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Single Mechanism = Single Representation? No!!

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Introduction

A great deal of recent discussion in the language processing literature has addressed the question of whether a single mechanism is sufficient to account for patterned behavior in language or whether multiple mechanisms are required. Much of this attention has focussed on the case of the past tense in English (Hare & Elman, 1995; Marcus et al., 1992; Pinker & Prince, 1988; Plunkett & Marchman, 1993; Rumelhart & McClelland, 1986), although the same issue clearly arises in many other areas of language.

In a recent paper involving PET methodology Jaeger et al. (1996) claim to have discovered data which argue strongly against the single mechanism or connectionist approach and weakly in favor of a perhaps modified version of the dual mechanism (rule-based plus association network) approach. The claim of this paper was that a dual mechanism approach predicts that distinct brain areas would be involved in processing regulars and irregulars, whereas a single mechanism approach predicts identical patterns of activity during the processing of both classes of verbs. Jaeger et al. found that although there was substantial overlap in the brain regions that were active while processing both classes of verbs, there were also areas which were more active while processing one but not the other.

Unfortunately, data of the sort reported by Jaeger and her colleagues do not in fact distinguish between the hypotheses in the manner that is claimed. The purpose of the present note is to examine the underlying premise which motivated that study, and to demonstrate—both logically and empirically—that the results that were obtained are necessarily to be expected for *both* classes of models

Simulation Model

A feed-forward network was taught the present/past relationship for 982 verbs (93 irregular, 889 regular). Frequency of presentation for each verb was based on the log of its frequency in the Celex database. After 2000 epochs of training, homophones were eliminated and the 944 non-homophonic forms were presented to the network. The activations of the 30 hidden units were recorded. A multiple regression was carried out over the hidden unit vectors to see how the hid-

den units' activity correlated with the regular/irregular distinction. The partial correlations are quantitatively small but 15 of the 30 units' activity is significantly correlated with the regular/irregular status of the input. (Positive correlations indicate units which are primarily active during processing of irregular verb forms; negative correlations indicate units which are primarily active for regular verbs). As was also found in the Jaeger et al. study, more units appear to be active while processing irregulars than regulars.

We conclude, therefore, that merely demonstrating differential brain activity in response to different types of stimuli does not distinguish between the single- and the dual-mechanism hypotheses. Localization data of the sort presented so far argue only that stimulus differences which produce differences in behavior must also produce differences in brain activity, and do not speak to the unitary or non-unitary nature of brain mechanisms.

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