Dissociation between Speech and Writing and Orthographic Autonomy

Shazia Tahira

Abstract

It is usually assumed that written word is dependent upon spoken word and in aphasia and similar disorders, speech and written components are equally affected. But there are many cases where it can be seen that its not always the same and speech and written components are many a times differently affected. Obligatory phonological mediation hypothesis and orthographic autonomy hypothesis represent these conflicting perspectives. According to the obligatory phonological mediation hypothesis, written language necessarily involves phonological mediation and is entirely dependent upon spoken language. The semantic system activates the phonological form of a word, which then activates the corresponding orthographic representation. In contrast, the orthographic autonomy hypothesis posits that the lexical orthographic representations of words can be accessed without any necessary phonological mediation and can be directly activated from the semantic system. The obligatory phonological mediation and orthographic autonomy hypotheses predicts differently the possible effects of brain damage on written naming. On the basis of the phonological mediation hypothesis, an impairment at the level of the phonological lexicon should always affect both spoken and written naming and in double naming tasks, the word selected for a written response should always correspond to the one selected for a spoken output. But on the basis of orthographic autonomy hypothesis, the orthographic lexicon can be accessed directly from semantics therefore it should be possible to observe cases with impaired spoken naming due to damage to the phonological lexicon with no written naming deficit and double naming tasks in spoken and written modalities may give rise to lexically inconsistent responses. In support of this view, a number of cases showing dissociation in phonological lexical forms and orthographic forms including spared knowledge of orthographic forms despite an impairment affecting phonological lexical forms with intact articulatory abilities or lexically inconsistent responses in consecutive double naming tasks in different modalities of writing and speech have been reported across a number of languages. Here, different case studies showing dissociation in phonological lexical forms (spoken speech) and orthographic forms (writing) are reviewed providing evidence that access to the orthographic form of words can occur independently.

Key Words

orthographic autonomy, obligatory phonological mediation, optional phonological mediation, dissociation between speech and writing, superior written vs. spoken naming

Author's Affiliation: University of Karachi, Karachi, Pakistan. Correspondence: shaziatahira@gmail.com

Introduction

It is usually assumed that written word is dependent upon spoken word and in aphasia and similar disorders, speech and written components are equally effected. But there are many cases where it can be seen that its not always the same and speech and written components are many a times differently affected. Obligatory phonological mediation hypothesis and orthographic autonomy hypothesis represent these conflicting perspectives.

According to the obligatory phonological mediation hypothesis, written language necessarily involves phonological mediation and is entirely dependent upon spoken language. During reading, one go from a written stimulus to a phonological representation before one can access the meaning of a word. During writing, one retrieve the spoken form of a word in order to gain access to the orthographic form [1]. The retrieval of the spoken form of the word or phonological lexical retrieval involves the activation of a lexical-semantic representation in the semantic lexicon. The semantic lexicon contains words and information about the meaning of words and is linked with the syntactic lexicon.. The selected semantic and syntactic representation activates the lexical-phonological representation or the representation of the spoken form of the word in the phonological output lexicon [2]. The phonological form of the word, then activates the corresponding orthographic representation.

There are two main forms of the obligatory phonological mediation hypothesis. According to the sub-lexical form of obligatory phonological mediation hypothesis, phonological words are translated into spellings via a sub-lexical phonology-to-orthography conversion route. According to the lexical form of the obligatory phonological mediation hypothesis, word spellings are retrieved from the orthographic lexicon via direct links with the corresponding representations in the phonological lexicon [3].

The autonomy of lexical orthography means that written word retrieval is not dependent upon phonological mediation and is independent of that. According to orthographic autonomy hypothesis, orthographic knowledge can be linked directly with the meaning and syntax of lexical knowledge without phonological mediation although there may be optional phonological mediation [1]. Without any obligatory involvement of phonology and direct links with semantics, the orthographic lexicon is involved in the retrieval of written words [3].

Zhang et al. did a study with healthy participants using a picture–word interference task requiring participants to write or to speak the names of pictures while trying to ignore visual distractors, They found a fast and direct link between meaning and orthographic lexicon and a slow and indirect link between meaning and orthographic lexicon via phonology [4]. In a study with fifth graders, Bosse et al. found that lexical orthography acquisition or orthography learning is more efficient when mediated by handwriting than by spelling aloud [5].

It has always been of interest to researchers if the ability to write depends on the integrity of a separate cortical centre distinct from areas through which speech is effected [6]. In the left lateral occipitotemporal sulcus, there is a site known as the visual word form area (VWFA) [7]. Visual word form area serves as neural equivalent of the orthographic word lexicon for reading and spelling and is found to be responsive in spelling-based studies [8].

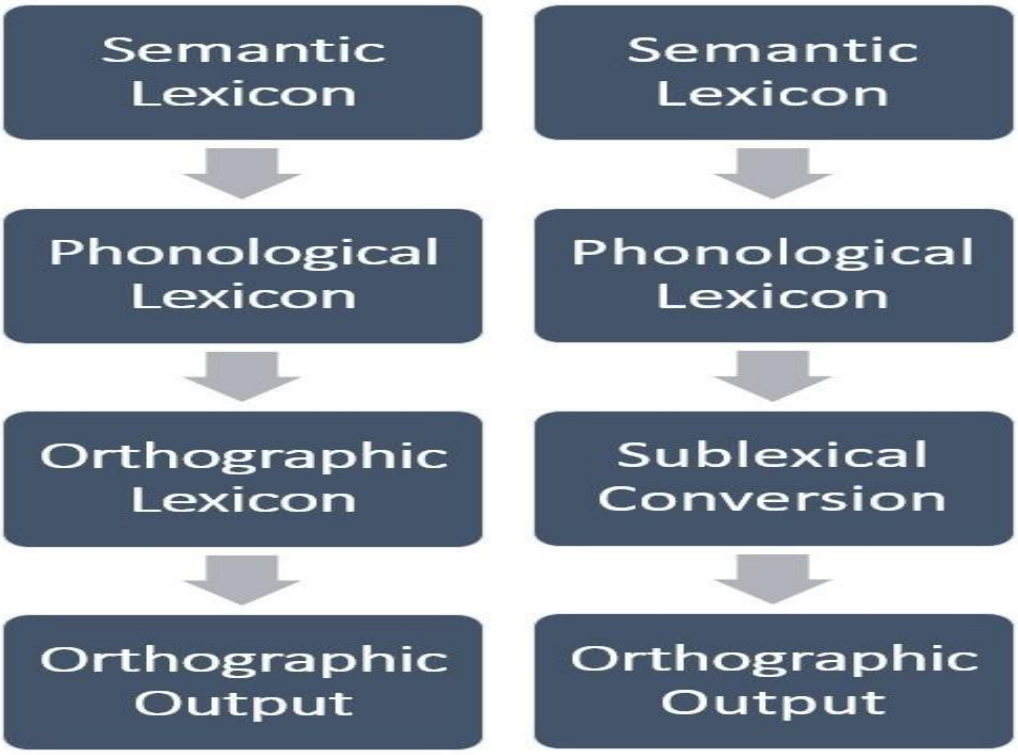

Fig 1. Obligatory Phonological Mediation
(Lexical via Orthographic Lexicon and Sub-Lexical via Sub-lexical Conversion)

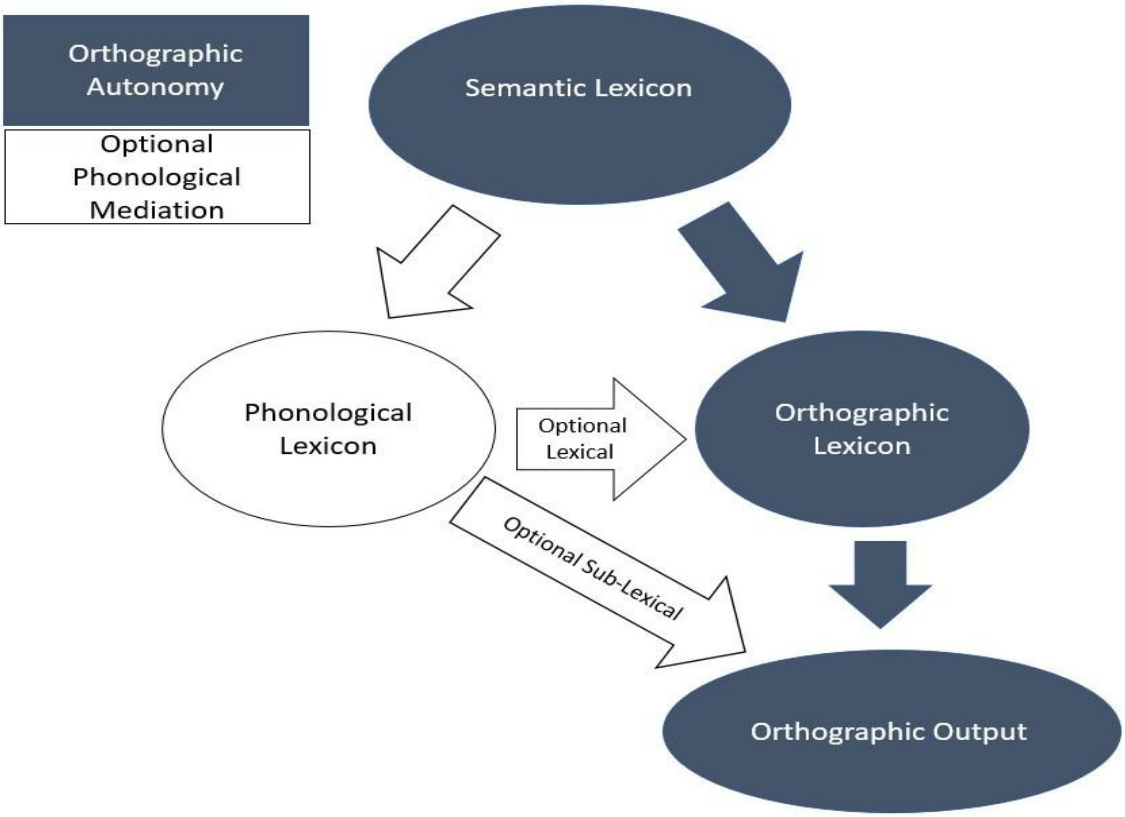

Fig 2. Orthographic Autonomy & Optional Phonological Mediation

The obligatory phonological mediation and orthographic autonomy hypotheses predicts differently the possible effects of brain damage on written naming. On the basis of the phonological mediation hypothesis, an impairment at the level of the phonological lexicon should always affect both spoken and written naming and in double naming tasks, the word selected for a written response should always correspond to the one selected for a spoken output. But on the basis of orthographic autonomy hypothesis, the orthographic lexicon can be accessed directly from semantics therefore it should be possible to observe cases with impaired spoken naming due to damage to the phonological lexicon with no written naming deficit and double naming tasks in spoken and written modalities may give rise to lexically inconsistent responses. Many patients with impaired spoken-naming usually also show impaired written naming but a number of dissociations have also been reported. But not all spoken-naming and written naming dissociation cases can prove orthographic autonomy because the mere presence of a spoken naming disorder is not sufficient to establish a lexical deficit to test the orthographic autonomy hypothesis,as damage at the level of post-lexical phonological or articulatory processes could also affect spoken naming. Under either hypothesis, damage to these more peripheral components should not interfere with spelling performance therefore to prove orthographic autonomy hypothesis, the deficit must be at the level of the phonological lexicon, since this is the component that would be involved in phonologically-mediated written naming. Many a times distinguishing between lexical and post-lexical damage can be complicated but superior written naming has been documented in several cases where spoken naming disorders were likely due to a lexical impairment. Such cases provide evidence against the hypothesis of obligatory phonological mediation and provide strong support for the orthographic autonomy hypothesis [3].

Different observations contribute to the growing evidence of orthographic autonomy. Here, different case studies showing dissociation in phonological lexical forms (spoken speech) and orthographic forms (writing) are reviewed providing evidence that access to the orthographic form of words can occur independently.

Dissociation in Phonological Lexical Forms (Spoken Speech) and Orthographic Forms (Writing)

Superior Writing vs Speech

A number of case studies have been reported exhibiting superior written vs. spoken naming.

Rapp et al. presented the case of a neurologically impaired individual PW who was often unable to provide the correct spoken name of an object although he might be able to write its name correctly. Across the four experimental tasks, on some occasions semantic errors in spoken naming involved the consistent production of a different semantic error in written production; or correct but different synonymic responses were produced in the two modalities, and a few times a correct spoken response was accompanied by a semantic error in writing. But in spite of considerable damage to the orthographic lexicon, PW was able to produce the appropriate lexical orthographic form on one out of five occasions on which he was unable to produce the appropriate spoken form [1].

Bub et al. described a case study with dissimilar written and spoken naming. Written naming for single words was remarkably superior to spoken naming. There was impaired retrieval of the underlying sound component of words in rhyme matching tasks and nonlexical

phonological processing was severely impaired in writing to dictation suggesting that written naming was not mediated by phonological processes [9].

Caramazza et al. described two brain-damaged individuals RGB and HW who showed similar and high rates of semantic errors in oral naming and oral reading; but did not make semantic errors in comparable written tasks. Further, results of a variety of lexical tasks with the same stimuli demonstrated unimpaired comprehension of printed or spoken words, including those that are orally produced as semantic errors. These patterns of performance were interpreted as resulting from damage to the phonological output lexicon [10].

Hier et al. presented a case study of a 28-year-old man who developed the fluent paraphasic speech characteristic of Wernicke's aphasia after an episode of necrotizing temporal lobe encephalitis. He exhibited superiority of written naming over oral naming along with reading comprehension modestly superior to his auditory comprehension [11].

Levine et al. presented the case of a 54-yr-old man who suddenly became mute with mild right hemiparesis. There was complete loss of inner speech and he was unable to appreciate the phonological structure of words. Written expression, comprehension of speech and print were slow but largely unimpaired [12].

Patterson et al. described a severely aphasic patient whose spelling ability although impaired was much superior to his speech and presented entirely different patterns [13].

Semenza et al. described a patient who showed several dissociations between oral and written language processing after bilateral retrorolandic vascular lesion. There was impaired auditory comprehension, preserved written comprehension and superior written vs spoken confrontation naming. Spontaneous speech was fluent and well articulated but consisted of neologistic jargon, while reading aloud was clearly superior though not perfect. A failure in retrieving the phonological word form from the semantic system could be the cause of this dissociation [14].

Piras et al. described a non-fluent aphasic patient, RA, with agrammatic speech and severe word- finding difficulties. His performance on picture naming tasks was significantly worse in the spoken than in the written output modality. Errors were predominantly omissions. Few semantic paraphasias were present. Semantic errors did not arise from a deficit in the semantic system since the patient performed flawlessly on a semantic questionnaire and a word picture matching task and gave correct definitions of the items. On double naming tasks the patient gave inconsistent responses (i.e. he correctly wrote the stimulus "z-e-b-r-a" but he orally produced "giraffe") [15].

Tainturier et al. presented a cas e of a 60-year-old woman YP with a pattern of frontotemporal dementia. As her disease progressed, YP's ability to write down the names of pictures remained very good despite a severe decline in oral naming without any articulatory or post-lexical phonological deficit [16].

Kemmerer et al. described a brain-damaged individual, RR, who showed superior written over spoken naming of concrete entities from a wide range of conceptual domains. The dissociation between impaired spoken naming and comparatively better written naming was significantly greater for unique concrete entities (proper nouns including famous faces and famous landmarks) than for non-unique concrete entities (common nouns including animals,

fruits/vegetables, tools/utensils, musical instruments, and vehicles). RR's predominant error types in the oral modality were omissions for unique entities and semantic errors for non-unique entities. [17].

Law et al. described performance of a Cantonese-speaking brain-injured individual, LKY, on tasks involving oral and written production of single Chinese words. His performance pattern showed superior written over oral picture naming and better written naming than writing-to-dictation of the same stimuli. The differences in performance between oral and written naming and between the written tasks with pictorial vs oral input were due to deficits at the phonological level [18].

Ellis et al. reported the language deficits of a single Wernicke's aphasic patient R.D who showed poor speech comprehension but good reading comprehension. His spontaneous speech and attempts at reading aloud contained many neologisms and some verbal paraphasias due to problems with retrieval of the phonological specifications of words from phonological output lexicon. R.D.'s spelling was superior than his spoken naming and he was able to spell many words he was unable to say correctly [19].

With a standard quantitative battery Basso et al. investigated left brain-damaged patients with educational level above elementary school for dissociation between oral and written expression, speech was found to be selectively impaired in two patients with fluent aphasia with marked sparing of writing [20].

Dissociation between Speech and Writing

Many case studies have been reported describing dissociation between speech and writing.

Assal et al. presented a case study of an aphasic patient who displayed a dissociation between his oral and written disorders with oral Wernicke and written Broca [21].

Rapp et al. described the case of a brain-damaged individual whose speech was characterized by difficulty with all words except for elements of the closed class vocabulary and his written sentence production was impaired involving the omission of closed class vocabulary items and the relative sparing of nouns [22].

In a different study, Rapp et al. presented 5 individuals with aphasia with a double dissociation in which the production of affixes (e.g., the -ing in jumping) was impaired in writing but not speaking or vice versa suggesting considerable independence of written and spoken language systems [23].

In another study, Rapp et al. described an individual with a double dissociation of grammatical category by modality who exhibited greater difficulties in speaking nouns than verbs and greater difficulties in writing verbs than nouns across a range of both single word and sentence production tasks [24].

Miceli et al. described the performance of an individual WMA on picture naming tasks that required two consecutive responses to explore issues concerning the relations between the phonological and orthographic components of the lexical system. Responses to tasks requiring responses in different modalities (one oral and one written) often resulted in lexically "inconsistent" responses. For example, to a picture representing pliers, WMA said

"pincers," but wrote saw; and, to a picture representing peppers, he wrote tomato but said "artichoke." By contrast, inconsistent responses never occurred in tasks that required two consecutive responses in the same modality (oral or written). In these tasks, WMA always produced the same right or wrong response twice suggesting that orthographic word forms are autonomous from phonological forms, activated directly from lexical semantic information [25].

Case Study	Speech vs Writing	Predominant Error Type
Rapp et al. (1997)	Superior Written vs Spoken Naming	Semantic Errors & Omissions in Spoken Naming Different Response in Spoken vs Written Naming
Bub et al. (1982)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Caramazza et al. (1990)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Hier et al. (1977)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Levine et al. (1982)	Superior Written vs Spoken Naming	Mute, Absent Inner Speech, Written Expression Largely Preserved
Patterson et al. (1987)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Semenza et al. (1992)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Piras et al. (2004)	Superior Written vs Spoken Naming	Semantic Errors & Omissions in Spoken Naming, Different Response in Spoken vs Written Naming
Tainturier et al. (2001)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Kemmerer et al. (2005)	Superior Written vs Spoken Naming	Semantic Errors & Omissions in Spoken Naming
Law SP et al. (2006)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Ellis et al. (1983)	Superior Written vs Spoken Naming	Semantic Errors in Spoken Naming
Basso et al. (1978)	Superior Written vs Spoken Naming	Selectively Impaired Speech in Two Patients with Fluent Aphasia with Remarkable Sparing of Writing
Assal et al. (1981)	Dissociation between Speech and Writing	Oral Wernicke vs. Written Broca
Rapp et al. (1997)	Dissociation between Speech and Writing	Difficulty with All Words except Closed Class Vocabulary in Speech, Omission of Closed Class Vocabulary and Relative Sparing of Nouns in Writing
Rapp et al. (2015)	Dissociation between Speech and Writing	Double Dissociation in the Production of Affixes
Rapp et al. (2002)	Dissociation between Speech and Writing	Greater Difficulty in Speaking Nouns than Verbs, Greater Difficulty in Writing Verbs than Nouns
Miceli et al. (1997)	Dissociation between Speech and Writing	Inconsistent Consecutive Spoken and Written Naming

Table 1. Case Studies Showing Dissociation between Speech and Writing

Conclusion

Two main hypotheses have been proposed regarding the role of phonology in written word production. According to the phonological mediation hypothesis, the retrieval of the lexical phonological representation of a word is a compulsory prerequisite to the retrieval of its orthographic representation. The semantic system activates the phonological form of a word, which then activates the corresponding orthographic representation. Therefore, deficits to the phonological lexicon should affect both spoken and written picture naming and in double naming tasks, the word selected for a written response will always correspond to the one selected for a spoken output. In contrast, the orthographic autonomy hypothesis posits that the lexical orthographic representations of words can be accessed without any necessary phonological mediation and can be directly activated from the semantic system therefore there can be preserved written naming despite impaired lexical phonology following brain damage and double naming tasks in spoken and written modalities may give rise to lexically inconsistent responses. In support of this view, a number of cases showing dissociation in phonological lexical forms and orthographic forms including spared knowledge of orthographic forms despite an impairment affecting phonological lexical forms with intact articulatory abilities or lexically inconsistent responses in consecutive double naming tasks in different modalities of writing and speech have been reported across a number of languages. This pattern can't be explained by obligatory phonological mediation but can be explained by orthographic autonomy. Altogether, these studies confirm the orthographic autonomy hypothesis providing evidence that access to the orthographic form of words can be accomplished independently, without the mediation of phonology.

References

1. Rapp B, Benzing L, Caramazza A. The Autonomy of Lexical Orthography. Cognitive Neuropsychology. 1997;14(1):71-104. doi:10.1080/026432997381628

2. Friedmann N, Biran M, Dotan D. Lexical retrieval and its breakdown in aphasia and developmental language impairment. In The Cambridge Handbook of Biolinguistics. Cambridge University Press. 2013. doi:10.1017/CBO9780511980435.021

3. Tainturier M J, Rapp B. The Spelling Process. In What Deficits Reveal About the Human Mind/Brain: A Handbook of Cognitive Neuropsychology. Psychology Press. 2001

4. Zhang Q, Wang C. Phonology is not accessed earlier than orthography in Chinese written production: evidence for the orthography autonomy hypothesis. Front Psychol. 2015;6:448.. doi:10.3389/fpsyg.2015.00448

5. Bosse ML, Chaves N, Valdois S. Lexical orthography acquisition: Is handwriting better than spelling aloud?. Front Psychol. 2014;5:56. doi:10.3389/fpsyg.2014.00056

6. Gordinier HC. Arguments in favor of the existence of a separate centre for writing. Am.J.M.Sc.1903;126(3):490

7. Dehaene S, Cohen L. The unique role of the visual word form area in reading. Trends Cogn. Sci. 2011; 15(6): 254-262. doi:10.1016/j.tics.2011.04.003

8. Wimmer H., Ludersdorfer P. Searching for the Orthographic Lexicon in the Visual Word Form Area. In Lachmann T., Weis T (Eds). Reading and Dyslexia. Literacy Studies (Perspectives from Cognitive Neurosciences, Linguistics, Psychology and Education). Springer. 2018;16. doi:10.1007/978-3-319-90805-2_3

9. Bub D, Kertesz A. Evidence for Lexicographic Processing in a patient with preserved written over oral single word naming. Brain, 1982; 105(4): 697–717. doi:10.1093/brain/105.4.697

10. Caramazza A, Hillis AE. Where do semantic errors come from?. Cortex. 1990;26(1):95-122. doi:10.1016/s0010-9452(13)80077-9

11. Hier DB, Mohr JP. Incongruous oral and written naming: Evidence for a subdivision of the syndrome of Wernicke's aphasia. Brain and Language. 1977;4(1):115-126. doi:10.1016/0093-934X(77)90010-4

12. Levine DN, Calvanio R, Popovics A. Language in the absence of inner speech. Neuropsychologia. 1982;20(4):391-409. doi: 10.1016/0028-3932(82)90039-2

13. Patterson K, Shewell C. Speak and spell: Dissociations and word-class effects. In Coltheart M, Sartori G, Job R (Eds). The cognitive neuropsychology of language. Lawrence Erlbaum Associates. 1987; 273–294.

14. Semenza C, Cipolotti L, Denes G. Reading aloud in jargonaphasia: an unusual dissociation in speech output. J Neurol Neurosurg Psychiatry. 1992;55(3):205-208. doi:10.1136/jnnp.55.3.205

15. Piras F, Marangolo P. Independent access to phonological and orthographic lexical representations: a replication study. Neurocase. 2004;10(4):300-307. doi:10.1080/13554790490507614

16. Tainturier MJ, Moreaud O, David D, Leek EC, Pellat J. Superior written over spoken picture naming in a case of frontotemporal dementia. Neurocase. 2001;7(1):89-96. doi:10.1093/neucas/7.1.89

17. Kemmerer D, Tranel D & Manzel K. An exaggerated effect for proper nouns in a case of superior written over spoken word production. Cognitive Neuropsychology, 2005;22(1): 3-27 doi:10.1080/02643290442000013

18. Law SP, Wong W & Kong A. Direct access from meaning to orthography in Chinese: A case study of superior written to oral naming. Aphasiology. 2006. 20(6):565-578. doi:10.1080/02687030600591799

19. Ellis AW, Miller D, Sin G. Wernicke's aphasia and normal language processing: a case study in cognitive neuropsychology. Cognition. 1983;15(1-3):111-44. doi:10.1016/0010-0277(83)90036-7

20. Basso A, Taborelli A, Vignolo LA. Dissociated disorders of speaking and writing in aphasia. J Neurol Neurosurg Psychiatry. 1978;41(6):556-563. doi:10.1136/jnnp.41.6.556

21. Assal G, Buttet J, Jolivet R. Dissociations in aphasia: a case report. Brain Lang. 1981;13(2):223-240. doi:10.1016/0093-934x(81)90092-4

22. Rapp B, Caramazza A. The modality-specific organization of grammatical categories: evidence from impaired spoken and written sentence production. Brain Lang. 1997;56(2):248-286. doi:10.1006/brln.1997.1735

23. Rapp B, Fischer-Baum S, Miozzo M. Modality and morphology: what we write may not be what we say. Psychol Sci. 2015;26(6):892-902. doi:10.1177/0956797615573520

24. Rapp B, Caramazza A. Selective difficulties with spoken nouns and written verbs: A single case study. Journal of Neurolinguistics. 2002;15(3-5):373-402. doi:10.1016/S0911-6044(01)00040-9

25. Miceli G, Benvegnu B, Capasso R, Caramazza A. The Independence of Phonological and Orthographic Lexical Forms: Evidence from Aphasia. Cognitive Neuropsychology. 1997;14(1):35-69. doi:10.1080/026432997381619