

Reply

Moving past the past tense

The commentaries written by MacWhinney and by Embick and Marantz (2005) address a range of important theoretical and empirical issues, and provide a number of valuable insights. As the two commentaries raise largely different issues, we will address each in turn.

Response to MacWhinney

MacWhinney argues that the dual-system theory presented by Ullman, Pancheva, Love, Yee, Swinney, and Hickok (UPLYSH, Ullman et al., 2005) is committed to six core properties. While he agrees with the basic premise of a dual-system view, and concurs with some of these specific properties, he suggests that others should be modified, and that still others are not essential and should simply be dropped from the theory. Although we differ with his perspective in some respects, we actually agree with many of the points he makes, and have in fact argued for them both in UPLYSH itself and elsewhere (Pinker & Ullman, 2002; Ullman, 2001a, 2001c, 2004; Ullman et al., 1997). Indeed, MacWhinney's "meaner, leaner" dual-system account shares a number of characteristics with the neurocognitive dual-system declarative/procedural model proposed by Ullman and colleagues. This model, which is only briefly discussed in UPLYSH, has been presented extensively elsewhere (Ullman, 2001a, 2001c, 2004; Ullman et al., 1997), and therefore will be discussed here only insofar as it relates to the points made by MacWhinney in his commentary.

MacWhinney does not seem to disagree with the first property he lists, namely that the brain subserves symbol manipulation. Moreover, we agree with him that symbol manipulation may itself be understood as resting upon computational mechanisms that are non-symbolic (Pinker & Ullman, 2002), provided that any such account preserves the crucial explanatory advantages of

symbol manipulation (Fodor & Pylyshyn, 1988; Marcus, 2001; Pinker & Mehler, 1988).

The second commitment identified by MacWhinney states that the brain implements linguistic rules. This accurately captures an important aspect of the dual-system model discussed by UPLYSH. MacWhinney argues that the global reach of this claim does not seem to be justified empirically, because most of the supporting experimental work has focused on concatenative inflectional morphology. On the one hand, we also take the position that more research examining issues relevant to dual-system claims must probe linguistic phenomena beyond inflectional morphology. However, it must be emphasized that a wide range of cross-linguistic data from syntax as well as morphology has been presented in support of the existence of a neurocognitive system that subserves rule-governed linguistic behavior, and is distinct from the neurocognitive substrates of lexical and semantic knowledge (Clahsen, 1999; Friederici, 2002; Pinker, 1999; Pinker & Ullman, 2002; Ullman, 2001c, 2004; Ullman & Pierpont, in press).

MacWhinney also argues that the notion of "rule" articulated by UPLYSH seems problematic, both because "Chomsky has been retreating from his former commitment to rules," and because the rules proposed by UPLYSH have been reduced to a set that possibly includes "nothing more than the productive, default grammatical morphemes of the language." However, as we have discussed in UPLYSH and elsewhere, the grammar system is posited to subservise a wide range of rules across grammatical domains (Pinker & Ullman, 2002; Ullman, 2001c, 2004; Ullman & Pierpont, in press). Moreover, our notion of rule is compatible with both constraint- and construction-based theories, as long as they allow for variables and combinatorial operations (Jackendoff, 2002; Marcus, 2001; Pinker & Ullman, 2002). Indeed, we strongly agree with MacWhinney that "combination" is a key feature of the grammar system. We seem to diverge from MacWhinney in *also* emphasizing the rule-governed nature of the combinations subserved by this system, which we have argued is critical for rule- or constraint-governed combination or composition (Ullman, 2004; Ullman & Pierpont, in press).

MacWhinney concurs with the third property he lists, that "the brain implements rote lexical retrieval." How-

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ever, it should be pointed out that whereas many researchers, in particular theoretical linguists, use the term “rote” to refer to a memory system in which items are stored in separate unrelated slots, MacWhinney envisions a memory system with associative similarity-based characteristics like those emphasized by neural network models. Our own view of lexical memory is somewhat similar to this (Ullman et al., 2005), although we have crucially underscored the semantic, phonological, morphological, and syntactic structure of stored lexical items (Pinker & Ullman, 2002; Ullman, 2001a, 2001c).

The fourth and fifth commitments listed by MacWhinney are related to each other, namely that “the formation of words by rote and the formation of words by rule are computed in separate cognitive modules,” and that “rote is processed in posterior areas and rules are processed in anterior areas.” MacWhinney agrees with these commitments, with certain modifications: he suggests that “rule” should be replaced by “combination,” and “modules” by “neural areas.” As discussed above, we have argued that both rules and combinations are critical features of the grammar system, and thus combination alone is an inadequate characterization. With respect to the contrast between “modules” and “neural areas,” we should stress that the former term was not used at all in UPLYSH. Rather, here and elsewhere, we have highlighted the notion of “system” (Ullman, 2001a, 2001c, 2004; Ullman et al., 1997). This term, which is borrowed from the field of (cognitive) neuroscience, refers to a network of anatomically interconnected and functionally inter-related parts (Eichenbaum, 2000; Gabrieli, Stebbins, Singh, Willingham, & Goetz, 1997; Iacoboni, 2002; Mishkin, Malamut, & Bachevalier, 1984; Poldrack, 2001; Squire et al., 1990; Ungerleider, Courtney, & Haxby, 1998; Willingham, Salidis, & Gabrieli, 2002). On the one hand, the notion of “system” is more specific and clearly defined than that of “neural area.” On the other hand, it suffers from being somewhat less well specified in certain respects than the Fodorian notion of module (Fodor, 1983), although importantly it is not constrained by the Fodorian denial of interactivity that worries MacWhinney. Note also that whereas in UPLYSH we emphasize a relatively simple distinction between a frontal (and basal ganglia) grammar-sub-serving system versus a temporal/temporo-parietal system underlying lexical memory, other evidence suggests a more subtle anatomical separation of the two systems (Ullman, 2004; Ullman & Pierpont, in press).

There seems to be some confusion regarding the sixth property listed by MacWhinney. According to him, UPLYSH claims that the “brain organization to support this dissociation between rote and rule is a domain-specific adaptation that was required for the evolution of human language.” However, we do not argue for such

a view in UPLYSH, nor have we made such claims elsewhere. Indeed, we have argued extensively that both the grammar- and lexicon-sub-serving systems are domain-independent, each subserving a particular set of non-linguistic as well as linguistic functions (Ullman, 2001c, 2004; Ullman et al., 1997). This declarative/procedural perspective is not emphasized in UPLYSH, since the studies it reports do not directly probe the domain-independence of grammar or lexicon. Nevertheless, the declarative/procedural perspective is clearly presented in two places, including the final sentence of the paper (manuscript pages 80 and 84). Note that the confusion may have arisen because we state in the Introduction that, within the broad class of dual-system models, domain-specificity of one or more components is generally assumed. Although this is indeed the case for most dual-system models, our perspective posits domain-independence.

There also appears to be a misunderstanding regarding the storage of regulars. We do *not* maintain that regulars cannot be stored in lexical memory. Rather, as we state briefly in UPLYSH (manuscript pages 14 and 32), and discuss extensively elsewhere (Pinker & Ullman, 2002; Ullman, 2001a), regulars and other complex forms can and often are stored in lexical memory, despite the fact that they can alternatively be computed by the rule-governed compositional system. It would be difficult to prohibit regular forms from ever being stored, given that human memory can acquire many kinds of verbal material (e.g., poems, speeches). Indeed, many other dual-system models also posit the storage of at least some regularly inflected forms (Alegre & Gordon, 1999; Baayen, Burani, & Schreuder, 1997; Baayen, Dijkstra, & Schreuder, 1997; Caramazza, Laudanna, & Romani, 1988; Chialant & Caramazza, 1995; Frauenfelder & Schreuder, 1992; Laudanna & Burani, 1985; Schreuder & Baayen, 1995). Evidence suggests that whether a regular form is stored, and whether stored regular forms are accessed, depends on multiple word-, task-, and speaker-specific factors, including the frequency of combined forms and even the sex of the learner and their hormonal status (Estabrooke, Mordecai, Maki, & Ullman, 2002; Estabrooke, Mordecai, Maki, & Ullman, 2004; Pinker & Ullman, 2002; Ullman, 2001a, 2004; Ullman et al., 2002; Ullman & Pierpont, in press).

MacWhinney seems to suggest that an MEG study of regular and irregular inflection (Rhee, Pinker, & Ullman, 1999) constitutes evidence for the storage of regulars. While we embrace the notion that regulars can be and often are stored, the results of this study appear to be best explained by the frontal-based computation of (at least many) regulars. Rule-governed computation is posited to succeed only if no appropriate form (irregular or regular) is found in lexical memory. Since lexical memory is always examined for a stored form, temporal/parietal activation should be found for both verb

types, as was observed. In the case of irregulars, a past-tense form is (generally) found, and so no rule-governed combination occurs, explaining the absence of frontal activation. For regulars, however, the initial memory search often fails (though not necessarily, if a stored regular is retrieved), in which case the rule-governed computation takes place, yielding the observed subsequent left frontal activation.

Finally, we agree with MacWhinney that testing more patients on additional tasks probing regular/irregular morphology would be desirable, and should help tease apart the competing theoretical perspectives. Nevertheless, we believe that the patients presented by UPLYSH, constituting 18 agrammatic non-fluent aphasics with frontal damage and 9 anomic fluent aphasics with temporal/temporo-parietal lesions, who were tested on combinations of production, reading, judgment, writing, and repetition tasks of regular and irregular past-tense or plural forms, provide a substantial data set that significantly constrains the competing explanatory hypotheses.

Response to Embick and Marantz

Embick and Marantz (EM) focus their attention on the morphological theory known as Distributed Morphology (DM) (Halle & Marantz, 1993). We agree with a number of the points made by EM, but take a different position on others. We concur that complex linguistic structures whose parts are linked in memory, including idioms (e.g., *kick the bucket*) and irregular affixed morphological forms, are unlikely to be stored as unanalyzed wholes in the lexicon. We rather assume that these items are represented in a structured manner (see point above regarding the structure of stored lexical items). Although this point is not specified in UPLYSH (neither is it denied), it has been presented and discussed elsewhere (Pinker & Ullman, 2002; Ullman, 2001a, 2001c).

Consistent with DM (cf. Anderson, 1992), we also do not deny that the parts of a stored complex structure may need to be composed with each other. That is, it is not the case that such memorized structures are necessarily manipulated as complete wholes that are simply “analyzed” with respect to their parts. Rather, the analyzed parts may require some sort of manipulation and compositional computation in much the same manner as the completely independent elements which are composed to form predictable structures, as in default morphological transformations (e.g., English regular past-tense formation).

Composition is particularly likely when morphologically complex words are formed from an irregular stem and an apparently *default* affix or set of affixes. Such constructions occur commonly in languages other than English. For example, in Italian, the same agreement af-

fixes are generally added to irregular and regular stems (e.g., first person singular present tense *am-are* → *am-o* ‘I love’; *rot-are* → *ruòt-o* ‘I rotate’; both of which have the default agreement marker *-o*). While it is possible that irregular forms like *ruòto* are memorized and retrieved in their entirety (Say, 1999; Say & Clahsen, 2002), this strategy becomes less likely as the number of possible combinations of morphemes increases. Thus in agglutinative languages such as Turkish or Swahili, it seems improbable that the presence of an irregular stem with a long sequence of additional morphemes would require the entire sequence to be memorized.

Nevertheless, it should be pointed out that these languages tend to highly regular (Comrie, 1989), with very few irregular stems (e.g., Turkish has at most a handful of them; J. Hankamer, personal communication). Given such a dearth of irregulars, it is at least plausible that non-novel forms (i.e., those that have previously been encountered) containing an irregular stem are memorized, even when they are fairly complex, rather than being combined every time they are used. Even novel forms could in principle be formed in the associative lexical memory system (Hartshorne & Ullman, under review; Ullman, 2001b), although, as pointed out in UPLYSH, the extent of this system’s productivity remains unclear. In sum, while we agree that composition in the formation of irregular morphological forms and in various other lexicalized complex structures likely occurs, and that such composition is subserved by the same mechanisms and system that underlie the formation of predicable (regular) structures, the circumstances under which it actually takes place remain to be elucidated.

Which brings us to the case of English past-tense, and the data from UPLYSH. Whatever the likelihood that irregular morphological forms are combined in other languages, the case for English past-tense is still open. Indeed, we and others have argued extensively that at least the extant data do not seem to be consistent with such combinatorial processes for English irregular past-tense forms (McClelland & Patterson, 2002; Pinker, 1999; Ullman et al., 1997; Ullman, Walenski, Prado, Ozawa, & Steinhauer, 2001). This does not mean of course that *none* of the past-tense data are compatible with any combinatorial processes for irregulars. Indeed, we agree with EM that DM can account for much of the frequency effect data, though these data certainly do not favor this perspective as compared to other dual-system views.

The evidence reported in UPLYSH itself does not seem entirely consistent with DM. On the one hand, we accept EM’s point that the non-fluent aphasics’ lack of forms like *kep* is not incompatible with DM, on the view that phonological readjustment “will not apply if the affix is not present” (EM manuscript page 5). On the other hand, we are not convinced by EM’s claim that

the memorized connections between irregular verbs and their affixes should somehow reduce the number of errors made by the non-fluent aphasics. If combination is impaired, then it should be equally impaired in all cases, wherever the pieces that are being combined came from. Therefore DM should expect a similar number of errors made by non-fluent aphasics on regulars and irregulars, contrary to the data.

Moreover, we reject the argument made by EM that DM can better account for certain past-tense data. Thus the tendency for a conservation of phonological material between stem and irregular past-tense forms (e.g., in *spring-sprang* only the vowel is modified) can be explained not only by DM-like stem-readjustment rules, but also as historical artifacts or a consequence of superpositional memory (Pinker, 1999; Pinker & Ullman, 2002). Similarly, while DM may be able to account for the non-fluent aphasics' imperfect performance on irregulars, and their unmarked and inflected error forms (e.g., *keep-keep*, *keep-keeping*), it is certainly not alone in doing so. Consistent with these data, we accept the notion of the syntactic computation of tense, which is moreover independent from the morpho-phonological processing in which the regular/irregular distinction occurs (Pinker & Ullman, 2002; Ullman, 2001a, 2001c). Indeed, we have argued that the specific pattern of unmarked and inflected errors made by these and other non-fluent aphasic patients supports the hypothesis that the impairment in non-fluent aphasia independently affects combinatorial processes in both morpho-phonology and morpho-syntax, consistent with the declarative/procedural perspective. On this view, the morpho-syntactic deficits cause difficulties in building hierarchical syntactic structures, resulting in the particular error patterns observed in these patients (Izvorski & Ullman, 1999; Pancheva & Ullman, under revision).

Conclusion

Although MacWhinney and Embick and Marantz differ in many of their arguments, they both point out that empirical investigations of dual-system models have focused on English past-tense as a test case for broader claims about the nature of language. Both commentaries argue that these models' predictions need to be developed and examined beyond this linguistic phenomenon if broader claims are to be substantiated. Although the English past-tense is by no means fully understood yet, and moreover provides a useful paradigm for investigating issues such as subject variability and language impairments in abnormal populations (Bird, Lambon Ralph, Seidenberg, McClelland, & Patterson, 2003; Estabrooke et al., 2002; Patterson, Lambon Ralph, Hodges, & McClelland, 2001; Ullman, 2004, in press; Ullman et al., 2002), we strongly agree

that the domain of inquiry must be expanded both across languages and across linguistic domains, including in both syntax and compositional semantics (Steinhauer, Portner, Walenski, & Ullman, 2003). These avenues of approach should reveal new twists and insights to familiar problems, and will provide a fresh perspective on the broader issues at the core of the debate surrounding English past-tense.

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Errata

On page 249 in the right column:

The phrase “manuscript pages 80 and 84” should read “pp. 228 and 230”.

The phrase “manuscript pages 14 and 32” should read “pp. 189 and 197”.

On page 250 in the right column:

The phrase “EM manuscript page 5” should read “EM pp. 246”.