The dual origin of semantic errors in access deficits: activation deficit vs. inhibition deficit

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Two sources have been identified as origins of semantic errors (e.g., “dog” for “cat”) after brain damage: damage to semantic concepts (“storage deficit”), and damage to the links between semantic concepts and lexical representations (“access deficit”; e.g., Lambon-Ralph et al., 2016). I present data suggesting that an access deficit can be further broken down into two distinct deficits: problems in activating the target (*activation deficit*), and problems in inhibiting competitors (*inhibition deficit*). These two deficits are expected to show dissociations on three categories of tests listed in Table 1.

Lexical-semantic memory. Activation of lexical items supports activation of semantic features, either through feedback connections (e.g., Foygel & Dell, 2000) or simply by verbal rehearsal (Baddeley & Hitch, 1974). Either way, poor lexical activation as proposed in the activation deficit should impair semantic working memory.

General indirect competitive control. If lexical selection depends on domain-general inhibitory control (e.g., Shao et al., 2015), an inhibition deficit should be accompanied by impaired performance on a non-linguistic task that measures competitive inhibitory control.

Naming under increased competitor activation. Any cues that increase competitor activation should promote the production of the competitor in inhibitory deficit because it cannot be properly suppressed. These cues include misleading onset cues (/d/ for cat), or switching between words that share onset or rhyme phonology (e.g., cat-cup). A special dissociation is expected for boosting semantic competitors: the extra activation of semantic space in this case should be beneficial in activation deficit, but detrimental in inhibition deficit.

Methods. Participants were two individuals (XR, female, 57; QD, male, 66) with an access-deficit profile summarized in Table 2. Seven controls (Mean age = 61.14) were also tested. Lexical semantic memory was assessed using a modified version of the Category-Probe test (Freedman & Martin, 2001). Participants decided whether a word-probe belonged to the same semantic category as any of the words in a memory list (increasing length 1:6). General indirect competitive control was measured using the spatial Simon task that taps into response inhibition (Lu & Proctor, 1995). Performance under increased lexical competition was assessed using two tasks: a) a miscueing task (see Lambon-Ralph et al., 2016) where a picture was paired either with the correct first sound or the first sound of a semantic competitor. b) a word-pair reversal paradigm (Nozari et al., 2016) in which participants reversed the name of two pictures on several trials. Four conditions included unrelated pairs, semantically-related pairs or pairs overlapping in onset or rhyme.

Results. Figure 1 summarizes the results that confirm the predictions in Table 1. Activation deficit is marked by worse semantic working memory, normal general inhibitory control, and relatively better

performance on reversed naming when the competitor is semantically related to the target. Inhibition deficit, on the other hand, is marked by intact semantic working memory, impaired inhibitory control, and significantly worse naming accuracy under conditions that increased competitor activation by either semantic or phonological cues.

Conclusion. Access deficit comprises two distinct problems: activation deficit and inhibition deficit.

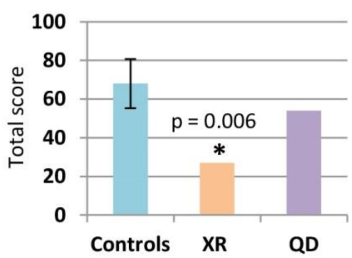
Table 1- Expected dissociations in activation vs. inhibition deficit

	1. Lexical-semantic memory (Category probe test)	2. General competitive inhibitory control (Simon task)	3a. Increased lexical competition (Miscueing errors)	3b. Increased lexical competition (word-pair reversal in semantic, unrelated, onset, and rhyme conditions)
Activation deficit	impaired	not impaired	omissions	1- accuracy: semantic > unrelated 2- accuracy: onset = rhyme = unrelated
Inhibition deficit	not impaired	impaired	production of the cued competitor	1- accuracy semantic < unrelated 2- accuracy: onset ≈ rhyme < unrelated

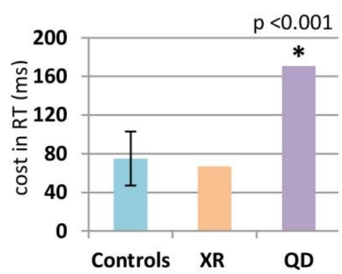
Table 2- Scores on language tests showing good conceptual and lexical comprehension, predominance of semantic errors in naming and inconsistent item performance. S = Semantic

	conceptual comprehension	auditory word comprehension	Philadelphia Picture Naming (Roach et al., 1996)	Cronbach's α across 2 naming attempts (406 pictures each)
XR	27/28	173 /175	152/175 (65% of errors = S)	0.65
QD	27/28	174 /175	132/175 (58% or errors = S)	0.63

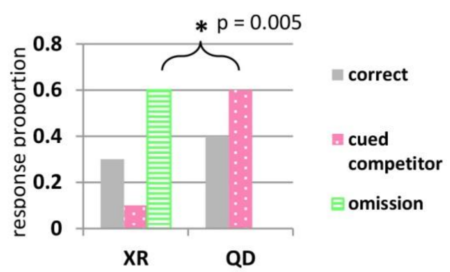
Figure 1- Results. Comparisons between patients were conducted by Chi square. Comparisons to controls were performed using the Bayesian method proposed by Crawford & Garthwaite (2007).



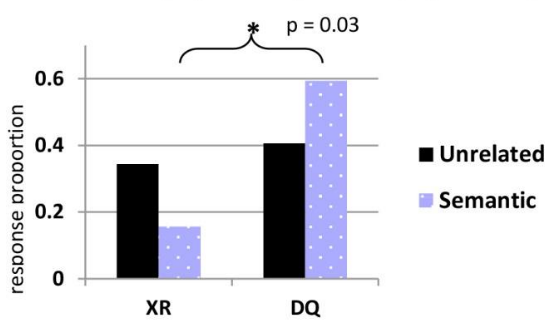
Category probe - XR is significantly impaired compared to QD and controls. (Higher score = better performance)



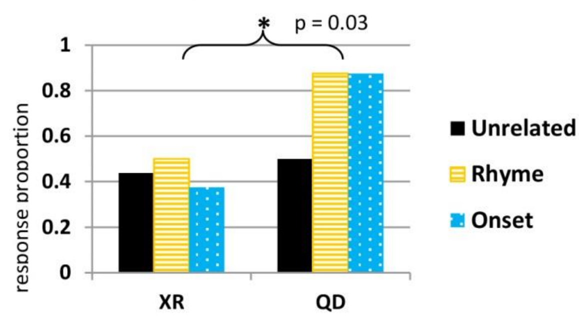
Simon- QD is significantly impaired compared to XR and controls. (Higher cost = worse performance)



Miscueing- XR's responses are 60% omission and 10% miscued competitor. QD shows the opposite pattern of 60% miscued competitor and no omissions.



Word-pair reversal (unrelated vs. semantic) - XR's performance is helped by semantic similarity, while DQ's performance is hurt by semantic similarity.



Word-pair reversal (unrelated vs. onset & rhyme) - XR's performance is not hurt by phonological similarity, while QD's performance is significantly hurt by it.

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