PALPA

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PSYCHOLINGUISTIC ASSESSMENTS OF LANGUAGE PROCESSING IN APHASIA (PALPA):

An Introduction

Janice Kay, Ruth Lesser, and Max Coltheart

PALPA is designed to be a resource for speech and language therapists and cognitive and clinical neuropsychologists who wish to assess language processing skills in people with aphasia. We believe that *PALPA* can make a substantial contribution to the investigator/therapist's resources for examining people with aphasia. The comments made by a large number of aphasia therapists throughout the UK, other parts of Europe, and Australia and Canada—some of whom have been using research versions of the battery—have been encouraging. *PALPA* already seems to have brought a new approach to the clinical examination of individual patients with dysphasia, one which is in tune with the philosophy of considering language assessment as an iterative procedure of hypothesis testing.

At the same time, we must make it clear that it provides materials for only a circumscribed part of what needs to be assessed when one investigates the language abilities of a person with dysphasia. In the first place it is concerned primarily with language as a complex series of mental processing steps and makes a somewhat artificial distinction between this and what we do when we use language to communicate. At present, there is a substantial gap between the assessment of language processing as a mental activity and language used as a means of communication in everyday life. But as assessment of the latter through conversational analysis is at an early stage of development (see, for example, Gerber, S. & Gurland, G.B. (1989) *Seminars in speech and language, 10,* 263-281; Lesser, R. & Milroy, L. (in press) *Linguistics and aphasia: Psycholinguistic and pragmatic aspects of intervention.* London: Longman), the investigator/therapist has no alternative but to assume that it is acceptable to examine language processing and language use as separable. Current psycholinguistic investigations of language processing (and *PALPA* is no exception) may seem to maintain this gap by using some tasks which rarely form part of the customary use of language. One of these is reading single words aloud, an activity generally only performed in restricted situations (by mothers or teachers of young children, for example). Another is reading aloud or repeating invented 'words', although this may have some similarity to what happens when new brand names are introduced. The justification for including such artificial tasks is that they can provide a window through which to view individual components or 'modules' of language processing that might otherwise remain hidden if one considered only global measures of performance.

Before discussing the underlying rationale of *PALPA*, we should perhaps mention why we embarked on this enterprise at all. In the course of our research into aphasia and aphasia rehabilitation during the early 1980s, we were made rather forcibly aware that there were very few off-the-peg tests of language processing for people with acquired disorders of language and cognition. Research papers mentioned the use of tasks such as lexical decision and word repetition, but frequently the materials themselves were not published with the papers. Using a task usually meant that one had to compile it oneself. This involved many hours spent combing through standard word-counts such as that of Francis and Kucera (1982, *Frequency analysis of English usage*. Boston: Houghton Mifflin), constructing a task that already existed in differing forms in many different research centres. We therefore decided in 1984 to construct a battery of tests for publication that could readily be used as a baseline for further detailed investigation and that would allow detailed comparisons to be made across individual cases. Our initial conception of the battery was that it would be designed specifically to assess acquired reading and spelling disorders at both the single word and sentence level. It soon became apparent, however, that we should widen our brief to produce a more general battery that included auditory processing tasks as well. In the time between then and now, we have been compiling tasks and gathering data on them from people with aphasia and from non-brain-damaged subjects. As we considered it to be important to put the tasks into a format that was well-designed and easy to understand and use, we have also taken some care in the production of instruction forms, stimulus materials and presenter's and marking forms.

We must make clear that the data that we have collected so far are not intended as a full standardisation of the battery. Thus, we have not carried out psychometrically satisfactory measures of validity or reliability. We have published the tasks at this point because of the great demand for well-controlled psycholinguistic materials and we would welcome suggestions for modifications—either to the tasks or to the way the tasks are presented—that we can include in future revisions of the battery.

RATIONALE

PALPA stands for "Psycholinguistic Assessments of Language Processing in Aphasia". It consists of 60 assessments designed to help to diagnose language processing difficulties in individuals with acquired brain damage. As its name suggests, *PALPA* applies a psycholinguistic approach to the interpretation of processes concerned with the recognition, comprehension and production of spoken and written words and sentences. The approach is based on the assumption that the mind's language system is organised in separate modules of processing, and that these can be impaired selectively by brain damage. *PALPA* aims to provide information about the integrity of these modules, to find those in which the aphasic person seems to be functioning below normal and those which appear to be continuing to function normally or near-normally. It is important to realise that *PALPA is not designed to be given in its entirety to an individual*—rather the assessments should be tailored to those that are appropriate to the hypothesis under investigation. Once a hypothesis about which modules are dysfunctioning is set up, the clinician can then plan a treatment programme which would be appropriate to restoring, reorganising or compensating for the impaired processes. *PALPA* does not specify *which* treatment programme should be carried out; rather its aim is to provide a firm grounding for an understanding of a particular processing disorder on which any treatment programme must be based.

A THEORETICAL BACKGROUND

To appreciate how *PALPA* works and to use it effectively, the model of language processing upon which each assessment is based must be understood, and one of the aims of this introductory manual is to provide a brief (and therefore necessarily basic) understanding. We need to explain what the components of the model are, what the pathways of communication between these modules are, and what language-processing function depends upon each module or pathway. At the end of the manual we have provided a list of references that will allow you explore, in your own time, the complex theoretical issues on which the approach is based.

Recognising Printed Words

If someone asks you which of the two letter-strings *meach* and *peach* is a word, you can perform this task rapidly and effortlessly. How do you do it? What are the mental processes involved in making such a decision? The letter-string *meach* is a perfectly well-formed item which could have become a word of English, but never did, unlike *peach.* Given this, the only way you could be carrying out this task is by searching through all the words of English that you know, and finding that *peach* is among this large set of words, whereas *meach* is not. Here you are dealing with one particular sort of knowledge about words, namely orthographic knowledge: knowledge about spelling. It is as if you are consulting a kind of mental dictionary that contains the spellings of all the words you know. Recognising a word consists of finding it in this system. The system you use to recognise visually-presented words is often called an "*orthographic input lexicon*": *orthographic* because it deals with the spellings of words; *input* because it is for taking in information rather than producing it; and *lexicon* because it is a list of words, like a dictionary. It differs from the usual kind of dictionary, however, because it contains only one kind of information about words: orthographic information. It does not know anything about meanings or pronunciations. These forms of information are stored in other modules of the language-processing system, which will be discussed below. Figure 1 is our first step towards building up a complete diagram of the whole language-processing system; it is a picture of just one fragment of that system. Every word that the reader knows is represented by a separate entry in this orthographic input lexicon. According to this view, nonwords like *meach*, no matter how similar to words they are, do not have entries in the orthographic input lexicon. As there is good evidence that the letters of a word must first be recognised before the word itself can be recognised, there must be a system for recognising letters that operates before access to the orthographic input lexicon. This called "*abstract letter identification*" because, to this procedure, an A is an 𝒜 is an a: it ignores letter font and letter case.

This minimal information-processing system cannot do much: it cannot understand words or speak them, as it does not contain information about word

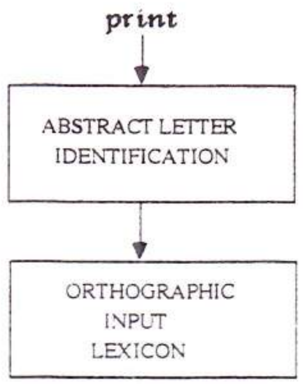

Figure 1

meanings or word sound-forms. However, it is not entirely ignorant of language, as it can recognise printed words, and can decide whether a string of letters is a real word or not.

Understanding Printed Words

Not only do you know that the letter-string *peach* is a word, but you also know that it means a kind of fruit. Thus, you possess not only orthographic but also semantic knowledge about this letter-string. Knowledge of the meanings of words is stored in a module of the language-processing system which we will call the "semantic system"; this contains information about the meanings of all the words known by the person concerned. To get to this system from a printed word, you have to recognise the word first, that is, to find its entry in the orthographic input lexicon. Having done this will enable you then to find its representation in the semantic system. So, as Figure 2 shows, the orthographic input lexicon is a gateway to the semantic system. This figure shows a slightly larger fragment of the language-processing system, a fragment that can not only recognise printed words but can also understand them (though not speak them).

A Digression: Boxes and Arrows

At this point, it might be worth digressing briefly to explain what the boxes and arrows in diagrams like Figure 1 and Figure 2 are actually supposed to represent. In all of the box-and-arrow diagrams you will see here, the boxes have two types of function. Firstly, they are repositories of information; for example, the box labelled Semantic System in Figure 2 actually contains semantic information. Secondly, the boxes are also processors of information. It is not enough for a language-processing system to include a component containing semantic information; it will also be necessary for there to be a procedure for finding the desired information within that component. To take another example: we have said that the way someone decides that *peach* is a word is by finding its entry in the orthographic input lexicon. For this to happen, not only must there be a representation of this word in the orthographic input lexicon, but there must also be a procedure which enables this representation to be found among the tens of

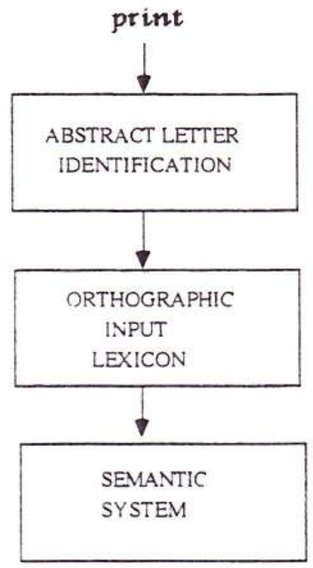

Figure 2

thousands of other word-representations there. A really precise description of the language-processing system, then, would depict it in a way that distinguished between systems of representations and the procedures that are used to find entries in these systems. However, this degree of precision is something we don't need here, so we simply collapse the two aspects of boxes into one. Any box you see might therefore actually consist of a collection of representations, or a system for processing representations, or both.

What about the arrows? These are to allow communication between the boxes. Once the entry for the word *peach* has been found in the orthographic input lexicon, some form of communication from this system to the semantic system will be needed if the reader is to know what the word means. This communication is represented by the arrow from the orthographic input lexicon to the semantic system in Figure 2. Exactly how these channels of communication might work is something about which little is known. Fortunately, nothing important about the use of *PALPA* depends on this. However, it might be worth briefly describing a couple of ways in which one could imagine these arrows working.

Suppose that each of the entries in the semantic system had some kind of unique and quite arbitrary code associated with it—a code that one might think of as a unique number, so that *peach*, for example, might be word number 1873 in the semantic system. Now, if the code 1873 is stored along with the word's entry in the orthographic input lexicon, then once the entry for *peach* has been found in that lexicon, the code stored there could be transmitted to the semantic system, and the processor in the semantic system would then find the right meaning by finding meaning No. 1873. Another completely different way of thinking about how the arrows might work is to imagine that there is a direct connection between each entry in the orthographic input lexicon and its corresponding entry in the semantic system. Now an arrow is a large bundle of private lines, not a single channel for transmitting a word's unique code.

These are two ways of thinking about how arrows might work; there are various other possibilities too. We don't need to choose among them; all that matters is that the language-processing system must have a way of arranging communications between its components, and we depict this as an arrow.

Having digressed into this discussion of what the boxes and the arrows may represent, we now return to our discussion of things people can do with words and what mental processes allow them to do these things. We have discussed recognising and understanding words; we will now discuss saying them.

Speaking

When someone is having a conversation, among the multiplicity of activities that are taking place the speaker is selecting certain meanings and then turning these

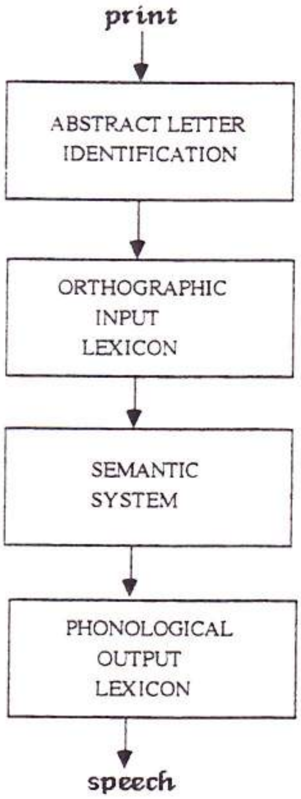

Figure 3

into the appropriate spoken words. To do this, the language processing system must contain a set of representations of all the spoken words in the speaker's vocabulary. This is a set of *phonological* representations, it is for *output*, and it is a *store* of words: so we can refer to it as a "*phonological output lexicon*". Hence we can think of speaking as involving the semantic system (where the meanings the speaker wishes to convey are selected) and communication from it to the phonological output lexicon (where the corresponding spoken forms of words are selected), as described in Figure 3. Beyond this are further processes involved in the realisation of the word as part of an utterance. These may include a 'buffer' system of temporary storage in which the string of sounds that will form the word is assembled, allowing their allophones within the context of the word to be specified and neuro-muscular programming for the utterance to be carried out. For simplicity's sake, we have subsumed all these operations under the term 'speech' in Figure 3, although we expand on why buffers are needed in the section on Buffer Storage on page 14. It is important to note, however, that disturbances at any of these further stages can interrupt word-realisation for speech in aphasia, and that distinguishing the level or levels at which the difficulties lie can be critical for planning therapy for anomia (see Lesser, R. (1987) *Aphasiology, 1*, 189–200).

We reached this diagram by thinking about how we recognise words, how we understand words, and how we speak them spontaneously. Not surprisingly, then, the information-processing system in Figure 3 can do all of these things. There is, however, something else it can do that it was not specifically constructed to do: it can read aloud. If there is a pathway from orthographic input lexicon to semantic system, and another pathway from semantic system to phonological output lexicon, then the use of both pathways will provide a route from print to speech; that is, a procedure for reading aloud. So this system can not only recognise and understand printed words and speak spontaneously, it can also read aloud.

Reading Aloud

Is this all we need to say about reading aloud? Is Figure 3 sufficient to describe everything about reading aloud? No. In the case of nonwords like *meach*, not only can you recognise that these are not words, you can also read them aloud, which the system in Figure 3 cannot do. The nonword *meach* will not be found in the orthographic input lexicon, so there will be no communication from this lexicon to the higher components of the system, and in particular nothing will get to the phonological output lexicon. Even if it did, that wouldn't help: the phonological output lexicon contains only words, so could not be used to utter a nonword. Hence the system in Figure 3, when confronted with a printed nonword, would remain mute; it could not read nonwords aloud. Yet non-brain-damaged (and not necessarily practised) readers can do this. Hence we need to add something to Figure 3 to account for how nonwords are read aloud.

What is required is some procedure which will relate the spellings of nonwords to their sounds: a set of "spelling-to-sound" rules. For example, if you know the three rules m →/m/, ea →/i/, and ch →/tʃ/, applying these rules to the letter-string *meach* will give you the right phonological output, /mitʃ/. Hence the developing model needs to be supplemented with a letter-sound rule system, as in Figure 4.

Now the model has two separate procedures for reading aloud: it is a "dual-route" model. One of these procedures goes from the orthographic input lexicon to the phonological output lexicon (via the semantic system), so we'll call this the

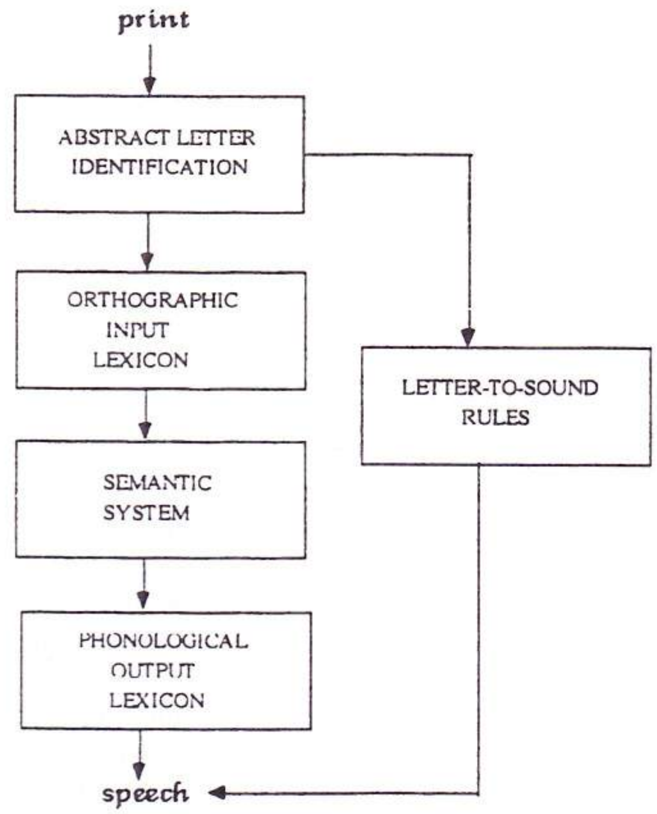

Figure 4

"lexical route". The other does not use lexicons at all, so we'll call this the "non-lexical route".

As we have explained, the lexical route cannot read nonwords at all (because lexicons contain only words). The non-lexical reading route also has a limitation: as it uses spelling-sound rules, it cannot succeed with words that disobey such rules—the irregular or 'exception' words of English. It will read *pint* as if it rhymed with *mint*, it will pronounce the *ch* in *yacht* and both *l*s in *colonel*, because this is what the rules prescribe. These are known as "regularisation" errors. On the other hand, if the input is a 'regular' word like *mint* or *boat* or *army*, the non-lexical route will respond correctly, as it will when the input is a nonword.

This means that, to read aloud adequately, the language-processing system needs both procedures. Only the lexical procedure can read exception words correctly. Only the nonlexical procedure can read nonwords correctly.

Are two procedures enough to explain what we know about reading? Possibly not. Schwartz, M.F., Saffran, E.M. and Marin, O.S.M. (1980, *Deep dyslexia,* (Chapter 12). London: Routledge & Kegan Paul) described a dementing patient

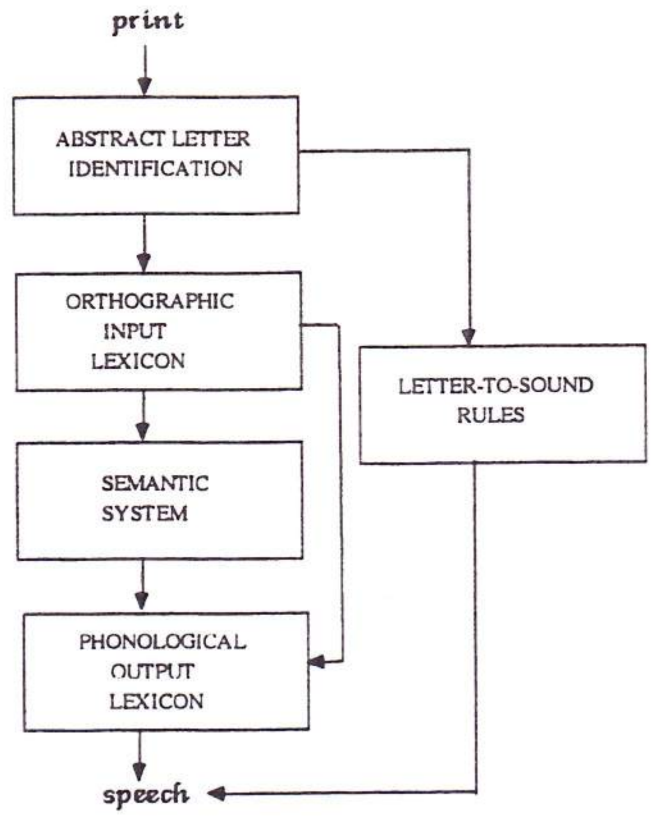

Figure 5

who had almost no word comprehension left; that is, she could make little or no use of her semantic system. However, she could read aloud rather well, including exception words such as *leopard.* How did she read exception words aloud so well? Not by using spelling-to-sound rules (which would result in regularisations of exception words); and not by using the lexical route via the semantic system, because she had a very severe semantic impairment. These and similar findings (e.g. Funnell, E. (1983) *British Journal of Psychology, 74,* 159-180) lead us to introduce a third reading route, or, rather, to subdivide the lexical route, by adding a pathway that goes directly from orthographic input lexicon to phonological output lexicon, by-passing semantics; this is shown in Figure 5.

Recognising Objects and Pictures

Recognising a peach, or a picture of a peach, is not purely a linguistic activity. Nevertheless, we need to add this capability to our model of the language-processing system simply because picture–word or object–word matching are commonly used as tests of comprehension in aphasia assessments (including *PALPA*); so we have to say something about picture and object comprehension.

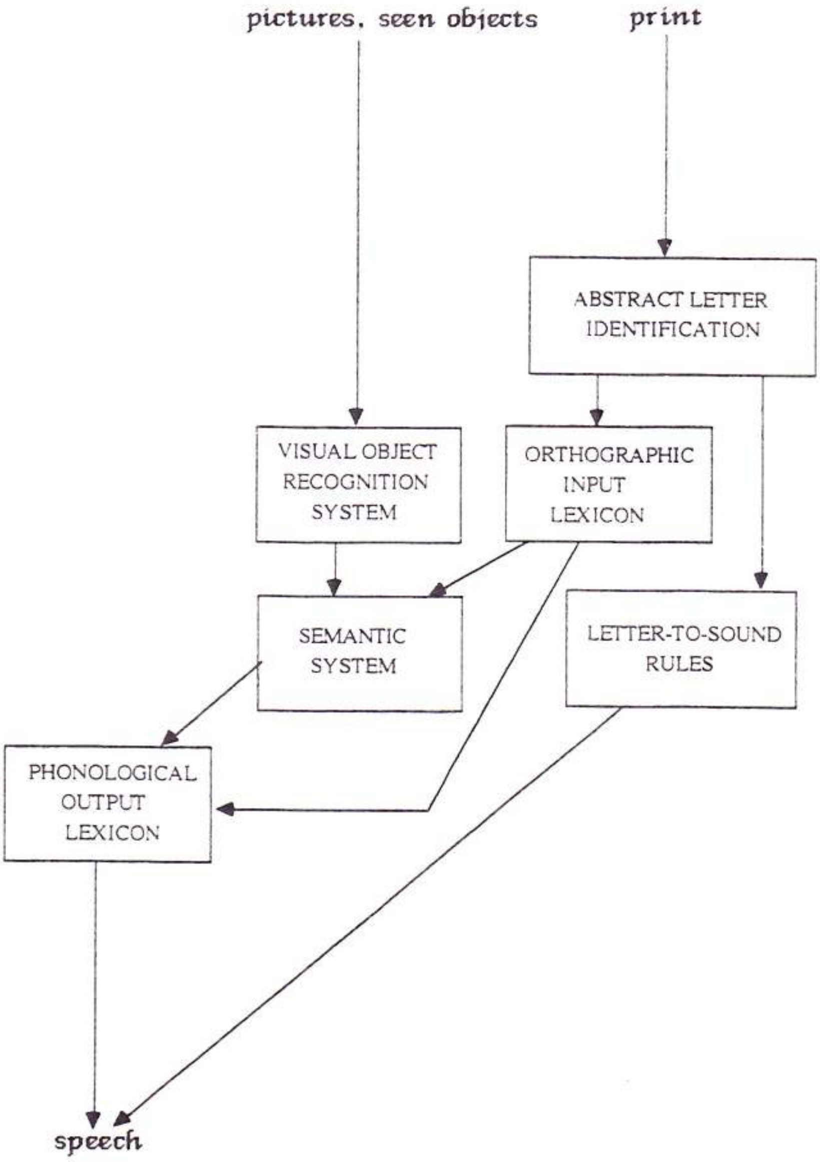
pictures, seen objects
print
ABSTRACT LETTER IDENTIFICATION
VISUAL OBJECT RECOGNITION SYSTEM
ORTHOGRAPHIC INPUT LEXICON
SEMANTIC SYSTEM
LETTER-TO-SOUND RULES
PHONOLOGICAL OUTPUT LEXICON
speech

Figure 6

We are going to assume (though not everyone does) that the semantic system used to understand printed words (and spoken words) is the same as the semantic system used to understand pictures and seen objects. If this is so, then to understand a picture or a seen object the viewer will have to gain access to the representation of that picture or object in the semantic system of Figure 5. To achieve this there would need to be a system capable of recognising familiar pictures or objects and then communicating with the semantic system—something analogous to the orthographic input lexicon of Figure 1, but operating upon pictures or objects rather than words. We'll call this the "*visual object recognition system*", and see it as containing entries which are structural descriptions of objects—there will be an entry for "giraffe", for instance, that specifies long-neckedness, long-leggedness, and spottedness. Recognition of an object or picture will have occurred when the viewer has succeeded in matching up the visual features of the viewed stimulus with the details of one of the structural descriptions in the visual object recognition system. Once this is done, communication to the appropriate representation in the semantic system will be possible, and the picture or object will then be comprehended. In this way we arrive at Figure 6.

Note that, although there is a direct pathway from orthographic input lexicon to phonological output lexicon in this figure, there is no direct pathway from visual object recognition to the phonological output lexicon. Thus, reading words aloud does not require that they be comprehended, whereas naming pictures or objects does require prior comprehension. If evidence were found of a patient who could name pictures well while understanding them poorly, a picture-naming route that by-passed semantics would have to be added. We do not think any convincing evidence of this kind exists, so the model has no such route.

Recognising and Repeating Speech

The system in Figure 6 can process print and pictures, but not speech: an obvious lack is a "*phonological input lexicon*", so it is time to add this, and a preceding system of "*acoustic analysis*" that is analogous to the abstract letter identification system of Figure 1. There will need to be an arrow from the phonological input lexicon to the semantic system, to allow spoken words to be understood rather than merely recognised, and an arrow from phonological input lexicon to phonological output lexicon, for repetition of words.

We can, however, repeat not only words but also nonwords, which could not happen if repetition were accomplished only via a route from an input to an output lexicon. Hence it must be possible to repeat by going directly from acoustic analysis to speech (via a process of "*acoustic-to-phonological conversion*"), by-passing lexical systems.

This gives us Figure 7. Just as it has a lexical and a non-lexical route for reading aloud, it has a lexical and a non-lexical route for repeating. Why? We have already seen that our ability to repeat nonwords requires a non-lexical repetition route. It is often found in aphasic patients that words can be repeated whilst nonwords cannot; this could not happen if the only repetition route were non-lexical, so there must be a lexical repetition route as well.

Spelling and Writing

Spelling and writing are part of language-processing, a part that the system in

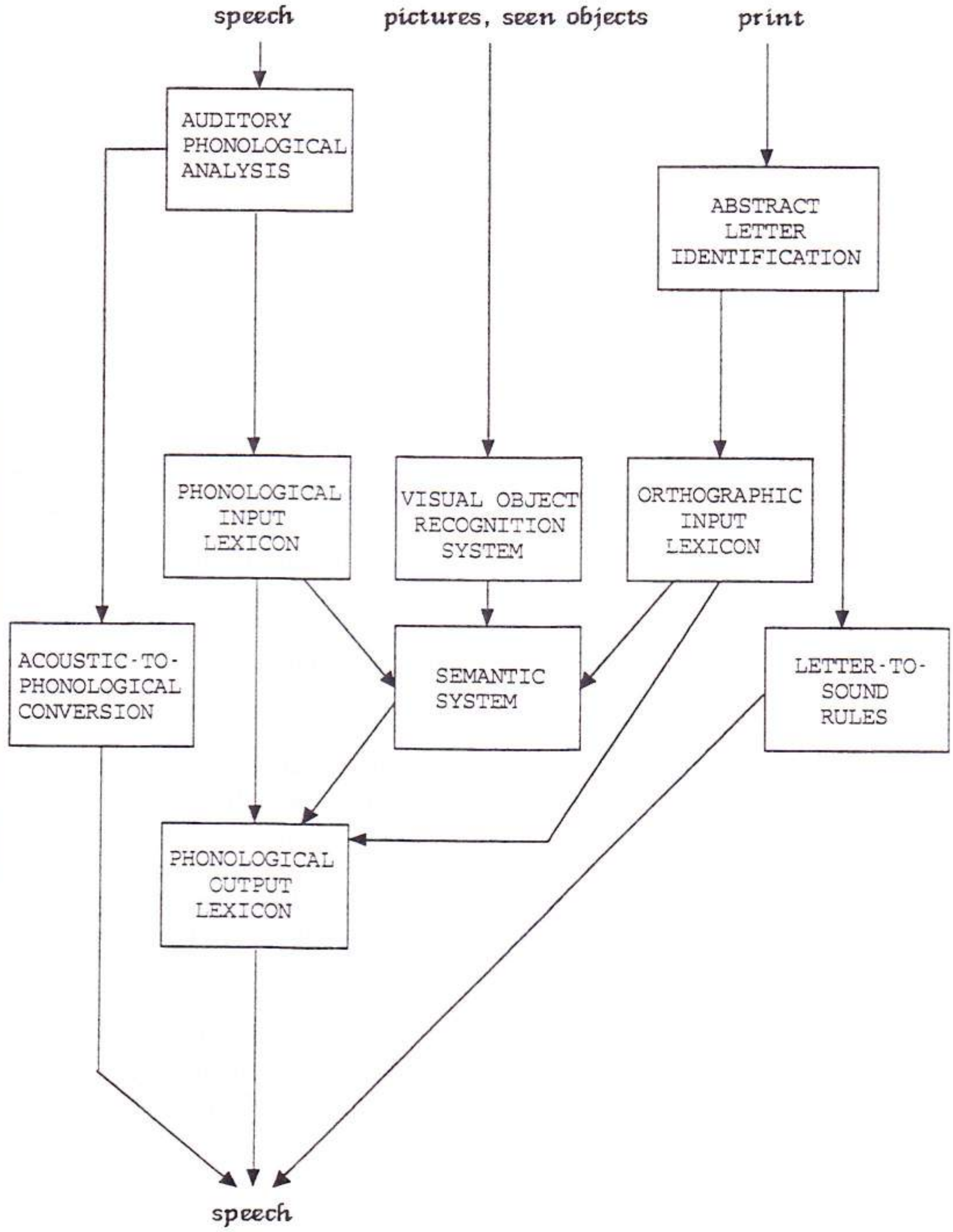
speech
pictures, seen objects
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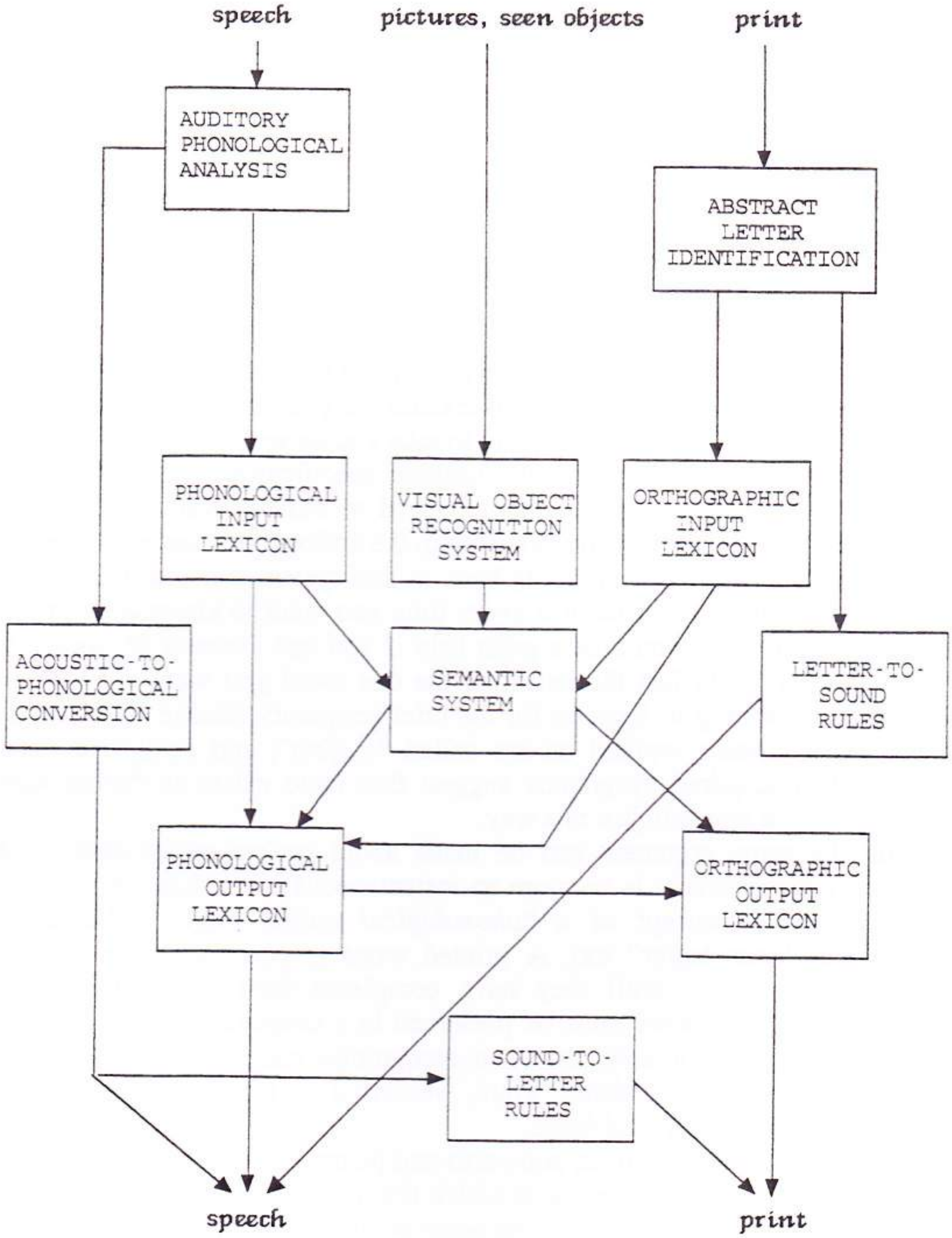
Figure 7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ORTHOGRAPHIC OUTPUT LEXICON
SOUND-TO-LETTER RULES
speech
print

Figure 8

Figure 7 cannot accomplish. Hence it needs further elaboration. We already have a phonological output lexicon for producing spoken words, so we will add an "*orthographic output lexicon*" for producing written words. So spontaneous writing consists of communication from semantic system to orthographic output lexicon, and retrieving from that output lexicon the written forms of the appropriate words. This would not explain our ability to write to dictation spoken nonwords like *meach*, so we have to add a system of "*sound-to-spelling rules*" too.

The arguments here are exactly those discussed earlier in relation to reading. If spelling depended only on sound-to-spelling rules, we would spell exception words incorrectly, perhaps spelling *yacht* as *yot*. If spelling depended only on an orthographic output lexicon, we could not spell nonwords to dictation; so both spelling routes must be included in the model, and this gives us Figure 8.

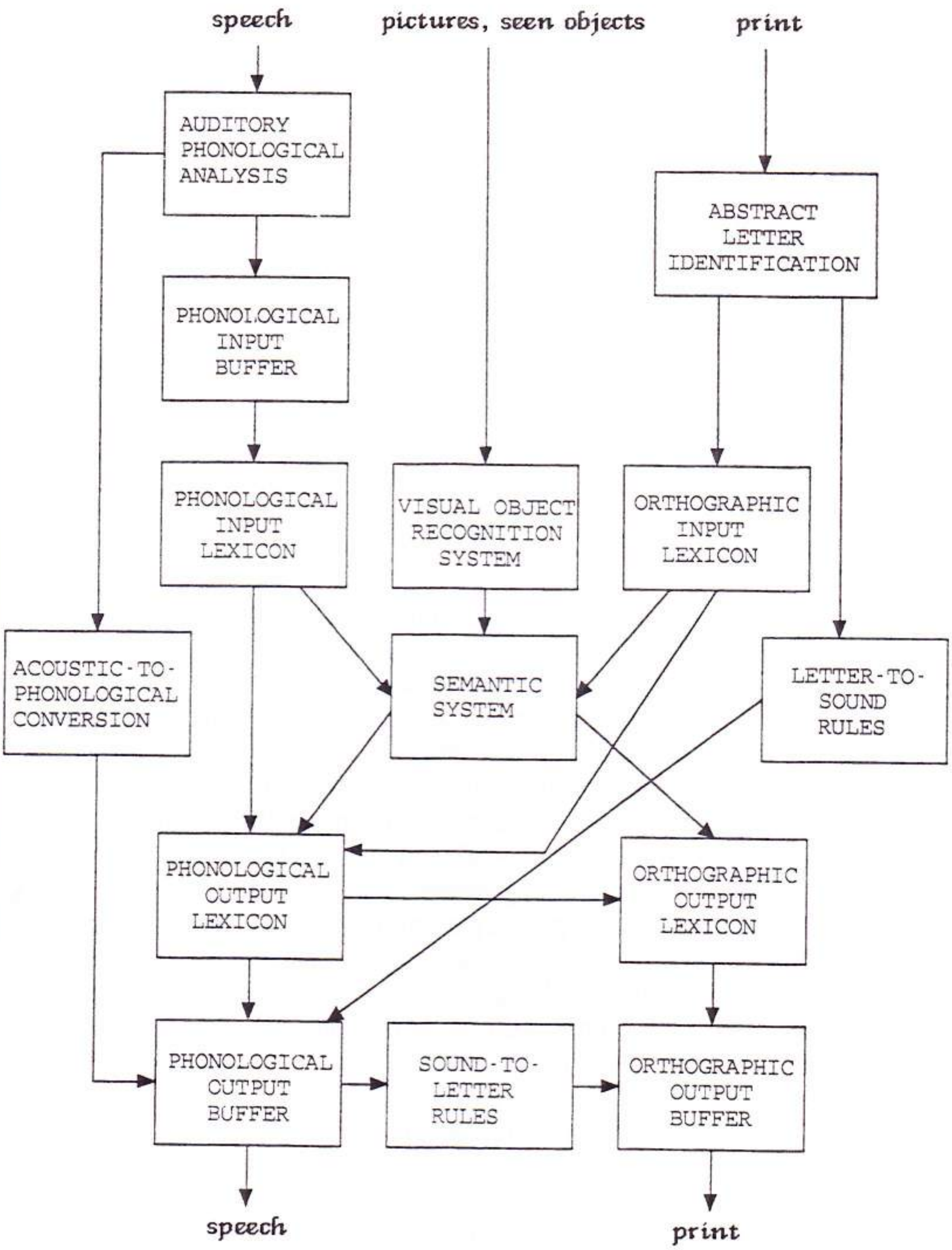
Buffer Storage

Suppose someone asked you to write down the word *rhinoceros*. Its spelling is one of the entries in the orthographic output lexicon, so you retrieve this spelling and begin to write the word. Now, it is going to take you several seconds to get all ten of these letters down on paper, so the spelling specification you have retrieved from the orthographic output lexicon will need to remain available for several seconds. Where? It is permanently available in the orthographic output lexicon, but you don't want to have to keep going back to that system and searching through the tens of thousands of words in it every time you want to know what the next letter in the word is. It would be a great help if you had a means of storage that could temporarily hold just the letters of the one word you want to write until you've finished writing it. Systems for the brief temporary storage of information that is currently being worked on are called "*buffers*", and studies of normal spelling and of acquired dysgraphia suggest that there exists an "*orthographic output buffer*" that works in just this way.

Exactly the same argument can be made about spoken rather than written output—saying *rhinoceros* is no more an instantaneous event than writing it—so this leads to the concept of a "*phonological output buffer*". We need a "*phonological input buffer*" too. A printed word is permanently available to processing mechanisms until they have completed their job, but speech is fleeting—so a spoken word must be preserved in a temporary memory for long enough that the task of auditory word recognition can be completed by the phonological processing systems. Thus, we arrive at Figure 9, the model of language-processing in its final form.

Is this *really* how single words, nonwords and pictures are processed?

We have already indicated ways in which the model set out in Figure 9 is not universally accepted, and there are yet other points of controversy: some people would want an arrow from visual object recognition to phonological output lexicon by-passing semantics; others reject the distinction between input and output lexicons, arguing instead that there is just a single phonological lexicon and a single orthographic lexicon; others dispute the claim of separate lexical and non-lexical routes for reading aloud. Hence, while Figure 9 represents our current best guess as to the organisation of the language-processing system, and while it is accepted as such by many others (e.g., Patterson, K.E. and Shewell, C. (1987) *The cognitive neuropsychology of language*, (Chapter 13). Hove: Lawrence Erlbaum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speech
print

Figure 9

Associates Limited; Ellis, A.W. and Young, A.W. (1988) *Human cognitive neuropsychology*. Hove: Lawrence Erlbaum Associates Limited), it would be objected to on various grounds by various theorists.

Although it may seem odd to say so, this is not crucially important for present purposes. In combination with the *PALPA* materials, this model can be used to interpret various patterns of language impairment, to guide the choice of assessments, and to assist in the design of treatment programmes. We are sure that the model is extremely helpful for all three of these endeavours, even if it turns out that there are various ways in which it is wrong. To try to understand why a particular patient can succeed in certain language-processing tasks while failing in others by relating the pattern of successes and failures to the Figure 9 model forces one to think hard and with precision about the patient's performance, and the model tells one how to do so. Data gathered by the *PALPA* assessments suggested by the model are going to be informative simply because basic distinctions upon which the model is based (such as word vs. nonword or regular word vs. exception word) are known to have major influences upon patient performance and so must be basic to any model that aspires to explain normal and disordered language-processing.

Sentence Processing

Aphasic patients may be able to recognise and to understand single written and spoken words, yet have difficulty in understanding the meanings of whole sentences. *PALPA* assesses this by using sentence-picture matching tasks. One of the features we have included in designing these tasks is whether the sentence is plausibly semantically reversible; that is, whether if one interchanged the two noun phrases, the resulting sentence would still be pragmatically acceptable. This is essential; if the sentences are not pragmatically reversible, a patient with a sentence-processing impairment could work out what a sentence must mean by working out the only semantically and pragmatically possible combination of the sentence's words. For example, suppose a patient has lost the ability to identify the subject and the object of a sentence. In the non-reversible sentence, "The man likes the steak", as steaks cannot like anything, it must be the man that is liking and the steak that is liked, and the patient could work this out even if unable to assign syntactic categories to the words in the sentence. But in the reversible sentence, "The man likes the woman", this non-syntactic strategy will not be useful, and so performance will be poor on sentence–picture matching tasks if the patient has a sentence comprehension impairment.

If a patient does do poorly on sentence–picture matching, two possible reasons for this can be explored. The first possibility is that sentences are not understood because single words are not successfully understood. Test [57] helps to evaluate this possibility, as it provides some information about how well the subject understands individual verbs and adjectives that are used in the sentence–picture matching tasks [55, 56]. Lexical semantic influences are controlled in the sentence–picture matching task, partly through using a limited set of referents (all animate), and partly through incorporating the dimension of directionality of motion in some of the verbs used (e.g. following, leading). Of course the results of picture and word semantics tests should also be taken into consideration here, as these tasks measure single word comprehension.

Other factors are also controlled for in our sentence-picture matching task: these are whether the predicator is a verb or an adjective, active-passive mood, length of sentence, and sentence complexity in terms of whether all the elements are made specific in the spoken or written sentence, or whether the person listening or reading the sentence has to fill in 'gaps'. For example, in the sentence, "The man is demonstrating what to do", there is a presumed gap in that the person who will be doing what has been demonstrated is not grammatically specified (the same applies even when the doer is the same as the subject of the sentence, as in, "The man is asking what to do"). This relates to a linguistic theory which involves what are called 'PRO structures at a d-structure level', or 'traces at an s-structure level' (see Caplan, D. & Hildebrandt, N. (1988) *Disorders of syntactic comprehension*. Cambridge, Mass.: MIT Press, for a discussion of this as applied to syntactic comprehension in aphasia). The point of including these distinctions in *PALPA* is to see whether some patients have more difficulty with these more complex types of sentences than with others. Moreover, as well as comparing verbs and adjectives as predicators (given that it has been suggested that some patients have specific difficulties with verbs), we have included a further picture-choice task in which the predicators are locative prepositions [58, 59]; this task also allows for the influence of degree of animacy/abstractness to be examined.

A possible reason for poor performance on sentence–picture matching is impaired memory. It is often argued that sentences need to be held in working memory while syntactic processing is carried out; this kind of memory seems to be different from the memory needed to store a string of words (such a phone number) which are not syntactically related and which do not require a hierarchical 'tree structure' to be formed. If patients have a poor working memory for sentence processing, they will not be able to understand sentences precisely, although they may be able to extract some gist in the form of a string of referents. One of our tasks investigates reduced memory span in sentence processing by giving the subject a sequence of words which could take the roles of noun phrase and verb phrase in an anomalous sentence. Instead of having to understand the sequence, the patient simply needs to hold it in memory, and this ability is assessed by requiring the patient to point, in the correct order, to the pictures that correspond to each of the words. If the patient can do this with word sequences of a particular length but fails in sentence-picture matching with sentences of that length, the problem with sentence processing cannot be ascribed to a failure of memory. Of course, the results of some of our auditory processing tasks ([7] to [13] inclusive) should also be taken into consideration here, as these tasks also measure memory for linguistic stimuli.

As well as compiling our own sentence-processing tasks, we also gave Bishop's (1983) *Test for the reception of grammar* to a selection of our non-brain-damaged subjects. This test examines performance on a variety of different sentence constructs and is designed for assessing receptive grammatical abilities in children with a variety of specific and non-specific language disorders. Bishop indicates in the manual that accompanies TROG that centiles for 12-year-olds can be used for adults passing up to 18 blocks. When the TROG sentences were presented auditorily to 17 of our non-brain-damaged subjects, their mean score was 18.5 blocks passed (standard deviation = 1.07), which falls roughly between the 50th and 60th centile. The results are broadly similar for sentences presented in written form: 15 subjects passed 18.5 blocks (standard deviation = 1.46).

SELECTION OF ASSESSMENT TASKS

Each of the 60 tasks that comprise the *PALPA* battery is designed to help to illuminate the workings of specific components of the language-processing model described here. The tasks are well-founded and, in the main, are based on those described in the neuropsychological and experimental literature and do not introduce new theoretical constructs or experimental techniques. Even with 60 tasks, there are bound to be tests of language processing that we have not included. We have omitted any assessment of sentence production, for example, because in this case we felt that there were already readily-accessible analyses of this language function (e.g. Saffran, E.M., Berndt, R.S. & Schwartz, M.F. (1989) *The quantitative analysis of agrammatic production: Procedure and data. Brain and language, 37,* 440–480). We have also not chosen to assess many important aspects of language use, such as inference-making. Just as the theoretical basis of the battery assumes a modular organisation, the organisation of the battery can be seen as modular and can be added to as further assessments of language use are developed. Neither have we chosen to look at 'on-line' processing of language, which requires more complex measures of presentation and assessment. For ease of use, all of the tasks are simply presented 'over the desk' and rely, for the most part, on assessment of accuracy rather than speed of responding. On the other hand, the materials we have provided allow for further investigation using techniques such as computer presentation and reaction-time measurement.

CONSTRUCTION OF THE TASKS

Each test is designed so that the effect of one (or more) psycholinguistic variable is tested, while other variables that might also exert an effect are balanced across each of the experimental conditions. Thus, we might look at whether there is an effect of syllable length on word repetition by using one-, two- and three-syllable words, while matching them on factors such as word frequency, imageability and morphemic complexity. As far as possible, materials in each experimental condition are matched on a one-to-one basis, rather than matched as a group.

We used a number of resource books to construct the materials: word frequency ratings were taken from the Francis & Kucera (1982) word count; and imageability ratings were taken from the MRC Psycholinguistic database (Coltheart, 1981). The "Instructions for Use" that preface each task state the variables that are tested and those on which the materials are matched, though, for the sake of brevity, we have not included actual descriptive statistics in this publication.

In order to obtain reliable measures of a person's performance and to allow accurate comparisons across conditions, a reasonable number of items have to be used. As far as possible, one should aim to do the whole of a particular task; where applicable, we have stated the conditions under which it may only be necessary to complete half of the task.

DATA FROM NON-BRAIN-DAMAGED SUBJECTS

The assessment tasks were given to 32 non-brain-damaged subjects. These subjects were generally the partners of the aphasic subjects and were thereby loosely matched with them on age, educational and social variables. We have summarised their performance on each task in the "Instructions for Use" section. In this publication we have only provided descriptive statistical analyses: means and standard deviations (and ranges where relevant). We discuss what can be considered as "abnormal performance" in the section on Interpretation of Test Scores below. Note that some of the tasks were either newly compiled or changed substantially after we had gathered our data from non-brain-damaged subjects. In these cases, we have been unable to provide normative data and we recommend that you gather relevant control data for yourself before judging whether a particular pattern of performance can be considered to be impaired.

On the basis of the data from non-brain-damaged subjects, we found that most of the tasks did not reveal differences between experimental conditions in terms of accuracy, and we had to make modifications to materials in just a few of the tasks. We cut down the Visual Lexical Decision task [25] to 15 items per condition because our subjects "missed" some of the low frequency—low imageability words (because this didn't happen when the same items were presented for Auditory Lexical Decision [5], it suggests that subjects only found written forms of these words unfamiliar). Subjects also had difficulty in writing low frequency–low imageability words to dictation [40], compared with those in other conditions—though because of small numbers in this task to begin with, we have been unable to reduce the numbers further. We did, however, modify the task that examines oral reading of regular and exception words [35]. With our original set of 40 words per condition, subjects did show a significant regular word advantage in terms of accuracy. We therefore removed 10 exception words and 10 corresponding regular words, so that there are now 30 words per condition. Finally, our non-brain-damaged subjects found it hard to judge whether some of the mirror-reversed letters [18] were reversed or the right way round. We took out particularly difficult cases, together with the corresponding correct form, reducing the total number of items from 60 to 36. We have not retested our non-brain-damaged subjects with these revised materials.

DATA FROM SUBJECTS WITH APHASIA

The assessment tasks were also given to 25 subjects with aphasia. These subjects had all acquired aphasia after cerebro-vascular disease. We placed no constraints on the time post-onset at which they were seen, nor on the severity of language disturbance. We did, however, exclude subjects with severe perceptual disturbances and with severe dysarthria. We do not discuss patient data in this publication.

Using the Battery

The battery is divided into four broad sections and each section is published as a separate manual: *Auditory Processing*; *Reading and Spelling*; *Picture and Word Semantics*; and *Sentence Comprehension*. In each manual, all of the tasks requiring a particular response are grouped together (e.g. Minimal Pair Judgement, Oral Reading). This method of organisation makes it easy to locate a particular task quickly. It also means that one can test for the effects of a number of linguistic variables (e.g. word frequency, imageability, syllable length) on a particular task in order to construct *initial* hypotheses about impaired and relatively spared language functions. One potential difficulty with this way of ordering is that tasks that are designed to work in tandem to test particular processing components (e.g. recognition and production of lexical morphology), or to assess the effects of particular linguistic variables (e.g. grammatical word class) are not necessarily close to one another in a manual and may even be represented in different manuals. We have reduced this difficulty by pointing out relationships between tasks in the Instructions for Use that preface each task (we have more to say about this below).

Format of the Tasks

Each task follows the same format. There is an *Instructions for Use* page that explains what the task is designed to test and how it was constructed. It also gives descriptive statistics from non-brain-damaged subjects, suggests where to go next in testing and details any special points. *Stimulus materials* are presented next, followed by *Presenter's Forms* and *Marking Forms*. In tasks that are presented auditorily, stimulus materials are often given using the Presenter's Forms themselves. It is important to realise that each task can be marked using the Presenter's Form(s) alone. The Marking Form sets out the materials by condition and shows how words are matched on a one-to-one basis across conditions. It requires the presenter to re-transcribe responses, but at the same time, it allows one *to see at a glance* particular response patterns.

A potential difficulty in having lots of different tasks and different forms for each task is that there are too many bits of paper to keep track of. We have tried to solve this problem in the following way. Each task has been uniquely identified by a number from [1] to [60]; for example, spelling-to-dictation of regular and exception words is task number [44], and spoken word-picture matching is task number [47]. Each form of each task is identified by that number, together with a separate page number and the total number of pages in the task. Thus, in the case of spoken word-picture matching, the Instruction for Use form is [47], page 1 (of 3).

Where to Begin and Where to Go Next

There is a temptation when assessing, say, particular skills involved in auditory processing, to start at task number [1] (Nonword Minimal Pair Judgements) and to work one's way through to number [17] (Phonological Segmentation of Final Sounds). Unless one has sound theoretical reasons to begin in this way, it is an inefficient strategy and one we would advise against. A good place to start an initial assessment of auditory processing is with spoken word-picture matching [47]. If a person performs poorly on this task, one can take account of what errors he or she makes and then compare ability on written word-picture matching [48], before going on to test auditory input processing skills. It is important to realise, however, that this is merely one suggestion for where to begin; it is one point of entry into the battery, rather than mandatory access. Above all, we want you to use the battery in a flexible way; flexible because it should be tailored to the requirements of an individual client. Similarly, although we have made suggestions about where to go next after each task, it must be emphasised that these are only suggestions.

Task Administration

Most of the tasks are straightforward to administer, but most require explanation and practice to make sure that the person really knows what he or she is required to do. There are a number of tasks that require a "same" or "different" decision, but with different criteria (e.g. whether two words are near-synonyms or whether they are unrelated; whether two words sound the same or slightly different), and, in these cases, it is best not to perform these tasks in close succession. When the explanation for a task may require extra elaboration, take account of the instructions in the "Special Points" section of "Instructions for Use".

In addition to the usual considerations when carrying out an assessment (such as avoiding eye-pointing to correct responses, and being careful to avoid intonational differences between items requiring "yes" or "no" responses), there are a number of others of particular importance when using *PALPA*. Many of the assessment materials involve repeated testing with the same materials, but in different modalities (albeit generally with different orders of presentation). To avoid practice effects or priming effects, care should therefore be taken *not* to use the same materials on more than one occasion on the same day. For similar reasons, the person being assessed should not be told or made aware of which responses they made errors on or which were correct, so that re-testing in a different modality or at a later date can be carried out (most people will accept this if the reasoning is explained to them).

The large number and range of tasks that make up the battery mean that one is generally able to select tasks that one is sure that the patient will be able to do with relative ease. Thus, it is useful during a test session (and perhaps to close it) to give a task that can bolster a patient's confidence and to maintain morale.

Interpretation of Test Scores

In some cases, judging that performance is impaired is relatively straightforward. When the subject is required to make a choice, or some other form of categorical decision, estimates of what would be expected by chance are easy to make. For example, if a subject is given a binary choice of two responses ("yes" or "no" in a same/different judgement task), then one would expect the subject to be correct, by chance alone, on 50% of occasions. Deciding whether performance differs from what would be expected by chance is then a simple statistical matter. However, in many cases, a subject performs poorly on a particular task, but still manages to produce a substantial number of correct responses. The data that we have supplied from our non-brain-damaged subjects can help you to decide whether performance is impaired. Information about average (mean) number of correct responses and standard deviations allows one to calculate the number of standard deviations below the mean at which the patient scores. An arbitrary, but commonly used, criterion of two standard deviations (or further) below the mean can be judged as "impaired".

One must be careful in assuming that a patient is performing "normally" on a particular task if he or she falls within the range of our non-brain-damaged subjects. Remember that at least some of the tasks may be easy for a person without brain damage—their performance may be "at ceiling" without taxing them in any way. Simply testing accuracy, rather than more rigorous investigation such as speed of responding, makes it difficult to conclude that an individual patient is performing a task without deficit, or to his or her pre-morbid level.

These methods of interpretation focus on *number* of errors. Another way to decide whether performance is impaired is to examine *type* of errors. One of the bases of the approach discussed here is to use the errors patients make to draw conclusions about which processing components are operating at a sub-optimal level. However, it is not sufficient to examine the errors on one task alone as different disorders can underlie the same symptom. Evidence must be accumulated on a number of tasks that are designed to tap different levels of processing.

FURTHER ASSESSMENTS

The purpose of the *PALPA* battery is to allow one to derive hypotheses about the nature of the processing disorder in an individual with dysphasia. Its aim is to provide a firm grounding on which to base further assessments of a person's difficulties and on which to plan directed treatment programmes. As such, *PALPA* tasks can be used in a flexible way—the materials provided in some of the tasks can be used with different procedures (computer presentation with timed responses, for example), or in different modalities, or to give baselines on which to assess the effects of particular treatment programmes—providing that the principles of experimental design and evaluation are respected.

RECOMMENDED FURTHER READING

Campbell, R. (1992). *Mental Lives: Case Studies in Cognition.* Oxford: Blackwell.

Ellis, A.W. & Young, A.W. (1988). *Human Cognitive Neuropsychology*. Hove: Lawrence Erlbaum Associates.

McCarthy, R. & Warrington, E.K. (1990). *Cognitive Neuropsychology: A Clinical Introduction.* London: Academic Press.

Margolin, D.I. (1992). *Cognitive Neuropsychology in Clinical Practice.* Cary: Oxford University Press.

Shallice, T. (1988). *From Neuropsychology to Mental Structure.* Cambridge: Cambridge University Press.

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PALPA: Psycholinguistic Assessments of Language Processing in Aphasia

Kay, Lesser & Coltheart

Summary of Assessments

AUDITORY PROCESSING

1. Nonword Minimal Pairs
2. Word Minimal Pairs
3. Word Minimal Pairs Requiring Written Selection
4. Word Minimal Pairs Requiring Picture Selection
5. Auditory Lexical Decision: Imageability x Frequency
6. Auditory Lexical Decision: Morphological Endings
7. Repetition: Syllable Length
8. Repetition: Nonwords
9. Repetition: Imageability x Frequency
10. Repetition: Grammatical Class
11. Repetition: Morphological Endings
12. Repetition: Sentences
13. Digit Production/ Matching Span
14. Rhyme Judgements x Pictures
15. Rhyme Judgements x Words
16. Phonological Segmentation: Initial Sounds
17. Phonological Segmentation: Final Sounds