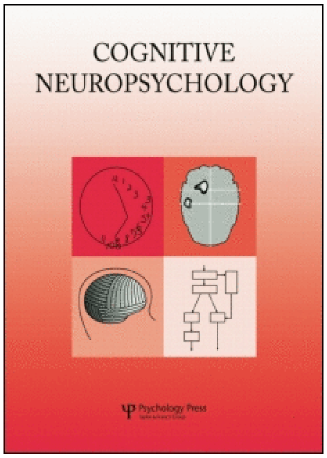

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ORAL NAMING AND ORAL READING: DO THEY SPEAK THE SAME LANGUAGE?

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We present evidence from a fluent aphasic subject with intact comprehension but moderate word-finding difficulties. Despite her anomia in picture naming, MOS displayed normal performance in reading aloud, even when tested on lower-frequency words with atypical spelling-to-sound correspondences. We argue that, contrary to some recent interpretations of preserved reading with impaired naming, this pattern does not demonstrate separate task-specific speech lexicons, but rather reflects inherent differences between the processes of naming and reading. In support of this hypothesis, when given appropriate assistance (in this case multi-phonemic cueing), MOS achieved picture naming scores within normal limits.

INTRODUCTION

When does differential performance on two tasks imply a dissociation between two cognitive processes or systems? This is clearly a question that goes to the heart of the single-case approach in neuropsychology. When a patient performs as well as normal control subjects on task A but significantly below the normal range of scores on task B, it is frequently concluded that two separate subsystems must underlie performance on the two tasks. Through a gradual accumulation of these dissociations, the cognitive neuropsychological approach can propose, test, and refine theories about mental structure (see Ellis & Young, 1988; Shallice, 1988). There are situations, however, in which differential performance should not be considered to reflect a dissociation between subsystems. Shallice (1988) notes a variety of such conditions, and the one that we shall consider here is perhaps the most straightforward of these. Although normal performance on both tasks A and B may be at or near ceiling, B may nonetheless constitute a more demanding task than A. This would render B more vulnerable to cognitive impairment. We shall consider these two alternative explanations for differential performance between tasks with specific reference to the relationship between oral reading of words and oral naming of objects.

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Naming and Reading: A Multiple-system Interpretation

Breen and Warrington (1995) reported data collected from patient NOR following his surgery for a large left-hemisphere posterior basilar aneurism. Four to five months post-operatively, NOR had excellent comprehension of both spoken and written words but very poor naming. He failed to score on the Oldfield picture set and named only 6/40 coloured pictures of common objects; this increased to 22/40 over the next 8 months. Breen and Warrington assessed NOR's performance in naming and reading aloud using the same set of 40 picturable items whose names have irregular spelling-sound correspondences (such as *yacht* and *bouquet*[1]. NOR named only 2/40 correctly but read 39/40. Breen and Warrington noted that although NOR had read half the picture labels a few minutes before attempting to name the corresponding pictures, his naming score did not improve. When a target word is produced in the task of word repetition (Patterson, Purell, & Morton, 1983) or reading (Lambon Ralph, 1998), its facilitating effect on subsequent picture naming by anomic aphasic patients has been shown to evaporate extremely rapidly; nonetheless, Breen and Warrington argued that, if the phonological word-forms for reading and naming are one and the same, then reading the target label might be expected to facilitate an anomic patient's subsequent attempts at naming the picture.

This possibility was tested further in two additional experiments. In the first, Breen and Warrington varied the lag between NOR's oral reading of the label and his attempt to name the picture, from 1 to 12 intervening items. There was no significant improvement in NOR's naming, even for the subset of items at lags of 1–5 items with a maximum of 1 minute between his reading response and naming attempt. A third experiment was conducted 5 months later in which NOR was asked to name 36 object pictures under 3 conditions. In unprimed naming, he succeeded in naming 50% of the target pictures, an improvement from the 28% achieved 5 months earlier. When he read the label immediately prior to naming the picture, his naming performance was perfect. When a filled delay (15–20 seconds of counting backwards) was inserted between reading and naming, NOR's naming score was 67%; the authors comment (Breen & Warrington, 1995, p. 586) that this brief delay was "sufficient to significantly reduce but not completely eliminate any effect of prior reading on naming performance". Breen and Warrington concluded that NOR's pattern of performance would be difficult to explain in a model assuming a shared route to phonology for reading and naming.

A similar dissociation between reading and naming was reported by Orpwood and Warrington (1995) for patient MRF, who had suffered a cerebrovascular accident primarily affecting left fronto-temporal-parietal structures. MRF was found to have normal comprehension as measured by both spoken and written versions of the Peabody Picture Vocabulary Test and by a graded synonym judgement test including concrete and abstract terms. He also had normal ability to read aloud real words, both regular and irregular. In contrast, he demonstrated impaired nonword reading, scoring 51% and 29% correct, respectively, on two different sets of monosyllabic nonwords. MRF was also significantly impaired in naming of pictures (e.g. 40/60 on the Boston Naming Test), naming to definition, and spelling in both the tasks of writing to dictation and written naming. In naming and spelling, MRF's performance was significantly worse for verbs than nouns.

[1] We note here the problem of stimulus selection for any study that aims to compare reading and naming in this fashion. As discussed by Graham et al. (1994) in their attempt to choose materials suitable for both tasks, relatively few objects with unambiguous labels have written names with highly atypical spelling-sound correspondences. Graham et al. considered high name agreement to be essential and thus settled for a less than perfect set of words for the reading task. From the two examples provided by Breen and Warrington (*yacht* and *bouquet*), we surmise that they chose the opposite compromise: At least these two are highly irregular words for reading, but they do not have unambiguous picture names (a *yacht* could legitimately be called "sailboat" or "boat", and a *bouquet* can presumably be named "flowers"), perhaps making this an especially difficult naming test.

In two direct comparisons of MRF's naming and reading, Orpwood and Warrington found near-perfect reading but impaired naming (Graded Naming Test: reading 26/30, naming 7/30; Oldfield naming test: reading 29/30, naming 19/30). In a further experiment, the authors compared performance in naming, spelling, reading, and word comprehension (the latter with a test of spoken word-picture matching where the two picture alternatives were the target and a close semantic foil) across the same 60 verbs and 60 nouns. MRF's comprehension was near perfect (119/120), though it should be noted that this is a test with a 50% chance level. His reading aloud was good although perhaps slightly impaired for verbs (58/60 nouns; 52/60 verbs). By contrast, he was clearly impaired for naming (52/60 nouns; 32/60 verbs) and spelling to dictation (41/60 nouns; 27/60 verbs).

Orpwood and Warrington noted three differences between MRF's reading and naming: (1) he was less accurate when naming than reading; (2) he demonstrated a part-of-speech effect in naming but not reading, despite intact comprehension; (3) his naming errors were omissions and semantic errors whereas, on the few occasions that he misread a word, MRF produced visual errors. Because MRF was impaired at nonword reading, Orpwood and Warrington inferred that his reading of real words must have relied on meaning. Furthermore, as his comprehension was intact, they argued that the dissociation between reading and naming must reflect differential impairment in post-semantic processes. They concluded that the qualitative and quantitative differences between reading and naming (and also spelling) were best explained by a model of word production in which there are separate word-form systems for each task. They also argued that these output systems are subdivided by syntactic category and possibly by semantic category. It is, however, the conclusion both of Breen and Warrington and of Orpwood and Warrington regarding separate speech lexicons for naming and reading that is the focus of interest here.

We note that Breen and Warrington (1995) were well aware that their hypothesis (that reading and naming activate different output systems) entails the following prediction: In addition to patients with intact comprehension and reading but impaired naming, there should also be cases of intact comprehension and naming but impaired reading of words with irregular spelling-sound correspondences. They cite one reported case demonstrating this pattern, that of BF (Goldblum, 1985); but three factors lead us to query this case as convincing evidence for the double dissociation. (1) BF had a complex pattern of reading impairment, with not only the salient feature of surface dyslexia (consistent > inconsistent words), but also both lexical (words > nonwords) and semantic (concrete > abstract) effects that are typically associated with different forms of acquired dyslexia. (2) BF's reading and naming performance was never compared on the same items, making it difficult to draw firm conclusions about her relative skill on these two tasks. (3) Most important, although BF was certainly not profoundly anomic, Goldblum reported her success in naming 20 real objects and 18 pictures as 27/38 = 71%. It is true that in almost every case scored as an error, following one or more initial incorrect responses (semantically or phonologically related to the target, including some phonemic paraphasias) BF eventually produced the correct name; but this does not seem to us to demonstrate unimpaired, efficient activation of phonology by meaning in the naming task.

Naming and Reading: How Do They Differ?

There are two reasons why one would not necessarily expect anomia to be accompanied by a reading impairment even if the two tasks activate the same set of phonological word forms. First of all, most models of naming assume that only one type of information or code—semantic—can serve as the source of phonological activation in naming (e.g. Humphreys, Lamote, & Lloyd-Jones, 1995). By contrast, most if not all conceptions of the reading process include two sources of phonological activation—orthographic and semantic (e.g. Coltheart, Curtis, Atkins, & Haller, 1993; Hillis & Caramazza, 1991; Kawamoto & Zemblidge, 1992; Plaut, McClelland, Seidenberg, & Patterson, 1996; Weekes, Chen, & Gang, 1997; Weekes & Robinson, 1997). Thus reading aloud, which is achieved by a combination (or "summation": cf. Hillis & Caramazza, 1991, 1995) of the phonological activation deriving from these two sources, should be less vulnerable to damage. Second, orthography is not just an additional source of activation: It is one that provides considerable internal structure specifying elements of the corresponding phonological code. The relationship between the meaning of a concept and its phonological label is arbitrary and whollistic: If one does not know what a whole object is called, there are no clues available from any segment of it. In all alphabetical orthographies, on the other hand (and even in most nonalphabetic writing systems), there are principled clues to the appropriate phonology from segments of the written form. In orthographically "deep" English (in contrast to relatively transparent orthographies like Italian, Serbo-Croatian and Japanese Kana), however, these segmental clues are only partially reliable, which is why the spelling-sound relationship in English has been described as "quasi-regular" (Plaut et al., 1996).

It is of course exactly because of this last fact that Breen and Warrington (1995) were careful to assess NOR's reading and naming performance on object names with irregular spelling-sound correspondences, and that Orpwood and Warrington (1995) emphasised MRF's impairment in nonword reading. On the two-route view of reading proposed by these authors, correct reading of irregular words is accomplished by a lexical-semantic procedure and correct reading of nonwords by a separate sublexical route. By this account, the normal ability of both patients to read irregular words demonstrates intact lexical-semantic reading; and MRF's subnormal nonword reading is taken as further evidence that he must have achieved his reading by the whole-word lexical-semantic route. If all of the components of this route from meaning to phonology were shared by the tasks of naming and reading, then on this view, anomic patients should also be impaired at reading irregular words. That is, they should show a surface dyslexic pattern of reading performance, as indeed many anomic patients do (see for example Behrmann & Bub, 1992; Coltheart & Byng, 1989; McCarthy & Warrington, 1986; Patterson & Hodges, 1992). It was the absence of a surface pattern of reading for NOR and MRF, in the context of this theory about reading, that led Breen and Warrington and Orpwood and Warrington to their conclusion that the two tasks must activate separate phonological output systems.

Some other views of the reading process, however, propose a rather less "either-or" picture of the operation of the lexical/semantic and sublexical procedures. Despite some significant differences in their details, the accounts of reading offered by Funnell (1996), Hillis and Caramazza (1991), Howard and Franklin (1988), Marshall and Newcombe (1973), Plaut et al. (1996), and others, all suggest that both of these procedures contribute in a collaborative fashion to the computation of phonology for a written word. Furthermore, according to these views, the correct pronunciation of a written word, even one with an atypical spelling-sound correspondence, is somewhat overdetermined by the combination of information from these two procedures. As a result, some degree of disruption to one or other procedure (or even to both: see Hillis & Caramazza, 1991) might still leave a patient able to achieve word-reading performance within normal limits.

By this kind of account, neither NOR nor MRF would demand the radical solution of different representations for speaking the names of pictures and the names of written words. Suppose that we make the (oversimplified) assumption that a patient's picture naming performance reflects the status of the lexical-semantic route for reading. Then in the case of NOR (Breen & Warrington, 1995), whose naming was rather severely impaired but whose sublexical reading procedure was presumably intact[2], the summation of full phonological information from the direct orthographic-to-phonological computation with reduced but not abolished activation from the semantic route would enable cor-

[2] The authors did not report NOR's nonword reading but no doubt would have done so had it been impaired.

rect reading of irregular words (see Funnell, 1996, for this interpretation of a different case). For patient MRF (Orpwood & Warrington, 1995), picture naming—at least for nouns—was only rather mildly disrupted, but his sublexical reading was impaired. In this case, one might infer that the balance of summed phonological activation from the two reading processes was shifted somewhat more towards semantic reading. This interpretation receives some support from the observation that MRF was less than perfect (84% correct) in reading aloud high-frequency function words. The account is not challenged by the fact that MRF made semantic errors in naming but none in reading. Ever since Newcombe and Marshall (1980), it has been widely accepted (1) that even minimal information about general spelling-sound relationships can block semantic reading errors like *symphony* → "orchestra"; and (2) that this may constitute a critical difference between deep dyslexic patients, who make semantic reading errors and typically produce not a single correct phoneme when asked to read nonwords, and a phonological dyslexic patient like MRF, who made no semantic reading errors and produced a rather respectable 51% of *completely* correct responses to Glushko's (1979) nonwords.

Since correct naming requires full activation of every element of the phonological representation, naming performance in fact probably underestimates the degree of activation from the semantic system to the phonological lexicon. Thus it seems plausible to assume that, even though NOR's naming was severely disrupted, there might still have been some partial semantic activation of phonology available to support reading aloud of irregular words[3]. On this hypothesis, one should in principle be able to facilitate naming by providing an additional source of phonological activation. The success of this principle has been demonstrated by Lambon Ralph (1998) in a study of a head-injured patient, JS, with intact comprehension but severe anomia (e.g. 16/60 on the Boston Naming Test: Kaplan, Goodglass, & Weintraub, 1976; 4/30 on the Graded Naming Test: McKenna & Warrington, 1983). Like patient NOR (Breen & Warrington, 1995), JS could read aloud nearly perfectly (and well within the normal range), including low-frequency exception words. Lambon Ralph demonstrated that JS's naming performance, even for consistently unnamed items, could be facilitated by two methods. In the first, JS was asked to read the name of the target picture either 15 minutes or 3 trials (approximately 30 seconds) prior to attempting to name the picture (a method very similar to Breen & Warrington, 1995). There was a significant improvement in JS's naming score when the delay was short, but no effect after a 15-minute interval, suggesting again that the facilitation of phonological word-forms is short-lived. The second method used a multi-phonemic cueing technique. JS had been given the Hundred Picture Naming Test (Howard & Franklin, 1988) on three occasions and, on average, he named only 52/100 items correctly. With additional cues that gradually increased the number of phonemes from the target word, JS was able to name all the remaining pictures from this test, including the 33 items that had been named on *none* of the three unprimed tests. In this kind of cumulative phonological presentation (similar to the technique known as *gating* in the literature on spoken word recognition: Grosjean, 1980; Tyler & Wessels, 1985), normal and even aphasic listeners can uniquely identify most words at a point (called the 'uniqueness' or 'recognition' point) prior to the end of the word (Graham, Patterson, & Hodges, 1995; Tyler, 1992). It is therefore important to note that the phonemic fragments that enabled JS to name otherwise un-named items all stopped short of the uniqueness point for these target words (Lambon Ralph, 1998).

In this study, we present data from an aphasic subject with moderate word-finding difficulties but

[3] An earlier study of NOR (Breen & Warrington, 1994) demonstrated significant facilitation of his picture naming by the provision of a very unconstraining sentence frame for which the name of the picture was a plausible completion. This intriguing result suggests that there must have been substantial activation of the correct phonological representation from the semantic code for the picture (although this was on its own clearly inadequate to support a response) that could combine with the information from the sentence frame to boost naming performance.

intact reading. We demonstrate that her naming performance could be (temporarily) improved by the use of multi-phonemic cues, suggesting that two sources of phonological activation can combine to produce adequate performance in naming as well as reading. On this basis, we argue that there is no need to propose separate sets of phonological representations for word production in these two tasks.

CASE REPORT

MOS, a 50-year-old right-handed woman, was a retired nurse who suffered from medically refractory partial epilepsy. The onset of her epilepsy appeared to have been at around the age of 5 years, and generalised seizures occurred at a rate of approximately 4–6 per month. An MRI scan performed in October 1996 revealed left-sided hippocampal sclerosis manifested both as a signal change and volume loss. This was the only visible abnormality.

Our study was conducted between April and June 1997. MOS obtained a verbal IQ of 108 and a performance IQ of 86 on a shortened version of the WAIS-R. Her reading of the words from the NART (Nelson, 1982) gave an estimated premorbid intelligence in the high average range (12/50 errors, predicted IQ = 116). Consistent with the picture of hippocampal damage, the patient's most notable abnormality (apart from the moderate anomia described further below) was in tasks requiring new episodic memory. For example, on the Warrington Recognition Memory Test (Warrington, 1984), MOS's score was at the 10th percentile on the verbal version and between the 5th and 10th percentile on the visual version (Words = 40/50; Faces = 38/50). Her visual recognition and perceptual functioning, as assessed by two subtests from the Visual Object and Space Perception Battery (VOSP: Warrington & James, 1991), were in the lower end of the normal range (Object Decision = 15/20; Fragmented Letters = 16/20). Her performance on tasks sensitive to frontal lobe damage was normal. She gave adequate Cognitive Estimates and her word fluency for phonological and semantic categories was within normal limits.

MOS's comprehension was assessed across a series of tasks. She scored 45/52 on the picture version and 49/52 on the word version of the Pyramid and Palm Trees Test (normal controls make 0-3 errors: Howard & Patterson, 1992). On a graded synonym judgement test (Warrington, McKenna & Orpwood, 1998) that includes concrete and abstract items, her score of 39/50 was between the 25th and 50th percentile. On another synonym judgement test with concrete and abstract words of high and low frequency (Franklin, Turner, & Ellis, 1992), MOS achieved a score of 157/160 (normal controls make 0–5 errors). On the Shallice and McGill word-picture matching task (Shallice & Coughlan, 1980), MOS attained 27/30 for the concrete items and 22/30 on the abstract concepts, both of which are within the range of undergraduate subject scores (10 subjects, range on concrete items 27–30; range for abstract words 21–29); her score for the "emotional" concepts, however, was only 6/15, which is not much above chance for this 4-alternative forced-choice test (similar-aged controls, mean score = 13.2 [Shallice, personal communication]; undergraduate range 11–15).

In spite of good comprehension (apart perhaps from her understanding of emotional concepts), MOS presented with a clear anomia. She only managed to name orally 5/30 pictures from the Graded Naming Test (less than the 1st percentile: McKenna & Warrington, 1983) and was equally poor when naming the same items from definition (7/30 correct). Similarly, MOS only named 17/30 of the Oldfield set (Oldfield & Wingfield, 1965). Her written naming accuracy on the same sets was very similar (GNT: 8/30; Oldfield set: 19/30). On a selection of pictures with low frequency names, MOS orally named 24/89 correctly. Her predominant error type was no response (48/65 errors) although she made occasional semantic errors (9/65 errors: e.g. *starfish* → "prawn", *casserole* → "saucepan"), circumlocutions (4/65 errors: e.g. *octopus* → "something in the sea", *barometer* → "for telling the weather"), and visual errors (4/65 errors, e.g. *turkey* → "shellfish", *lobster* → "butterfly").

We have already noted MOS's excellent reading aloud of the words from the NART. She achieved good performance on the high- and low-frequency regular and exception words from the Surface List (Patterson & Hodges, 1992): 185/192 correct, with 3 visual errors and 4 regularisations or LARC errors (Legitimate Alternative Reading of Components: Patterson, Suzuki, Wydell, & Sasanuma, 1995), almost all on low-frequency exception words. Her nonword reading was also very good (she read 81/86 of the Glushko, 1979, nonwords correctly). Thus, like NOR (Breen & Warrington, 1995) and MRF (Orpwood & Warrington, 1995), MOS had significant anomia unaccompanied by any measurable deficit in either comprehension or reading.

A DIRECT COMPARISON OF READING AND NAMING

MOS was asked to name and read a set of picturable words with irregular spelling-sound correspondences in three frequency bands (from Graham, Hodges, & Patterson, 1994) in an ABBA design (see Table 1). MOS read all the words, including the low-frequency irregular items, without error but named only 77/102 (75%) of the pictures correctly; the difference between naming and reading was significant by a Binomial test, $P < .001$. For these pictures her error types were as follows: 10/25 no responses, 13/25 semantic errors (e.g. *nest* → "egg", *bear* → "sea lion"), and 2 circumlocutions.

On a second set of 37 pictures with low-frequency irregular names, MOS read 33/37 of the written names correctly but named only 18 of the pictures (a significant difference: Binomial, $P < .001$). Her predominant type of naming error was a failure to respond (14/19 errors) and she also made 5 semantic errors (e.g. *canoe* → "yacht", *dove* → "sparrow"). Her four reading errors were all regularisation or LARC errors, e.g. *canoe* → /'kænou/.

Table 1: *Comparison of MOS's naming and reading aloud on words taken from Graham et al. (1994).*

Word	*Naming*		*Reading*	
Frequency	*Regular*	*Irregular*	*Regular*	*Irregular*
Low	14/20	15/20	20/20	20/20
Medium	13/17	12/17	17/17	17/17
High	11/14	12/14	14/14	14/14
Total	38/51	39/51	51/51	51/51

REPETITION

If a pattern of poor naming but intact reading implies separate phonological lexicons dedicated to each task, it is only a small extension to suggest that there might be a separate output system for repetition as well. On the alternative view expressed in the Introduction, a spoken word presented for repetition activates not only the same semantic system but also the same speech lexicon as in naming and reading. Like a written word, however—only more so—the spoken word provides an additional direct source of activation to the phonological word-form for production. This should make the repetition task less vulnerable than object naming to impairments in the semantic system and/or communication between meaning and phonology. When this kind of impairment is severe, then a sufficiently demanding repetition task may in fact reveal the detrimental effects of reduced activation from meaning. For example, several patients with profound anomia (mostly with severe semantic disorders as well) performed perfectly in immediate single word repetition but produced a startlingly high rate of error when asked to repeat a series of three or four words (Patterson, Graham, & Hodges, 1994) or even a single word after a short filled delay (Graham et al., 1995; Knott, Patterson, & Hodges, 1997). These errors were typically phonological blends of segments from different target items, and their rate of occurrence was strongly modulated by semantic factors such as word imageability or, even more strikingly, the patient's own comprehension performance on the target words. Note that there is now evidence that, even in language-intact normal subjects, the semantic factor of word concreteness/imageability facilitates the speed of single-word repetition (Tyler, Voice, & Moss, 1996) and the accuracy of multi-word immediate serial recall (Walker & Hulme, 1997).

MOS was given a variety of different repetition assessments[4]. Her forward repetition span was at least 7 digits. She was asked to repeat 15 individual words (of varying frequency and imageability) after a filled delay of 15 seconds, during which she was required to count forward rapidly (she managed to count from 1 to about 45 on each trial). MOS repeated every word without error. She was then given 16 lists of 4 words each for immediate serial recall, with the imageability and frequency of the words varying between lists (from Knott et al., 1997). MOS repeated 63/64 words correctly (15/16 sequences), making only 1 possible blend error ("leap" from leaf + lip).

Given that MOS performed well in these repetition tasks, then by the logic of Orpwood and Warrington (1995) one might conclude that word repetition relies on a different speech lexicon from the (impaired) one that MOS uses in picture naming. In our preferred account, successful repetition paired with disrupted naming instead reflects a single speech production system with different sources and levels of phonological activation for the different tasks.

NAMING AND CUEING

As noted in the Introduction, picture-naming performance by patient JS (Lambon Ralph, 1998) had been successfully facilitated by the use of multi-phonemic cues, even for pictures that he had failed to name on a number of occasions. We repeated this paradigm with MOS using the pictures from the Boston Naming Test (Kaplan et al., 1976). MOS was given 10 seconds to name each picture. After this period, the examiner provided the initial phoneme as a cue. If the cue failed to elicit the correct response, it was increased by one phoneme and MOS was given another 5 seconds to try to name the picture. This incremental procedure was repeated until MOS either gave the correct name or the entire picture label was included within the cue[5]. As noted earlier, this incremental cueing technique provides a clinically-practical alternative to the auditory word gating paradigm (Tyler, 1992), with the following differences. First of all, each successive cue here adds a discrete phoneme to the previous prompt rather than a temporally defined chunk of the spoken word (typically 50msec increments in the gating paradigm). Second, the gating paradigm, at least with normal subjects, is of course not conducted with a picture of the target word present (though see Graham et al., 1995, for use of the gating technique with and without pictures for an anomic aphasic patient). Finally, progressive phonemic cues, which increment by rather artificial phoneme chunks, disrupt the co-articulation information present in the roughly equivalent acoustic fragments of the gating paradigm.

MOS named 29/60 of the Boston Naming Test pictures correctly without assistance[6]. The incorrect items comprised 21 no responses and 10 semantic errors (e.g. *globe* → "universe", *wreath* → "bouquet"). The multi-phonemic facilitation proved extremely successful. Of the 31 unnamed pictures, only 6 failed to be named after cueing (i.e. 6 items where the full phonological form of the target picture was reached before MOS was able to name it). A combination of 29 spontaneously named and 25 named with a cue gives a very respectable score for this test (54/60: normal controls name 46–60 correctly). Between 1 and 3 phonemes were normally required: mean phoneme length of the successful cues was 2.52; number of pictures named after one

[4] We have also been able to assess patient JS (Lambon Ralph, 1998) on the same tasks. His performance was qualitatively and quantitatively very similar to MOS. His forward digit span was seven. On the multi-word repetition JS correctly recalled 63/64 words (15/16 sequences) with only 1 possible blend error ("true" from due + trim). On the single-word repetition with filled-delay, JS repeated all the words without error.

[5] In this procedure consonant clusters were split into their constituent parts, and initial consonants or consonant clusters were followed by schwa.

[6] On a separate occasion we asked MOS to write the names from the BNT. Her score (25/60) was, again, very similar to that achieved in oral naming.

phoneme 6/25; two phonemes 6/25; three phonemes 8/25; four phonemes 4/25; five phonemes 1/25).

The multi-phonemic cueing technique produced another interesting observation. On several occasions, MOS initially produced a semantic error containing the cue, although with additional phonemes she eventually produced the correct name. For example, to the picture of a *beaver* she initially gave no response; with the first phoneme she said "badger"; with two phonemes she gave the correct response, "beaver". For the picture of a *hammock* she initially named it as a "swing"; after /h•/ she produced "harness" but in response to /hæm/ MOS gave the appropriate name. We shall comment further on this finding in the Discussion.

We also used this technique with the pictures described earlier which have written names with irregular spelling-sound correspondences. For the 37-item low-frequency picture set, spontaneous naming and the multi-phonemic cueing method were assessed in the same testing session. As noted earlier, MOS spontaneously named 18/37 correctly. Multi-phonemic cueing was very successful (mean phoneme length required was 2.35; named with one phoneme 5/19; two phonemes 2/19; three phonemes 4/19; four phonemes 3/19). If spontaneous and cued naming are combined, her score of 32/37 correct is virtually the same as that obtained when she read these same words aloud (33/37). Furthermore, two of the four items that MOS read incorrectly also failed to be successfully cued for naming. There were, again, a few occasions on which MOS produced a semantic error containing the correct cue (e.g. to the picture of a *palette*, she responded "paint" after the initial phonemic cue) although with sufficient phonemes MOS was able to provide the correct name.

MOS had named 77/102 of the pictures taken from Graham et al. (1994). On a separate occasion, she was presented with 23 pictures that she had failed to name previously. Of these unnamed items, she spontaneously named 11/23; of the remaining 12 items, 11 were named with a phonemic cue (mean phoneme length required was 1.82; named with one phoneme 6/11; two phonemes 3/11; three phonemes 1/11; five phonemes 1/11).

COMBINED COHORT ANALYSIS

Lambon Ralph (1998) found that the length of the phonemic fragments required to cue JS's naming successfully all stopped short of the uniqueness point. For a comparable analysis of MOS's performance, we combined the cueing data from the three tests reported earlier. In total there were 62 unnamed pictures, of which 12 items remained unnamed until the entire word was contained within the phonemic cue. These 12 pictures represented relatively unfamiliar objects and, consequently, their names may not have been in MOS's premorbid vocabulary (e.g. toucan, platypus, centaur, pretzel, and abacus). MOS named the remaining 50 pictures (mean length 5.22 phonemes) following a cue between 1 and 5 phonemes in length (mean 2.26 phonemes). To estimate the size of the phonological cohort for each item, we used the entries in MRC Psycholinguistic Database with a phonemic transcription (Coltheart, 1981) to count the number of words that begin with the successful cue. The mean estimated cohort size from this database was 278.04 words (range between 1 and 2322 words). There were only five pictures for which MOS required a cue that exceeded the uniqueness point, that is, the cohort only contained the target item, as derived from the MRC Psycholinguistic Database, and again these were items with relatively infrequent names (pagoda, seahorse, asparagus, parachute, and trellis).

DISCUSSION

We have presented data collected from a fluent aphasic patient, MOS. Although detailed assessment on both concrete and abstract words turned up no clear evidence of a comprehension abnormality, MOS had obvious word-finding difficulties. When she failed to name pictures to confrontation, her errors comprised no responses (the majority) and some semantically related responses. Her reading aloud was excellent even for nonwords and for words with exceptional spelling-to-sound correspondences, as was her repetition, even when four-item word lists were to be reproduced after a filled delay. These data indicate a locus of impairment somewhere between semantic and phonological representations, neither of which were themselves detectably disrupted. The functional impairment between semantics and phonology could result from a number of different causes: (1) the semantic representations were sufficient for comprehension but insufficient on their own to activate the entire premorbid vocabulary, (2) the activation between semantics and phonology was attenuated, and (3) the phonological representations though not perturbed were hard to activate. It would be difficult, in practice, to distinguish between these possibilities. For the purposes of this paper, however, the critical point is the contrast between MOS's anomia and her intact oral reading.

The pattern of data presented here is very similar to that reported for patient NOR (Breen & Warrington, 1995) and in some ways to that of patient MRF (Orpwood & Warrington, 1995). All three patients demonstrated qualitative and quantitative differences between reading and naming. This differential performance could be explained in terms of a cognitive/linguistic architecture with a set of task-specific output systems. Thus MOS would fit the description offered by Warrington and colleagues for NOR and MRF: disruption to the naming-specific speech lexicon, with complete preservation of the output system for reading.

We prefer an alternative hypothesis in which reading and naming (also repetition) rely on the same set of phonological representations for speech production, and where apparent dissociations between tasks are attributable to differential task demands. Naming is the most vulnerable, (1) because there is only one source for the activation of phonology, and (2) because this source—conceptual knowledge —has an arbitrary mapping to phonology. Reading benefits both from having two sources of phonological activation and from the quasi-regular nature of the direct mapping between orthography and phonology (in English and indeed most writing systems). In the triangle model (Plaut et al., 1996), the major source of activation in reading aloud comes from the direct mapping between orthography and phonology. In order to read many low-frequency exception words correctly, *some* activation of phonology by semantics is required. Although a patient may be unable to name a picture, this does not demonstrate that there is *no* activation of the target word-form from its meaning. Even less than complete information from the two sources should combine to produce good reading accuracy.

Many other models of reading aloud provide similar accounts (Funnell, 1996; Hillis & Caramazza, 1991, 1995; Howard & Franklin, 1988; Newcombe & Marshall, 1980)[7]. For example, according to Newcombe and Marshall, a semantic representation activated by either an object or a written word sends activation to representations in the (single) phonological lexicon. If there is some disruption or underspecification in this communication from meaning to phonology, then in naming, where there is no additional source of information to boost activation of the correct name or block activation of a semantically similar alternative, either no-response or semantic errors may result. This is what we observed in picture naming by MOS. In reading, if no additional phonological activation were available directly from orthography, then a patient would also be prone to semantic or

[7] One review of this paper pointed out that although there are a number of theories in which reading is presumed to rely on the combination of direct orthography → phonology computation and semantic activation of phonology, there is a great need for more specific information about how much activation needs to be available from each source to yield the correct response. We could not agree more with this observation. We do not know, however, of any method by which the degree of phonological activation by semantics can be quantified during oral reading. Instead, this hypothetical "quantity" has to be inferred either from the degree of anomia or from the integrity of the semantic representations themselves (for varying views on the degree of semantic impairment required to elicit surface dyslexia, see: Funnell, 1996; Hillis & Caramazza, 1991, 1995; Patterson & Hodges, 1992). In addition to taking overall naming accuracy as an estimate of semantic → phonological activation during reading, we have endeavoured to use the progressive phonemic cueing paradigm to demonstrate that, even for unnamed items, there was partial phonological activation from meaning in this patient (i.e. the length of the successful cue was nearly always less than the uniqueness point). We assume that the degree of remaining semantic → phonological activation is related, inversely, to the length of the phonemic cue required to elicit the name of a target picture.

no-response reading errors: This is what one observes in deep dyslexia. But in a normal individual, or in anomic patients NOR and MOS with somewhat reduced semantic input to phonology, or even in anomic patient MRF with only partially successful sublexical reading, information combined from the two sources will typically ensure good reading, even on low-frequency irregular words.

In the present study, the crucial form of evidence comes from the success of eliciting target word-forms in the naming task by providing MOS with additional activation via multi-phonemic cues. On three different sets of items, this technique boosted the patient's naming scores to normal levels and/or to the same level as her reading score for the same items with inconsistent spelling-sound correspondences. Our interpretation of this effect is that in uncued naming, despite the patient's good comprehension, there was insufficient activation of phonology by the semantic representation; and that the cumulative phonological cueing procedure accomplished for naming what the additional orthographic input to phonology normally does for reading. In addition the phonological cues appear to provide something of a window on the phonological representations partially activated by the picture concepts. Without assistance, MOS produced no-response and semantic errors (which were phonologically unrelated to the target). With a phonemic cue of sufficient length (but short of the uniqueness point) she was able to retrieve the names of almost all the target pictures. On a number of occasions, a phonemic cue shorter than that required for correct naming elicited a semantically *and* phonologically related error. Presumably the initial phonemic cue acts by establishing an appropriate phonological cohort. In those cases where the target word and a semantically related candidate share the same initial sound (e.g., /b•/ for *beaver* and *badger*), the incorrect alternative ("badger") may occasionally be more strongly activated at this point. However, with an additional phoneme added in (cue = /bi/), the semantically related candidate will no longer be compatible with the phonological cohort, allowing the patient to produce the correct label ("beaver": see Lambon Ralph, 1998; Tyler, 1992).

The cueing technique used here is only one method by which residual activation of phonology by semantics can be estimated for an anomic patient. Other possible methods include cueing by reading the label of a picture some time before trying to name it (Breen & Warrington, 1995; Lambon Ralph, 1998), or phonological priming from unnamed pictures to either reading aloud or repetition. Indeed, even if an anomic patient failed to benefit from multi-phonemic cueing in naming but nevertheless read aloud perfectly, it would not necessarily imply two separate sets of phonological representations for reading and naming. For example, phonemic cueing might not improve naming performance in a patient with impaired ability to process phonological fragments. In order to strengthen a claim for multiple speech lexicons via a dissociation between naming and reading, it would be necessary to document the quantity of any remaining phonological activation using a number of tasks along the lines of those suggested earlier.

In summary, the results reported in this paper suggest that the naming process, i.e. the activation of phonology by semantics, can interact with other sources of phonological information (for further demonstrations see Hillis & Caramazza, 1995; Howard & Orchard-Lisle, 1984). In this way, our data are compatible with the notion of combined phonological activation in reading from the semantic and direct pathways (Plaut et al., 1996), and thus with a model in which different tasks address a common phonological lexicon rather than multiple, task-dependent output systems. Our own view of the relationship between naming and reading predicts that—leaving aside acquired reading impairments attributable to "early" deficits (for example, a deficit of letter identification, as in many interpretations of pure alexia: see Behrmann, Plaut, & Nelson, 1998)—naming and reading will create a single, not a double dissociation. We are not yet aware of any strong counter-evidence to this prediction.

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