maintain that it is not clear how to turn the foundational assumptions of generative linguistics into testable hypotheses, as many researchers, whether in labs or with notebooks, have been doing so for decades [16].

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Capturing underlying differentiation in the human language system

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The extended treatment of the 'past-tense debate' in *TICS* [1,2] is a useful reminder that this debate consists of two kinds of issue – a broad, almost philosophical dispute about the role of symbolic computation in human cognition, and a more specific and empirical debate about the underlying functional and neural structure of the human language system. Whether the philosophical issues are decidable is a matter of opinion, although there is little to suggest from the *TICS* contributions that we are any closer to resolution than we were 15 years ago. Where the actual structure of the language system is concerned, the accumulating evidence points to significant underlying differentiation in function. In this respect, we believe the McClelland and Patterson (M&P) position [2] to be ill-founded. On the other hand, we doubt that evidence for underlying differentiation is particularly strong evidence, *per se*, for the cognitive reality of symbolic computation.

Neuropsychological evidence clearly indicates some differentiation in language function between posterior, temporal brain regions and anterior, frontal regions. The English regular and irregular past tenses seem to differ in their dependence on these two regions. We argue that this is because regular inflected forms in English are morpho-phonologically complex, and this engages specialised frontal parsing mechanisms [3–5]. To cope with the growing evidence for neural differentiation, perceived as being incompatible with the connectionist 'single-mechanism' approach, M&P argue for a model where performance on irregulars is more dependent on semantics, and performance on regulars is more sensitive to phonological factors. This account not only fails to reflect the neurological structure of the language system in the brain, but also seems empirically incorrect.

The first problem is that the model makes the wrong predictions about the role of semantics in the relationship between an irregular past tense form and its stem. We were the first to report a correlation between semantic deficits and impaired performance on the English irregular past tense [6,3]. In subsequent studies with normal adults, designed to probe this implied causal link, we showed that the underlying relationship between irregular forms and their stems was morphological rather than semantic. Pairs like *gave/give* and *jumped/jump* are related because they share a common morpheme, in contrast to semantically related pairs (*cello/violin*) that do not have a common morpheme and are lexically separate. In a delayed repetition priming experiment designed to separate semantic from morphological effects, priming of regular and irregular pairs was equally well preserved over time, whereas semantic priming dissipated [3]. In an ERP study, the patterns of brain activity associated with regular and irregular crossmodal repetition priming patterned together, with both showing left anterior negativities standardly associated with linguistic processing, whereas semantic primes showed only a centrally

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distributed N400-type effect [7]. This evidence, that the irregular-stem mapping in the intact system is no more semantic than the regular-stem mapping, leads us to interpret the co-occurrence of semantic deficits and of disrupted access to irregular past tense forms as accidental rather than causal in nature. This interpretation is supported by the report of an anomic patient with a deficit for the irregular past tense but no semantic deficit [8].

The second problematic aspect of M&P's model is that it seeks to explain poor performance with the regular past tense purely in terms of general phonological processing deficits, and rejects the possibility of a deficit specific to morphological or morpho-phonological factors. This generates clear predictions, which we have falsified in two recent studies. Our experiments use a speeded same–different judgment task, where participants are asked to detect differences between the past tense and stem of regular (*played/play*)and irregular (*taught/teach*) past-tense verbs, matched pseudo-regular and irregular word pairs (*trade/tray*; *port/peach*), and matched sets of non-words. In one study [5], patients with documented difficulties with regular inflection performed consistently worse on the regular past-tense pairs than on the phonologically matched pseudo-regular and non-word pairs. Furthermore, performance on the task did not correlate with the patients' phonological processing difficulties, which ranged from very mild to severe. Preliminary results from a second study, using fMRI to examine activation patterns in the intact brain for the same experimental contrasts, showed differential activation for regular pairs in brain areas that overlap with regions that are damaged in the patients, and where purely phonological factors can again be excluded.

In summary, although we remain agnostic as to the types of mental computation implicated by these results, we do not believe that connectionist models of the type proposed by M&P represent a promising direction, either for resolving the past-tense dispute, or for capturing the specific functional and neural architecture of the human language system.

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Differentiation and integration in human language

Reply to Marslen-Wilson and Tyler

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The work of Marslen-Wilson and Tyler contributes importantly to our understanding of the neural basis of language processing. The arguments given in their letter [1], however, do not refute our view [2–5] that both regular and irregular verbs are processed in the same integrated system, and that performance on regular verbs is more affected by a disruption of phonological processes whereas performance on irregulars is more affected by a disruption in the use of semantics to constrain phonology.

Marslen-Wilson and Tyler (MW&T) argue against our suggestion that the relatively poor performance of Broca's aphasics with the regular past tense arises from the general phonological impairment that such patients exhibit. To be clear about our position: we hold that Broca's aphasia comprises a deficit in phonology as well as a deficit in the representation of syntactic and morphological information and/or the relevant underlying semantic distinctions that syntax and morphology convey, with relative sparing of concrete object semantics [5]. The syntactic/morphological deficit explains the finding that Broca's aphasics are impaired in the inflection of both regular and irregular verbs [5–7]. The deficit in phonology accounts for the apparent *relative* disadvantage for regular verbs compared with irregulars, and depends on the generally greater articulatory complexity and perceptual subtlety of regular past-tense forms [8,9]. MW&T dispute our account on the basis of a recent study [10] in which Broca's patients were significantly slower to detect a difference between

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