Testing the interactive two-step model of lexical access:
Part I. picture naming

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The weight-decay (WD) and semantic-phonological (SP) models offer competing accounts of how brain damage disrupts processing within an interactive 2-step lexical-access framework. A few studies have compared these deficit models for how well they fit individual naming profiles on the Philadelphia Naming Test (PNT) (Dell, Lawler, Harris, & Gordon, 2004; Foygel & Dell, 2000; Ruml, Caramazza, Shelton, & Chialant, 2000). The results, good for both, offer little basis for choosing among them. Moreover, the numbers of patients whose profiles were fit in these studies was small. The largest had \( n = 21 \) (Foygel & Dell, 2000) and was potentially biased by exclusion of non-fluent aphasics and those with many responses outside the standard error categories. Here, the WD and SP models are compared with data from a new sample that is larger and unbiased in those respects.

Methods

Participants

Participants were 94 individuals who had become aphasic after left hemisphere CVA. All were post acute-care discharge. Criteria for exclusion were: age below 18; symptomatic lesions outside the LH; evidence of dementia; significant sensory disturbance; speech rendered unscorable by articulatory distortion or jargon. Mean age was 59 (range 22–86); Mn. education, 13.2 (7–24); and months post-onset, 38.2 (1–195). 40.4% of the sample was female. 33% were classified as having Broca’s aphasia; 29% Anomic, 22% conduction; 14% Wernecke’s; and 3% Transcortical sensory.

Procedures

The 175-item PNT was administered as part of a battery that also included tests of word repetition, auditory input processing, picture-name verification, and more. The standard PNT scoring yields counts for correct trials (C) and 5 types of error: semantic (S), mixed (M), formal (F), unrelated (U), and nonword (N) (Dell et al., 1997). For each of the 94 naming profiles, fitting routines were used that identified the \( w \) and \( d \) settings (for the WD model) and the \( s \) and \( p \) settings (for the SP model) that generated the closest fits overall, as measured by \( \chi^2 \) (see Foygel & Dell, 2000). Here, we report root mean squared deviation (RMSD) as the index of goodness-of-fit. For example, an RMSD of .030 means that the model and patient predictions are on average .030 apart.

Results

Comparison of the models’ fits

Average RMSD for the WD model is .034 and for the SP model, .024. The difference, favoring the SP model, is significant (\( t(93) = 4.58; p < .0001 \)). The SP model accounts for 94.4% of the variance in profile proportions. Fig. 1 shows that its obtained—predicted deviations are generally small; also, they are largely unsystematic in each response category, i.e., more or less symmetric around zero.

Of the many profiles that are not possible to fit by the SP model, only one occurred in more than one or two patients. Eight patients produced a version of what we call the “pure semantics” profile, with many errors in the S and M categories and few others.

Interactive error effects

According to the SP model, the occurrence of lexical formal errors is not predicted by the magnitude of \( p \), but by the \( (p−s) \) difference. This is precisely what the data show: In both low \( p \) and high \( p \) patients, the mean percentage of chance-corrected noun formals differs from zero when \( (p−s) \) is large and not otherwise. Regarding mixed errors, the SP model predicts—and the data support—that such errors occur in excess of chance only when \( s \) and \( p \) are both high.

Discussion

The SP model is superior to the WD model in fitting naming-error profiles. The reason is that SP can explain certain dissociations that
WD cannot, e.g., many phonological errors with few lexical errors (Foygel & Dell, 2000).

A major claim of the WD model is that its characterization of patients generates true predictions of other characteristics of their naming performance, most notably the likelihood of lexical formals (Dell et al., 1997). The SP model also succeeds in this regard. The present sample is notable for its size and diversity, including some with very low correctness (4%). Many response profiles are “impossible” according to the SP model, yet only one (“pure semantics”) occurred with some frequency. In the model, s lesions that produce many semantic and mixed errors also produce other lexical errors. For the 8 “pure semantics” patients in the sample, the model underpredicts S and M and overpredicts F and U.

The “pure semantics” profile is equally problematic for the WD model. It may be that for such patients, the models’ assumption of intact semantic and syntactic representations is wrong (Foygel & Dell, 2000), or the estimated magnitude of lexical-phonological feedback too high (Rapp & Goldrick, 2000). Nonetheless, it is impressive that a model of damage with just two parameters is able to explain so much about naming profiles in aphasia.

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References


