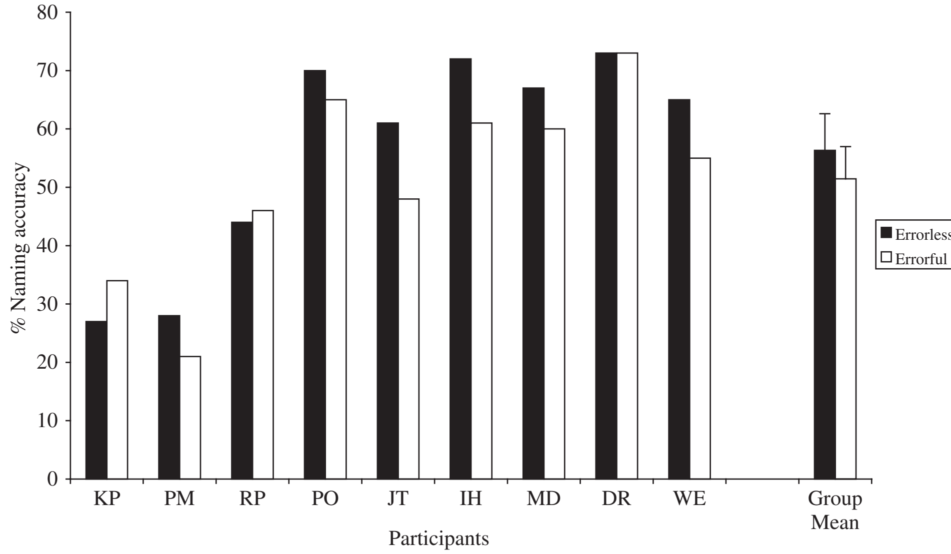

Figure 2. Naming accuracy following errorless vs. errorful therapy.

Naming results across verbs and nouns

The group-level ANOVA had revealed a significant main effect of word type (nouns > verbs). The individual and group data are shown in Figure 3 (collapsed across therapy type and testing point). Individual analyses found that, at immediate assessment, the participants with the greatest naming impairments (KP, PM, RP) demonstrated greater gains for noun than verb naming. This difference was statistically significant

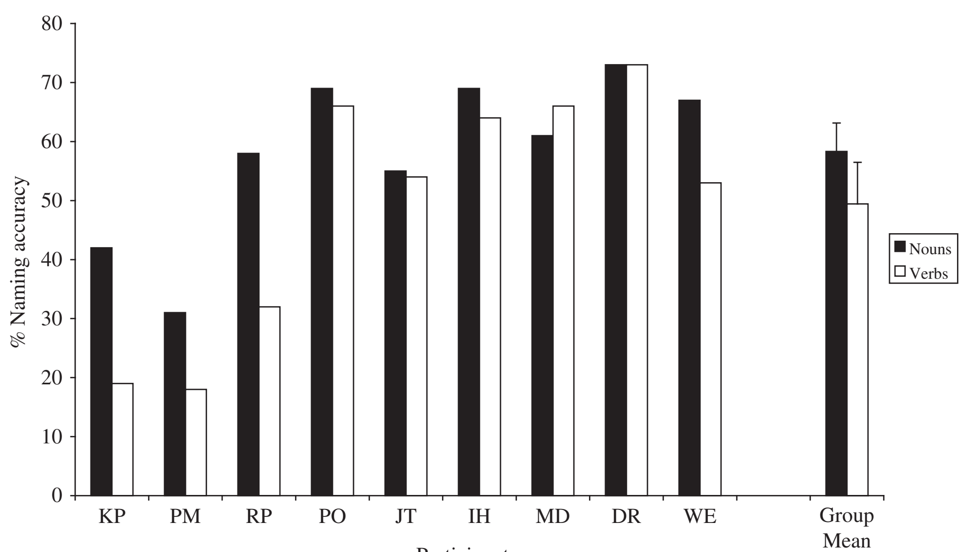

Figure 3. Overall naming accuracy for nouns and verbs. Baseline performance for all participants is 0.

for KP (χ^2 = 10.19, df = 1, p = .001) and for RP (χ^2 = 6.37, df = 1, p = .01). This noun-naming advantage for the severely naming-impaired participants was maintained at the follow-up assessment point and was statistically significant for RP (χ^2 = 8.34, df = 1, p < .001). In addition, the most mildly naming-impaired participant, WE, also displayed superior noun naming (χ^2 = 5.2, df = 1, p = .02).

Rate of errors during therapy

When formally comparing errorless and errorful interventions, it is important to monitor accuracy during therapy to confirm the levels of error made (Fillingham et al., 2005a, 2005b). Figure 4 shows the percentage of naming errors made during the errorless and the errorful therapies. The errorless therapy was truly errorless for five of the nine participants. In other words, these participants correctly named all therapy items for the 10 naming sessions of the errorless therapy. There were a few errors for the other four participants (one naming error for participant PO; five for JT; six for KP; and seven for IH) in the errorless therapy. The errors were all phonological and derived from a very small number of target words (e.g., two words on which IH made seven naming errors).

As expected, and intended, participants made substantially more errors in the errorful therapy. Unsurprisingly, the rate of errors mirrored the severity of the participants, with around 40% errors (overall) for the more severely impaired cases down to around 10% for the mildest participant. As one might expect, more errors occurred in the early errorful therapy sessions (rates between 40% and 60% of naming attempts) but the rate reduced over the course of the 10 therapy sessions. This was reflected in the cue levels the participants required in order to name target items accurately during therapy (the highest cue level was cue 5 – whole word repetition; the lowest was cue 1 – a broad semantic cue).

Figure 5 shows the mean cue levels for all the items across the 10 sessions of errorful therapy for all the participants. These data show that some participants, e.g. DR,

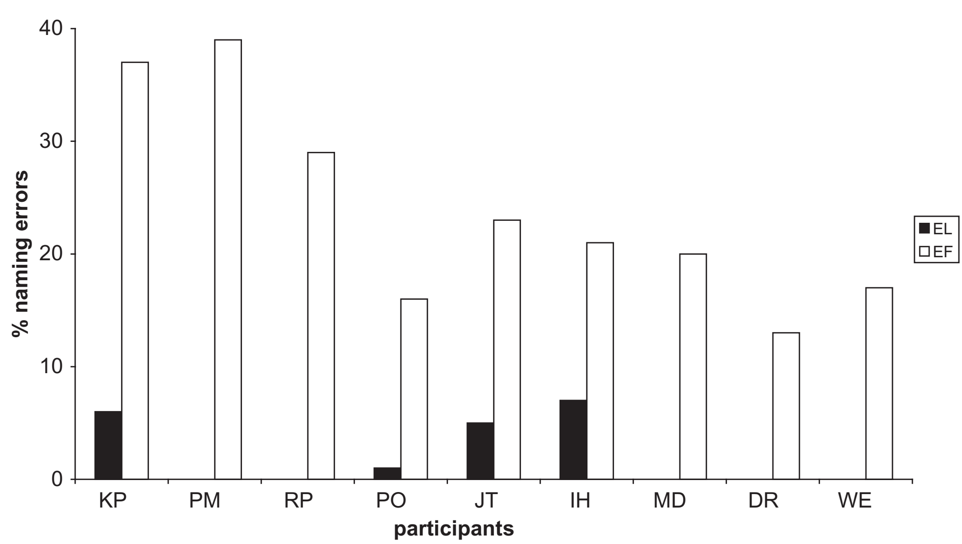

Figure 4. Percentage naming errors across errorless and errorful therapies.

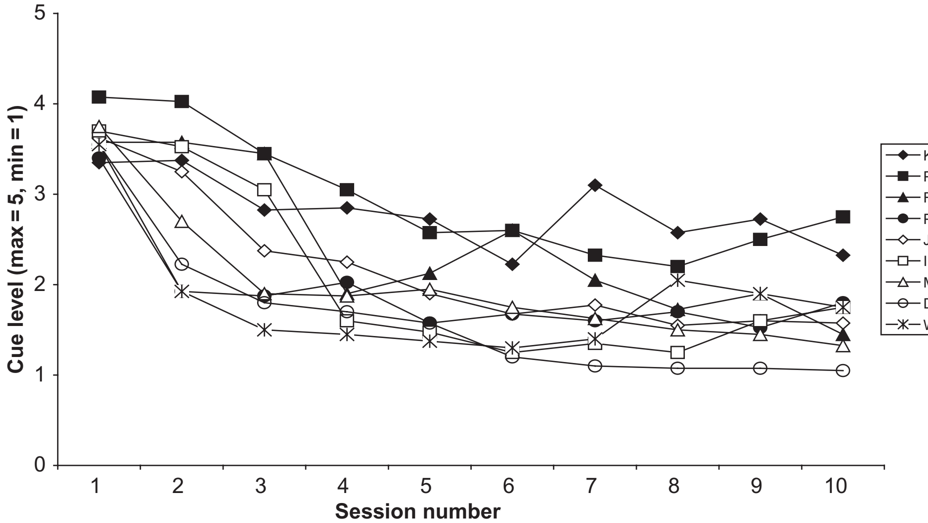

Figure 5. Progression through the errorful therapy cueing hierarchy.

progressed rapidly from requiring substantial cues in sessions 1–3, but required the lowest possible cue for the majority of items for sessions 5–10. Therefore, the errorful therapy became progressively less errorful (and eventually errorless) for some participants. For other participants (e.g., KP and PM) relatively high levels of cues were required across the sessions. This need for continued support across the 10 therapy sessions was reflected in their relatively limited gains post-therapy accuracy (when no cueing support was provided). Furthermore, for these participants the errorful therapy remained truly errorful throughout.

Figure 6 shows the naming errors across both therapies for verbs versus nouns. For seven of the nine participants there were more errors in verb naming in therapy, while for two participants there were more in noun naming.

DISCUSSION

In the present study we recruited a new case-series of participants with aphasia, and compared errorless and errorful therapies in an attempt to replicate the results from Fillingham et al. (2005a, 2005b, 2006). In addition to targeting object naming, we extended the study to include action naming. Given that the psycholinguistic literature indicates that verbs may be more demanding both cognitively and linguistically (see Introduction, and Conroy et al., 2006), we tested the hypothesis that the errorless approach might be beneficial for verbs more than nouns. Given the lack of overall differences between errorless and errorful therapy reported by Fillingham et al., we also aimed to contrast the two types of therapies more strongly. We devised an errorless therapy that would be as free of error production as possible and an errorful therapy that would make production of errors inevitable at least in the early phase of therapy.

Nine participants were recruited to the study with varying degrees and types of aphasia. All had difficulties with both object and action naming (to similar degrees when the test materials were matched for psycholinguistic factors). Like the previous

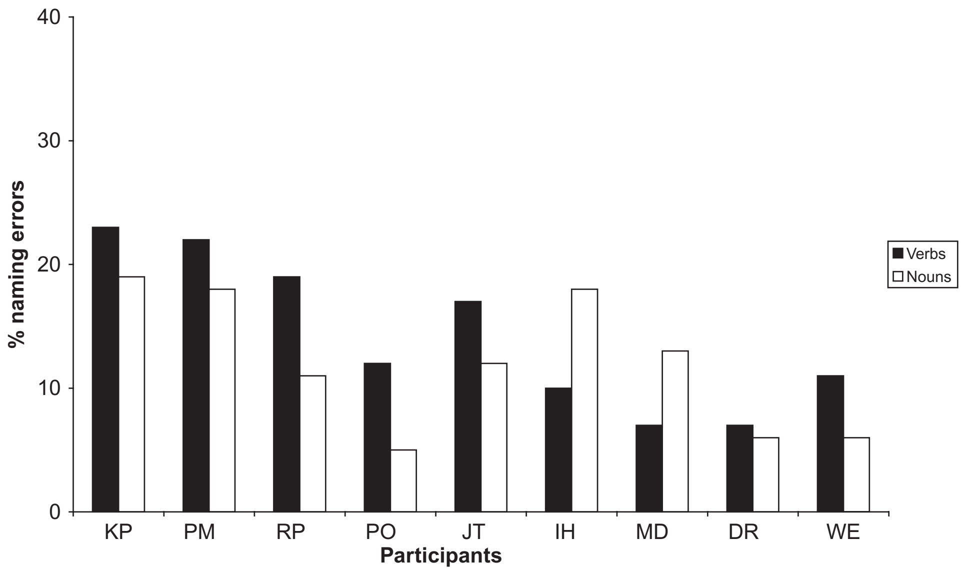

Figure 6. Percentage naming errors across verb and noun naming during therapy.

Fillingham et al. studies, we found that all nine participants made significant yet typically equivalent gains from errorless or errorful interventions. Substantial improvements on the target items were made (from a zero baseline) at the immediate (1 week post-therapy) assessment. Naming performance dropped across the participants when naming was re-assessed at the assessment 5 weeks later but all participants had maintained a significant improvement in naming performance over baseline. As per most other interventions for naming, there was little evidence for any kind of generalisation to the untreated set of items, except a small effect for one participant which may have reflected a change in naming behaviour (shifting from jargon-filled circumlocutions to single-response naming attempts) rather than true generalisation.

The prediction that errorless learning therapy would provide a significantly greater effect for verb naming accuracy was not confirmed, instead there was an equivalent boost in naming performance across both word types. The prediction that verb naming during therapy tasks may be more prone to error (relative to nouns) was borne out for seven of the nine participants. Participants did not show this effect in the outcome testing after therapy. When the error data across the sessions were examined (collapsing across therapy type) to see if there were differences in the number of errors for nouns compared to verbs, it was evident (Figure 6) that the overall error rate was low (between 5% and 25%) with many more items named correctly during therapy. Furthermore, while for some participants the contrast between errors on verbs and nouns was striking (e.g. PO – 12% errors on verbs, 6% on nouns), for many the difference was more marginal (e.g. KP – verbs 23%, nouns 19%). Overall, these data support a more general point about error production in naming therapy; when looking at accuracy scores, participants with aphasia were not directly hampered by their own errors (Abel et al., 2005).

Irrespective of word type, there was an overall trend, which as such did not reach statistical significance, for naming to improve a little more after errorless than errorful learning (as a group and for the majority of individuals at the 1-week post therapy assessment). The basic premise behind errorless learning is that participants may reinforce their own errorful responses, making them more likely to re-occur in the future (see Fillingham et al., 2003, for a review). Interestingly, we found some direct evidence for this in some of these aphasic participants. For example, participant IH presented with phonological impairments and appeared to be reinforcing her own errors in the errorful therapy. For example, in the case of one target word "stilts", IH would invariably name this item as "skilts" during the broad and narrow semantic cues in this therapy hierarchy. With the first phonological cue "st-", IH would then name the item correctly. Despite this, at post-therapy assessment IH named this item as "skilts", which might reflect a self-reinforcement of the original phonological error. Similar patterns were observed with other error types. Participant PM, for instance, tended to name the action picture "flying" (depicted as a bird flying in the sky) as "butterfly". PM would mis-name this picture in this way for two to three stages of the cueing process and then proceeded to repeat this error in post-therapy assessments. Such reinforcement errors were found across the case-series with most examples occurring, unsurprisingly, in the more severely naming-impaired patients. Beyond naming severity, there was little evidence that this reinforcement was related to the participant's background cognitive-language status.

Although there were signs of limited additional benefits of errorless over errorful, the main "take home" message from this and the previous Fillingham et al. studies is that both therapies give rise to very similar outcomes. Consequently, this begs the question of the potential therapeutic value of making errors. Abel et al. had found greater therapy effects with increasing over decreasing cues (Abel et al., 2005). This then led them to conclude that people with aphasia were not hampered by errors. However, the data from the present study suggest that the errors that were evoked in the errorful therapies did not lead to greater depth or intensity of processing of named items. Instead, errors required a greater investment by participants in terms of effort and time, in that they had to be "managed" in the learning process, recognised, corrected, and replaced (Lambon Ralph & Fillingham, 2007). Despite the apparent risk of errorless learning being a more superficial form of word processing—at worst word form repetition only—this was clearly not the case as the degree of naming gain was the same for each participant in both therapies.

This leads us to consider participants' reactions and feedback to both therapies. All participants found the errorless therapy, especially initially, engaging and satisfying, as they were being given the chance to practise naming of items that were difficult for them. In contrast, all participants initially found the errorful therapy somewhat frustrating, as it asked them to name items they could not name. As the therapy sessions progressed, differing reactions emerged from the participants according to their baseline naming skills. For participants with severe naming impairments, they continued to find errorless therapy more satisfying, especially as in many cases these participants did not improve in their naming quickly and the errorful therapy gave them implicit reinforcement of this fact. For participants with more moderate and mild naming impairments the errorless therapy eventually became needlessly prescriptive and intrusive in the face of their improving naming skills. On the other hand, the hierarchical cueing of the errorful therapy provided more graded support and thus maintained a certain level of challenge throughout the therapy.

There was also a more objective difference between the two therapies, that of time investment. Errorless therapy was markedly quicker for all participants, particularly at earlier stages in therapy. Errorless therapy would typically take 10 minutes for each run through of the 40 pictures, hence approximately 20 minutes per session. Errorful therapy, on the other hand, tended to take at least 15 minutes per run, hence approximately 30 minutes per session. As the therapy progressed, this reduced for many of the participants as they began to name pictures at earlier stages in the cueing hierarchy but for some it did not.

As well as comparing errorless and errorful learning, the study also compared action as well as object naming under these conditions for the first time. The prediction that verb naming overall (regardless of type of therapy) would result in lower accuracy scores than noun naming was confirmed. This was striking given that none of the participants individually showed greater noun than verb naming at baseline assessment when 20 nouns and 20 verbs were matched for imageability, frequency and visual complexity (see Table 1). Given that it was not possible to match the therapy sets on imageability as well as other factors (see Method) this emergent difference between nouns and verbs after therapy might reflect either a true word-class effect or the underlying differences in terms of imageability.

However, only some participants (those with more severe naming impairments at baseline) did not improve verb naming accuracy as much as noun naming. Therefore, the post-therapy naming results for nouns and verbs across the study reflected what might be characterised as a severity-threshold effect. For the severely naming impaired participants—i.e., taken to be those who scored below 10/60 on the BNT, Boston Naming Test (Goodglass et al., 2001), at baseline (KP, PM, and RP)—there was a noun-naming advantage post-therapy. The description of a severity threshold effect relates to the fact that once participants achieved above this severe level in baseline naming (e.g., >10/60 on the BNT), their ability to progress with both noun and verb targets appeared to be strikingly similar. This included participants with moderate impairments in baseline naming (e.g., PO: 24/60 BNT) and mild impairments in baseline naming (e.g., WE: 40/60 BNT). It appeared, therefore, that once participants had a certain level of skill in naming, then they could progress with both word forms equally well. While the differences between participants in relative progress in therapy with nouns and verbs was predictable in terms of the threshold effect described, there were changes in naming accuracy between immediate and follow-up assessment points that diverged from the patterns already noted. Participant WE showed a significant noun advantage at the follow-up assessment point only. Overall, the noun–verb naming data from this study and a similar study reported elsewhere (Conroy, Sage, & Lambon Ralph, 2009) pointed to two types of *relative* difficulty in verb naming in aphasia: difficulty in improving in naming during therapy for verbs; and difficulty in retaining these improvements after therapy ceases. While the first of these did appear to relate to baseline naming ability (i.e., severely naming-impaired participants had greater difficulty improving in verb as opposed to noun naming in therapy), the second did not. Difficulty retaining improvements in verb naming after therapy may well have also been likely in the severely naming-impaired participants' performance, but may have been masked by floor effects (fewer verbs were named after therapy for these participants in any case). The final prediction made in the Introduction, that improvements in verb naming accuracy would be more vulnerable than noun naming to the effects of withdrawal of therapy, was not borne out by the data, as most participants both progressed with and retained their greater accuracy scores across nouns and verbs.

Overall, the results underlined some of the relative inherent difficulties in dealing with verb as opposed to noun naming. Although verb naming is not differentially improved by errorless therapy methods, this study adds to the existing evidence in the literature that this simple intervention is as effective as more traditional trial-and-error cueing methods. More generally, in line with very recent similar findings (Raymer et al., 2007), this study shows that verb as well as noun naming can benefit from simple, replicable therapies, which in the case of errorless therapy, can be both effective *and* time-efficient.

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REFERENCES

Abel, S., Schultz, A., Radermacher, I., Willmes, K., & Huber, W. (2005). Decreasing and increasing cues in naming therapy for aphasia. *Aphasiology*, *19*(9), 831–848.

Baddeley, A., & Wilson, B. (1993). When implicit learning fails: Amnesia and the problem of error elimination. *Neuropsychologia*, *32*(1), 53–68.

Bak, T., & Hodges, J. R. (2003). Kissing and dancing: A test to distinguish lexical and conceptual contributions to noun/verb and action/object dissociation. Preliminary results in patients with frontotemporal dementia. *Journal of Neurolinguistics*, *16*, 169–181.

Bastiaanse, R., Edwards, S., Maas, E., & Rispens, J. (2003). Assessing comprehension and production of verbs and sentences: The verb and sentence test (VAST). *Aphasiology*, *17*(1), 49–73.

Bastiaanse, R., Hurksmans, J., & Links, P. (2006). The training of verb production in Broca's aphasia: A multiple-baseline across-behaviours study. *Aphasiology*, *20*(2/3/4), 298–311.

Berndt, R. S., Mitchum, C. C., Haendiges, A. N., & Sandson, J. (1997). Verb retrieval in aphasia 1. Characterising single word impairments. *Brain and Language*, *56*, 68–106.

Black, M., & Chiat, S. (2003). Noun-verb dissociations: A multi-faceted phenomenon. *Journal of Neurolinguistics*, *16*, 231–250.

Bland, J. M., & Altman, D. G. (1994). Statistical notes: Regression to the mean. *British Medical Journal*, *308*, 1499.

Clare, L., Wilson, B., Carter, G., Breen, K., Gosses, A., & Hodges, J. R. (2000). Intervening with everyday memory problems in dementia of Alzheimer's type: An errorless learning approach. *Journal of Clinical and Experimental Neuropsychology*, *22*(1), 132–146.

Conroy, P., Sage, K., & Lambon Ralph, M. A. (2006). Towards theory-driven therapies for aphasic verb impairments: A review of current theory and practice. *Aphasiology*, *20*(12), 1159–1185.

Conroy, P., Sage, K., & Lambon Ralph, M. A. (2009). The effects of decreasing and increasing cue therapy on improving naming speed and accuracy for verbs and nouns in aphasia. *Aphasiology*, *23*, 707–730.

Druks, J. (2002). Verbs and nouns – a review of the literature. *Journal of Neurolinguistics*, *15*, 289–315.

Druks, J., & Masterson, J. (2000). *The Object Action Naming Battery*. London: Psychology Press.

Edwards, S., Tucker, K., & McCann, C. (2004). The contribution of verb retrieval to sentence construction: A clinical study. *Brain and Language*, *91*, 78–79.

Fillingham, J. K., Hodgson, C., Sage, K., & Lambon Ralph, M. A. (2003). The application of errorless learning to aphasic disorders: A review of theory and practice. *Neuropsychological Rehabilitation*, *13*(3), 337–363.

Fillingham, J. K., Sage, K., & Lambon Ralph, M. A. (2005a). The treatment of anomia using errorless vs. errrorful learning: Are frontal executive skills and feedback important? *International Journal of Language and Communication Disorders*, *40*(4), 505–524.

Fillingham, J. K., Sage, K., & Lambon Ralph, M. A. (2005b). Further explorations and an overview of errorless and errorful therapy for anomia: The number of naming attempts during therapy effects outcome. *Aphasiology*, *19*(7), 597–614.

Fillingham, J. K., Sage, K., & Lambon Ralph, M. A. (2006). The treatment of anomia using errorless learning. *Neuropsychological Rehabilitation*, *16*(2), 129–154.

Fink, R. B., Martin, N., Schwartz, M., Saffran, E., & Myers, J. L. (1992). Facilitation of verb retrieval skills in aphasia: A comparison of two approaches. *Clinical Aphasiology*, *21*, 263–275.

Goodglass, H., Kaplan, E., & Barresi, B. (2001). *BDAE-3 The Boston Diagnostic Aphasia Examination* (3rd ed.). Philadelphia: Lippincott, Williams & Wilkins.

Grant, D. A., & Berg, E. A. (1993). *Wisconsin Card Sorting Test*. Lutz, FL: Psychological Assessment Resources Inc.

Howard, D., & Patterson, K. (1992). *The Pyramids and Palm Trees Test: A test of semantic access from words and pictures*. Bury St. Edmunds, UK: Thames Valley Test Company.

Jefferies, E., Patterson, K., Hopper, S., Corbett, F., Baker, S. S., & Lambon Ralph, M. A. (2008). Deficits of knowledge vs. executive control in semantic cognition: Insights from cued naming. *Neuropsychologia*, *46*, 649–658.

Kay, J., Lesser, R., & Coltheart, M. (1992). *Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)*. Hove, UK: Lawrence Erlbaum Associates Ltd.

Kelly, M. H. (1992). Using sound to solve syntactic problems: The role of phonology in grammatical category assignments. *Psychological Review*, *99*, 349–364.

Komatsu, S., Mimura, M., Kato, M., Wakamatsu, N., & Kashima, H. (2000). Errorless and effortful processes involved in the learning of face-name associations by patients with alcoholic Korsakoff's syndrome. *Neuropsychological Rehabilitation*, *10*(2), 113–132.

Lambon Ralph, M. A., & Fillingham, J. K. (2007). The importance of memory and executive function in aphasia: Evidence from the treatment of anomia using errorless and errorful learning. In A. Meyer, L. R. Wheeldon, & A. Krott (Eds.), *Automaticity and control in language processing* (pp. 193–216). Hove, UK: Psychology Press.

Luzzatti, C., Raggi, R., Zonca, G., Pistarini, C., Contardi, A., & Pinna, G. (2001). On the nature of the selective impairment of verb and noun retrieval. *Cortex*, *37*, 724–726.

Marshall, J., & Cairns, D. (2005). Therapy for sentence processing problems in aphasia: Working on thinking for speaking. *Aphasiology*, *19*(10/11), 1009–1020.

Marshall, J., Pring, T., & Chiat, S. (1998). Verb retrieval and sentence production in aphasia. *Brain and Language*, *63*, 159–183.

Mattys, S., & Samuel, A. G. (2000). Implications of stress-pattern differences in spoken-word recognition. *Journal of Memory and Language*, *42*, 571–596.

McCandliss, B., Fiez, J., Protopapas, A., Conway, M., & McClelland, J. (2002). Success and failure in teaching the /r/ – /l/ contrast to Japanese adults: Tests of a Hebbian model of plasticity and stabilization in spoken language perception. *Cognitive, Affective, & Behavioural Neuroscience*, *2*(2), 89–108.

McClelland, J., Thomas, A. G., McCandliss, B., & Fiez, J. (1999). Understanding failures of learning: Hebbian learning, competition for representational space, and some preliminary data. *Progress in Brain Research*, *121*, 75–80.

Meyers, J. E., & Meyers, K. R. (1995). *Rey Complex Figure Test and Recognition Trial*. Lutz, FL: Psychological Assessment Resources Inc.

Mitchum, C. C., & Berndt, R. S. (1994). Verb retrieval and sentence construction: Effects of targeted intervention. In G. W. Humphreys & M. J. Riddoch (Eds.), *Cognitive neuropsychology and cognitive rehabilitation*. Hove, UK: Lawrence Erlbaum Associates Ltd.

Murray, L. L., & Karcher, L. (2000). A treatment for written verb retrieval and sentence construction skills. *Aphasiology*, *14*(5/6), 585–602.

Nickels, L., & Howard, D. (1999). Effects of lexical stress on aphasic word production. *Clinical Linguistics and Phonetics*, *13*, 269–294.

Page, M., Wilson, B., Shiel, A., Carter, G., & Norris, D. (2006). What is the locus of the errorless-learning advantage? *Neuropsychologia*, *44*, 90–100.

Pashek, G. (1998). Gestural facilitation of noun and verb retrieval in aphasia: A case study. *Brain and Language*, *65*, 177–180.

Raymer, A. M., Ciampitti, M., Holliway, B., Singletary, F., Blonder, L. X., Ketterson, T., et al. (2007). Semantic-phonologic treatment for noun and verb retrieval impairments in aphasia. *Neuropsychological Rehabilitation*, *17*(2), 244–270.

Raymer, A. M., & Ellsworth, T. A. (2002). Response to contrasting verb retrieval treatments: A case study. *Aphasiology*, *16*(10/11), 1031–1045.

Robertson, I. H., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention (TEA)*. Bury St. Edmunds, UK: Thames Valley Test Company.

Rodriguez, A. D., Raymer, A. M., & Gondalez Rothi, L. J. (2006). Effects of gesture + verbal and semantic-phonologic treatments for verb retrieval in aphasia. *Aphasiology*, *20*(2/3/4), 286–297.

Schneider, S. L., & Thompson, C. K. (2003). Verb production in agrammatic aphasia: The influence of semantic class and argument structure properties on generalisation. *Aphasiology*, *17*(3), 213–241.

Silveri, M. C., Salvigni, B. L., Cappa, A., Della Vedova, C., & Puopolo, M. (2003). Impairment of verb processing in frontal variant-frontotemporal dementia: A dysexecutive symptom. *Dementia and Geriatric Cognitive Disorders*, *16*, 296–300.

Sorenson, J. M., Cooper, W. E., & Paccia, J. M. (1978). Speech timing of grammatical categories. *Cognition*, *6*, 135–153.

Squires, E. J., Hunkin, N. M., & Parkin, A. J. (1997). Errorless learning of novel associations in amnesia. *Neuropsychologia*, *35*(8), 1103–1111.

Tailby, R., & Haslam, C. (2003). An investigation of errorless learning in memory-impaired patients: Improving the technique and clarifying theory. *Neuropsychologia*, *41*, 1230–1240.

Tyler, L. K., Bright, P., Fletcher, P., & Stamatakis, E. A. (2004). Neural processing of nouns and verbs: The role of inflectional morphology. *Neuropsychologia*, *42*, 512–523.

Wambaugh, J. L., Doyle, P. J., Martinez, A. L., & Kalinyak-Fliszar, M. (2002). Effects of two lexical retrieval cueing treatments on action naming in aphasia. *Journal of Rehabilitation Research and Development*, *39*(4), 455–466.

Wambaugh, J. L., Linebaugh, C. W., Doyle, P. J., Martinez, A. L., Kalinyak-Fliszar, M. M., & Spencer, K. A. (2001). Effects of two cueing treatments on lexical retrieval in aphasic speakers with different levels of deficit. *Aphasiology*, *15*(10/11), 933–950.

Warrington, E. K. (1996). *The Camden Memory Tests*. Hove, UK: Psychology Press.

Webster, J., Morris, J., & Franklin, S. (2005). Effects of therapy targeted at verb retrieval and the realisation of the predicate argument structure: A case study. *Aphasiology*, *19*(8), 748–764.

Wilson, B., Baddeley, A., Evans, J., & Shiel, A. (1994). Errorless learning in the rehabilitation of memory impaired people. *Neuropsychological Rehabilitation*, *4*(3), 307–326.

Wilson, B., & Evans, J. (1996). Error-free learning in the rehabilitation of people with memory impairments. *Journal of Head Trauma Rehabilitation*, *11*(2), 54–64.

APPENDIX

Sets of 20 nouns and 20 verbs and their psycholinguistic properties taken from Object Action Naming Battery (Druks & Masterson, 2000) and matched for imageability (imageabil), frequency (sloglemf, cpwdfreq and slogwfreq), age of acquisition (realaoa), familiarity, number of phonemes. and visual complexity (viscom).

PICTURE	*imageabil*	*sloglemf*	*cpwdfreq*	*slogwfreq*	*realaoa*	*familiarity*	*phonemes*	*viscom*
judge	4.25	1.82	16	1.45	4.41	2.09	3	4.6
conductor	4.36	0.95	0	0.95	4.09	2.69	8	4
knot	4.58	0	19	0	2.86	3.4	3	2.95
stool	4.75	0.3	16	0.3	2.78	4.73	4	2.78
slide	4.78	1.43	65	1.32	2	2.7	4	2.88
picture	4.83	2.34	273	2.16	1.76	5.03	5	5.15
whistle	4.86	0.48	68	0.3	2.54	2.56	5	2.65
hammock	5.11	0	11	0	4.02	1.98	5	3.2
saddle	5.14	0.3	24	0	3.38	2.28	5	3.63
picnic	5.36	0.3	227	0	2.54	2.84	6	6.15
pocket	5.36	1.34	78	1.2	2.23	4.83	5	3.68
king	5.36	1.7	698	1.63	2.48	2.11	3	5.23
devil	5.42	1.11	0	0.9	3.41	1.83	5	4.58
shower	5.42	0.7	22	0.6	2.93	6.05	3	3.2
fruit	5.42	1.34	133	1	2.26	5.53	4	4.7
sword	5.44	0.7	24	0.6	3.04	1.81	3	2.25
waitress	5.44	0.6	5	0.48	3.83	3	6	5.03
brain	5.47	1.6	32	1.54	3.22	5.37	4	4.55
ticket	5.47	1.79	11	1.38	3.04	5.49	5	3.18
chain	5.47	1.26	24	1.18	3.19	2.98	3	3.68
MEAN	5.11	1.00	87.30	0.85	3.00	3.47	4.45	3.90
St Dev.	0.39	0.7	155.24	0.65	0.71	1.46	1.29	1.07
skating	4.61	0.48	32	0	3.23	2.1	6	3.5
kicking	4.69	1.2	65	0.3	2.1	2.69	5	4.28
ironing	4.78	0	8	0	3.23	3.86	5	5.3
jumping	4.78	1.56	157	1.11	1.85	3.4	6	3.93
flying	4.81	1.6	233	1.23	2.5	3.98	5	4.28
dancing	4.86	1.56	95	1.08	2.35	4.36	6	4.7
fishing	4.89	0.85	100	1.08	3.35	2.05	5	5.6
running	4.89	2.43	265	1.89	1.88	4.55	5	3.58
skiing	4.92	1.34	5	1.2	4.03	2.05	5	3.88
painting	4.92	1.46	154	0.85	2.1	3.52	6	3.83
bleeding	4.97	0.78	3	0.7	2.45	3.69	6	4
raining	5.03	0.7	57	0.6	2.13	5.48	5	2.6
drinking	5.08	1.7	41	1.32	1.5	6.48	7	4
driving	5.14	2.06	32	0.7	2.83	5.64	6	4.88
walking	5.14	2.09	108	1.64	1.68	6.45	5	3.53
swimming	5.17	1.48	154	0.7	2.43	4.21	6	4.33
smoking	5.31	1.42	3	1	3.1	4.71	6	4.38
snowing	5.42	0.3	30	0.3	2.18	3.26	6	4.35
smiling	5.44	1.04	41	0.48	1.43	6.19	6	3.45
kissing	5.47	1.15	3	0.6	1.83	5.48	5	3.55
MEAN	5.02	1.26	79.30	0.84	2.41	4.21	5.60	4.10
SD	0.25	0.77	73.52	0.56	0.68	1.53	0.59	0.7