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SUBLEXICAL CONVERSION PROCEDURES AND THE INTERACTION OF PHONOLOGICAL AND ORTHOGRAPHIC LEXICAL FORMS

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In double naming tasks requiring the production of consecutive spoken and written responses to the same picture, subject ECA produced inconsistent lexical responses in the say-then-write (stimulus: organ; spoken response: "church;" written response: *piano*) but not in the write-then-say condition (organ → *piano* → "piano"). This observation, together with the fact that ECA had damage to the semantic system and to sublexical phoneme-grapheme conversion but not to sublexical grapheme-phoneme conversion procedures, is used to constrain claims about the organisation of lexical form knowledge. It is proposed that phonological and orthographic lexical forms are accessed autonomously, but interact via sublexical conversion procedures. In ECA, the one-way interaction between phonological and orthographic word forms is prevented by damage to phoneme- grapheme procedures (hence, inconsistent responses in the say-then-write naming condition); the reverse interaction can take place because grapheme-phoneme conversion processes are spared (hence, the absence of inconsistent responses in the write-then-say naming condition).

INTRODUCTION

Semantic errors—for example, saying or writing table in response to a picture of a chair—are not infrequent in aphasic patients' performance (Kohn & Goodglass, 1985; Lecours & Lhermitte, 1979; Williams & Canter, 1982). These errors can arise from damage to the semantic or to the lexical form components of the lexical system. The two forms of damage can be distinguished empirically on the basis of the distribution of semantic errors across tasks. When the semantic system is damaged, semantic errors occur for all word comprehension (auditory, visual, tactile, etc.) and picture naming tasks (spoken and written) (e.g. Hillis, Rapp, Romani, & Caramazza, 1990; Patterson & Hodges, 1992). When damage is restricted to one (or both) lexical form system(s), semantic errors

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occur only in the naming tasks that involve the modality (or modalities) affected by the damage. Thus, patients RGB and HW, who had a deficit in accessing phonological lexical forms, produced semantic errors only in spoken picture naming (Caramazza & Hillis, 1990), whereas patient SJD, who had a deficit in accessing orthographic lexical forms, produced semantic errors only in written picture naming (Caramazza & Hillis, 1991). Furthermore, patient GM, who had a deficit in accessing both phonological and orthographic lexical forms, produced semantic errors in both spoken and written picture naming, but made no errors in comprehension tasks (Cappa, Ielasi, Gorno Tempini, & Miozzo, 1996).

Semantic errors also occur in oral reading (e.g. M. Coltheart, Patterson, & Marshall, 1980; Ferreres & Miravalles, 1995; Job & Sartori, 1984; Marshall & Newcombe, 1973; Ruiz, Ansaldo, & Lecours, 1994), in writing to dictation (e.g. Bub & Kertesz, 1982; Nolan & Caramazza, 1983; see also cases in M. Coltheart et al., 1980), and in repetition (e.g. Howard & Franklin, 1988; Katz & Goodglass, 1990). However, in all these cases the production of semantic errors in a given transcoding task is invariably associated with severe difficulties in processing nonwords on the same task. Thus, subjects who make semantic errors in reading aloud also have severe difficulties reading nonwords—those who produce semantic errors in writing to dictation are unable to write nonwords and those who produce semantically incorrect responses in repetition are unable to repeat nonwords.

This highly systematic co-occurrence of deficits has prompted speculation about the role of sublexical processes in accessing lexical forms in reading, writing to dictation, and repetition tasks (e.g. Hillis & Caramazza, 1991; Newcombe & Marshall, 1980; Patterson & Hodges, 1992; Saffran, 1985). Newcombe and Marshall suggested that sublexical processes act like a filter by blocking inappropriate responses that occasionally are generated by an intrinsically "noisy" and thus error-prone semantic system. Hillis and Caramazza (1991,1995) and Patterson and Hodges (1992) proposed that the phonological and orthographic information that is assembled by sublexical conversion procedures "summates" with semantic information in activating phonological and orthographic lexical representations. Consistent with these accounts, partial sparing of sublexical conversion procedures allows access to the correct lexical form for output even when there is damage to the lexical-semantic component; and, it is only when there is damage to the lexical-semantic component and *extensive* damage to sublexical conversion procedures that subjects make errors in transcoding tasks.

The hypothesis that sublexical procedures interact with the lexical-semantic system does not have obvious implications for picture naming tasks. However, recent observations suggest the possibility that in special circumstances sublexical conversion procedures may play a role in accessing word form representations in the course of picture naming tasks.

One set of observations consistent with the latter possibility is provided by the performance of three subjects with damage to the lexical-semantic system, who produced lexically inconsistent responses in double naming tasks (that is, in tasks that require the production of two consecutive responses to the same picture in the spoken and in the written modality[1]). Subjects WMA (Miceli, Benvegnù, Capasso, & Caramazza, 1997), PW (Rapp, Benzing, & Caramazza, 1997), and MGK (Beaton, Guest, & Ved, 1997) produced many response sequences involving two different words in the say-then-write and in the write-then-say naming conditions. Sometimes the first response was correct and the second a semantic error (PW: spool → "spool," *needle*; WMA[2]: butterfly → *but-*

[1] Short of asking subjects to say and write the name of a picture simultaneously (an impossible task for most aphasic subjects), double naming tasks are the best possible way to obtain information on the forms most active in the phonological and the orthographic output lexical systems in response to a stimulus, in a very short time window. For this reason, they have been used in studies dealing with the issue of the autonomy vs. interaction of output phonological and orthographic forms.

[2] Although WMA is an Italian-speaking patient, for expository purposes we will give examples of his errors in English.

terfly, "dragonfly"; MGK: finger → "finger", *foot*); sometimes the first response was a semantic error and the second correct (PW: tiger → "lion," *tiger*; WMA: shoe → *socks*, "shoe"; MGK: boot → "socks", *boot*); and at times two different semantic errors were produced (WMA: pliers → "pincers," *saw*; and, peppers → *tomato*, "artichoke"; PW: tweezers → "pliers," *needle*; MGK: couch → "bed", *chair*). Crucially for present purposes, the three patients also had extensive damage to both sublexical grapheme-phoneme and phoneme-grapheme conversion processes, as shown by their complete inability to read nonwords aloud or to write them to dictation.

Another set of observations relevant to the role of sublexical procedures in lexical access is provided by subjects PGE and GIM (Miceli & Capasso, 1997), who had damage to the lexical-semantic system but normal grapheme-phoneme and phoneme-grapheme conversion processes. Although both subjects produced many semantic errors they never produced different responses in double naming tasks: They either produced the same semantic substitution, or failed to respond altogether.

The two patterns of performance exemplified by subjects PW, WMA, MGK, PGE, and GIM invite the generalisation that whether or not a subject with damage to the semantic component produces inconsistent responses across modalities of output in double naming tasks depends on the integrity of sublexical conversion processes: when the latter processes are severely damaged subjects produce inconsistent responses, otherwise they produce consistent responses. Before considering the implications of the proposed generalisation for theories of the relation between sublexical conversion procedures and lexical processes, we provide a direct test of the proposed generalisation.

In the five subjects considered thus far, grapheme-phoneme and phoneme-grapheme conversion processes were either both damaged or both intact. What pattern of naming errors should we expect in a subject with damage to the semantic system and to only one of the two sublexical conversion procedures? The proposed generalisation predicts that we should observe inconsistent lexical responses in only one direction, with the direction depending on which of the two sublexical conversion procedures is damaged. Thus, a subject with damage to the semantic system and phoneme-grapheme conversion procedures should produce inconsistent lexical responses in the say-then-write but not in the write-then-say picture naming condition. The basis for this prediction is that the intact grapheme-phoneme conversion procedure can serve to constrain the selection of the phonological lexical form once an orthographic lexical response has been selected; however, because the phoneme-grapheme conversion mechanism is damaged, the selection of a phonological lexical form (in the say-then-write condition) cannot constrain the subsequent selection of the orthographic lexical form. Here we report this pattern of performance in a brain-damaged subject.

CASE HISTORY

ECA is a 75-year old, right-handed man, with 2 years of college education. He is 13 years post-onset of an ischaemic left temporo-parietal lesion. In a previous paper (Miceli, Capasso, & Caramazza, 1994) he was shown to have severe damage to the semantic system and sublexical phoneme(input)-phoneme(output) and phoneme-grapheme conversion procedures. However, his ability to convert print to sound sublexically was essentially intact. Thus, he performed extremely poorly in repetition and writing-to-dictation tasks with nonwords and made semantic errors with words, but performed well in reading aloud nonwords and did *not* make semantic errors with words. ECA's condition has remained stable over time. He discontinued speech therapy many years ago, carries out all his daily activities autonomously, and has an intense personal and social life.

In the course of this project, ECA was submitted to an MRI. The exam reveals a large lesion in the left hemisphere, both superficial and deep, involving the temporal lobe (most of the superior and middle temporal gyri), the parietal lobe (the angular and the supramarginal gyrus, and part of the superior parietal lobule), and the posterior portions of the insula. Marked perilesional gliosis is also present. The trigonal portions of the left lateral ventricle are mildly to moderately dilated.

PRELIMINARY ANALYSES

A set of analyses was carried out to ascertain that ECA's performance continued to indicate damage to the semantic component and sublexical phoneme-grapheme conversion procedures but not to grapheme-phoneme conversion processes.

Sublexical Processing Tasks

ECA read aloud 202 nonwords, ranging in length from 2 to 9 letters. He read correctly 173 (85.6%) stimuli. This figure overestimates ECA's problems with nonword reading, since most errors resulted in near misses, and differed from the target response by one or, rarely, two phonemes. In order to obtain a more accurate measure of his ability to convert print to sound sublexically, each grapheme-phoneme correspondence was scored separately. For example, in the case of *mefa* → /meba/, three segments were scored as correct, and one (*f* → /b/ as incorrect. (Because orthography-phonology correspondence is highly transparent in Italian, this count is unambiguous.) This analysis shows that ECA correctly converted 1147/1177 (97.4%) graphemes to phonemes.

ECA was also asked to write to dictation 104 nonwords. He performed very poorly in this task: He wrote correctly only 10/104 (9.6%) stimuli. More importantly, his errors were qualitatively different from the few he made in reading—in writing, most responses resulted in letter sequences that bore little resemblance to the target response (e.g. /firyo/ → *vinciore*; /ta'ʃolfo/ → *sensono*; /a'rusti/ → *aireche*). The results of the two tasks confirm that ECA continues to show a severe deficit in writing but not in reading nonwords.

Lexical Processing Tasks

ECA performed the following 7 tasks with the same set of 130 picturable nouns in separate testing sessions: auditory and written word-picture verification, spoken and written picture naming, and reading, writing, and repetition of the words. His performance in these tasks is summarised in Table 1.

The auditory and the written word-picture verification tasks were each administered in three sessions. Each of the 130 pictures was paired with the correct word, with a word closely related in meaning, and with an unrelated word. For example, the picture of an apple was paired with the words apple, pear, and shoe. For each target noun, only one of the three word-picture pairs was given in a testing session. The examiner showed a picture while at the same time pronouncing a word (in the auditory task) or presenting a written word (in the visual task). The subject's task was to decide if word and picture matched. Approximately the same number of correct, semantically related, and unrelated pairs was administered in a session. An item was scored as not having been comprehended if the subject made an error in any one of the three word-picture pairs in which it appeared. ECA performed roughly equally in the auditory word-picture (112/130; 86. 1 %) and the visual word-picture verification (117/130; 90%) tasks. All the errors on these tasks could be classified as semantic errors: Most errors were false alarms to semantically related foils (15/18 and 10/13 to the auditory- and visual-verification tasks, respectively); the remaining errors were incorrect rejections of the correct picture-word pairs. ECA never made false alarms to unrelated words.

Because the focus of the paper is on ECA's ability to retrieve lexical forms, responses in the repetition, reading, writing, and naming tasks that included minor phonological or orthographic distortions of the target were scored as lexically correct. Also scored as lexically correct were a very small number of errors that could be classified either as morphological or phonological/orthographic errors. These are errors such as, for example, gambe (legs) → gamba (leg) which can be classified as a number or final phoneme substitution error.

In repetition, ECA produced 116 (89.2%) lexically correct responses (of these, 16 were

Table 1. *Overall Performance Obtained by ECA in Producing the 130 Picturable Nouns Included in the Experimental List, in the Context of Word-picture Matching Tasks, of "Transcoding" Tasks (Repetition, Reading Aloud, Writing to Dictation), and of Oral and Written Naming Tasks (Percentages are in Parentheses)*

	Auditory W-P Matching	*Visual W-P Matching*	*Reading Repetition*	*Writing to Aloud*	*Oral Dictation*	*Written Naming*	*Naming*
Lexically correct[a]	112 (86.1)	117 (90.0)	116 (89.2)	129 (99.2)	108 (83.1)	111 (85.4)	104 (80.0)
Semantic substitutions	18 (13.9)	13 (10.0)	12 (9.2)	–	16 (12.3)	16 (12.3)	12 (9.2)
Omissions	–	–	1 (0.8)	–	4 (3.1)	–	12 (9.2)
Neologisms	N/A	N/A	–	–	–	2 (1.5)	–
Fragments	N/A	N/A	1 (0.8)	–	2 (1.5)	1 (.08)	2 (1.5)
Others	–	–	–	1 (.08)	–	–	–

[a] Responses that resulted unequivocally from minimal phonemic or orthographic distortions of the correct lexical target were scored as correct (the incidence of these responses in each task is reported in the text).

phonemically incorrect and 2 could be interpreted as phonemically and/or morphologically incorrect), 12 (9.2%) semantic errors, 1 (0.8%) incomplete response, and 1 (0.8%) failure to respond. In writing to dictation, he produced 108 (83.1 %) lexically correct responses (of which 28 were misspelled and 2 could be classified as orthographic or morphological errors), 16 (12.3%) semantic errors (1 of these responses was also orthographically incorrect—"maestro", teacher → *prosrore*, presumably for *professore*, professor), failed to respond to 4 (3.1%) stimuli, and produced 2 (1.5%) word fragments. In reading aloud, ECA's performance was much better than the other two tasks: He read correctly 129 (99.8%) stimuli (in 13 cases with minor phonemic/visual errors), and incorrectly assigned lexical stress to 1 (0.8%).

ECA produced 111 (85.4%) lexically correct responses in oral picture naming (of which 24 were phonemically incorrect), and 104 (80%) lexically correct responses in written picture naming (of which 18 were misspelled). He produced semantic substitutions in both tasks (16 [12.3%] in oral naming; 12 [9.2%] in written naming), and failed to respond to 12 (9.2%) stimuli in written picture naming. In addition, he produced 2 (1.5%) neologisms in speaking and several word fragments (1 oral; 2 written).

These results fully replicate our previous observations with ECA. Consistent with the hypothesis that he has damage to the semantic system, he produced comparable numbers of semantic errors in word-picture matching and in picture naming tasks. Furthermore, he produced semantic errors in repetition and in writing to dictation, but never in reading aloud. In the framework of the summation hypothesis (Hillis & Caramazza, 1991; Patterson & Hodges, 1992), this pattern of performance is accounted for by assuming that the semantic component and sublexical input-output phonology and phonology-orthography conversion procedures are damaged but that orthography-phonology conversion procedures are relatively intact.

EXPERIMENTAL STUDY

Double naming tasks were administered to ECA under two experimental conditions (the same as those administered to WMA, PGE, and GIM, and similar to those administered to PW).In each task, the subject was asked to produce two responses on the same trial. In the first condition, he was asked to say then write the name of the stimulus picture; in the second, he was asked to write then say the name of the stimulus picture. In the write-then-say condition, ECA was allowed to freely look at his own output while writing. However, the written response was withdrawn from the subject's view as soon as it was completed. This precaution was taken in order to prevent him from producing the spoken response by merely reading it aloud (recall that reading aloud is largely spared in ECA). In both conditions, ECA was instructed to produce the first response, then to count aloud from one to five, and finally to produce the second response. The proposed generalisation concerning the presence of inconsistent lexical responses in double naming tasks predicts that ECA should produce inconsistent responses in the say-then-write naming condition (due to the impairment of phoneme-grapheme conversion procedures), but not in the write-then-say condition (because grapheme-phoneme conversion mechanisms are spared).

Spoken-then-written Naming

In the say-then-write condition, ECA performed similarly in the two response modalities (see Table 2). He produced 78 (60%) correct spoken responses and 81 (62.3%) correct written responses (here, too, minor phonemic and spelling errors were ignored). The incorrect spoken responses were distributed as follows: 39 (30%) semantic errors, 7 (5.4%) failures to respond, and 6 (4.6%) incomplete responses. The incorrect written responses were distributed as follows: 30 (23.1 %) semantic errors, 13 (10%) failures to respond, and 6 (4.6%) word fragments.

When both responses are considered (see Table 3), ECA produced 2 correct responses to 75 (57.7%) stimuli and the same incorrect response to 34 (26.1 %) stimuli. He also produced 1 (0.8%) ambiguous sequence that resulted from a phonemically deviant oral response followed by an incomplete written response (carciofo, artichoke → /kar'tchofyo/ [Correct pronunciation: /kar'tchofo/] → *cio* ...). The remaining 20 (15.4%) trials involved inconsistent lexical responses: in 2 instances a correct spoken response was followed by a semantically incorrect written response (e.g. moustache → "moustache", *beard*); in 6 cases a semantically incorrect spoken response was followed by the correct written response (e.g. tiger → "lion", *tiger*); in 6 cases 2 different semantic errors were produced (e.g. to the picture of an organ, he said "church" and wrote *piano*); and in 6 cases a failure to respond and a semantic error were observed (e.g. to the picture of a sweater, he failed to produce a spoken response but then wrote *shirt*; and, to the picture of a harp, he said "violin" but failed to produce a written response). The inconsistent lexical responses produced by ECA are listed in Appendix A.

Table 2. *Performance Obtained by ECA in the Two Double-naming Tasks (N = 130) (Percentages are in Parentheses)*

	Say-then-write		*Write-then-say*	
	Spoken Response	*Written Response*	*Written Response*	*Spoken Response*
Correct	78 (60.0)	81 (62.3)	89 (68.5)	89 (68.5)
Semantic	39 (30.0)	30 (23.1)	25 (19.2)	26 (20.0)
Anomias	7 (5.4)	13 (10.0)	9 (6.9)	9 (6.9)
Fragments	6 (4.6)	6 (4.6)	5 (3.8)	4 (3.1)
Neologism	–	–	2 (1.5)	2 (1.5)

Table 3. *Distribution of Sequences Resulting in the Same (Correct or Incorrect) Word or in Two Different Words (One Correct, One Incorrect; or Both Incorrect) in the Say-then-write and in the Write-then-say Task (Percentages are in Parentheses)*

	Response Sequence	
	Say-then-write	*Write-then-say*
Both correct	75 (57.7)	89 (68.5)
Both incorrect (lexically consistent)	34 (26.1)	38 (29.2)
First correct, second incorrect	2 (1.5)	–
First incorrect, second correct	6 (4.6)	–
Both incorrect (different semantic error)	6 (4.6)	–
Both incorrect (lexically inconsistent)	6 (9.2)	–
Unscorable	1 (0.8)	3 (2.3)
Total	130 (100)	130 (100)

Written-then-spoken Naming

In the write-then-say condition, ECA produced the same number of correct responses (89/130; 68.5%) in the two modalities (see Table 2). Incorrect written responses consisted of 25 (19.2%) semantic errors, 9 (6.9%) failures to respond, 5 (3.8%) fragments, and 2 (1.5%) neologisms; incorrect spoken responses consisted of 26 (20%) semantic errors, 9 (6.9%) failures to respond, 4 (3.1 %) fragments, and 2 (1.5%) neologisms.

When both responses are considered (see Table 3), ECA produced 2 correct responses to 89 (68.5%) stimuli, and the same incorrect response to

38 (29.2%) stimuli[3]. The remaining three sequences resulted in different responses but are unlikely to reflect the selection of distinct lexical entries for spoken and written output. In one case, an incomplete written response was followed by the complete spoken response (braccio [arm] → *la...* → "labbra" [lips]; in another case, ECA produced two neologistic responses (zampogna [bagpipe] → *anglano* → /dzambor'dzano/); and the remaining error consisted of circumlocutory responses in the two modalities (sandwich → *in order to eat* → "filled with salami"). Even if the last sequence were to be considered as resulting from the selection of distinct word forms for speaking and for writing, it would still constitute the only inconsistent lexical response produced in this condition.

In short, ECA produced 20 (15.4%) inconsistent responses in the say-then-write naming condition, and no unambiguously inconsistent responses in the write-then-say naming condition. This difference is statistically reliable ($\chi^2 = 16.784$; $P < .001$).

WRITING WITHOUT SEEING THE RESPONSE

The results of the tasks described in the previous section are consistent with the hypothesis that phonological and orthographic representations interact via sublexical conversion procedures. In agreement with the hypothesis, lexically inconsistent responses occur in the say-then-write naming condition because, due to extensive impairment of phoneme-grapheme conversion processes, the phonological lexical form activated for output cannot be used to constrain the selection of the corresponding orthographic form for writing. The behaviour observed in the write-then-say naming condition is also consistent with this view: Lexically inconsistent responses do not occur in this condition because spared grapheme-phoneme procedures allow the selected orthographic word form to constrain the selection of the corresponding phonological word form.

This dissociation across double naming conditions may have a less interesting explanation, however. The absence of lexically inconsistent responses in the write-then-say condition could conceivably be accounted for by a procedural flaw in the experiment. Even though the written response was removed from view as soon as it was completed, the testing procedure used in this condition allowed ECA to keep his eyes open while writing. Thus, it could be argued that he might have produced the oral naming response by *reading* his written response and not by *naming* the picture. To exclude this possibility, new double naming tasks were administered with a procedure that prevented ECA from seeing his written responses. If in our previous experiment ECA had failed to produce inconsistent responses in the write-then-say naming condition simply because he "read" his written responses, then, by preventing him from seeing his written responses we should induce a significant number of inconsistent responses. If, however, response consistency did reflect the interaction between sublexical grapheme phoneme conversion and phonological lexical forms, then, the new experimental procedure should result in a pattern of performance comparable to that reported in the previous section.

Materials and Methods

In addition to the set of 130 pictures used in the previous tasks, 80 pictures from the Snodgrass and Vanderwart (1980) set were presented, for a total of 210 stimuli in each condition. These tasks were administered several months after the double naming tasks discussed in the previous section.

[3] ECA performed less accurately in the double-naming than the single-naming tasks. This discrepancy in performance may simply be due to the fact that the double-naming tasks were administered first in this project. In the time between the administration of the double- and single-naming tasks, ECA was exposed to the same 130 stimuli a number of times in the course of auditory and visual word-picture matching, reading aloud, writing to dictation, and repetition tasks, thus acquiring considerable experience with these items.

The procedure used for these tasks differed from that used previously in only one respect: For both picture naming conditions a large screen was placed approximately 15cm above the writing surface so that ECA could see neither the sheet of paper on which he was writing nor the movement of his hand and forearm.

Performance in the Say-then-write Naming Condition

In the say-then-write condition (see Table 4), ECA produced comparable numbers of correct spoken (140/210, 66.7%) and written responses (149/210, 70.9%). Of these, 26 (12.4%) spoken and 51 (24.3%) written responses were segmentally incorrect (that is, resulted in phonemic, orthographic, or inflectional errors). Incorrect responses were distributed as follows: 39 (18.6%; including 4 that were phonemically incorrect) spoken and 44 (21%; including 11 that contained spelling errors) written semantic errors; 18 (8.6%) failures to produce spoken responses and 9 (4.3%) failures to produce written responses; 7 (3.3%) circumlocutory responses in speaking and 1 (0.5%) in writing. The remaining incorrect responses resulted in neologisms (3 spoken, 4 written), word fragments (3 spoken, 1 written, 0.5%), and visual errors (2 spoken, 1%).

When the spoken and written responses are considered together (see Table 5), ECA produced the correct response twice to 132 (62.9%) stimuli, and the same incorrect response to 21 (10%) stimuli. However, he also produced inconsistent responses in speaking and writing for the remaining 57 (27.1%) stimuli (these responses are listed in Appendix B). These responses are distributed as follows:

In 8 cases ECA produced the correct spoken response followed by a lexically incorrect written response (6 semantic errors, 1 fragment, and 1 failure to respond), and in 16 cases he produced an incorrect spoken response (10 semantic errors, 1 failure to respond, 1 circumlocution, and 2 fragments) followed by the correct written response. In 6 cases he produced 2 different semantic errors (e.g., ankle → "leg", *hip*); in 14 cases he failed to respond (13) or produced a fragmented oral response (1) followed by a semantic error (11), a morphological error (1), or a neologism (2); in 5 cases he produced a semantic error (3), a circumlocution (1), or a neologism (1) followed by a failure to respond in writing. There were also 6 complex sequences (reported in the Appendix as "other" lexically inconsistent responses) consisting of a neologism followed by a circumlocution (1), a circumlocution followed by a neologistic compound (1) or a semantic error (2), and a semantic error followed by a circumlocution (1) or a visual error (1). And there were 2 "unclassifiable" sequences: to the picture of a house, he correctly said "casa" (house), but wrote *cassetta* (misspelled for *casetta*, little house); and, to the picture of a candle, he correctly said "candela" (candle), but wrote *candenina* (misspelled for *candelina*, little candle).

Table 4. *Double-naming Tasks: Written Response Produced with Eyes Closed—Analysis of Written and Spoken Responses (N = 210) (Percentages are in Parentheses)*

	Say-then-write		*Write-then-say*	
	Spoken Response	*Written Response*	*Written Response*	*Spoken Response*
Correct	140 (66.7)	149 (70.9)	149 (70.9)	151 (71.9)
Semantic	39 (18.6)	44 (20.9)	34 (16.2)	33 (15.7)
Circumlocution	7 (3.3)	1 (0.5)	3 (1.4)	3 (1.4)
Anomias	18 (8.6)	9 (4.3)	15 (7.2)	16 (7.6)
Fragments	3 (1.4)	1 (0.5)	7 (3.3)	5 (2.4)
Neologisms	3 (1.4)	4 (1.9)	2 (1.0)	2 (1.0)
Visual	–	2 (1.0)	–	–

Table 5. *Double-naming Tasks: Written Response Produced with Eyes Closed—Analysis of Response Sequences Produced in the Oral, then Written Condition and in the Written, then Oral Condition (N = 210) (Percentages are in Parentheses)*

	Response Sequence	
	Say-then-write	*Write-then-say*
Both correct	132 (62.9)	147 (70.0)
Both incorrect (lexically consistent)	21 (10.0)	58 (27.6)
First correct, second incorrect	8 (3.8)	–
First incorrect, second correct	16 (7.6)	1 (0.5)
Both incorrect (different semantic error)	6 (2.9)	–
Both incorrect (lexically inconsistent)	25 (11.9)	1 (0.5)
Unscorable	2 (1.0)	3 (1.4)
Total 210 (100)	210 (100)	

Performance in the Write-then-say Naming Condition

In the write-then-say condition (see Table 4), ECA produced a similar number of correct responses in writing (149 [70.9%], of which 54 were misspelled) and speaking (151 [71.9%], of which 15 were phonemically deviant). His errors were distributed as follows: 34 semantic errors in writing (of which 11 were misspelled) and 33 semantic errors in speaking (of which 4 were also phonemically incorrect); 15 failures to respond in writing and 16 in speaking; 3 circumlocutions in each response modality (2 written and 1 spoken circumlocutions were also semantically incorrect); 2 neologisms in each response modality; and 7 fragments in writing and 5 in speaking.

ECA produced the correct response in both output modalities to 147 (70%) pictures, and the same incorrect response in both modalities to 58 (27.6%) pictures (see Table 5). The breakdown of the latter responses yields 32 semantic substitutions resulting in the same incorrect word, 5 response fragments resulting in exactly the same letter/phoneme sequence (e.g. carciofo, artichoke → *ca* ... ; "ca ..."), 15 failures to respond in both modalities, 3 identical written and spoken circumlocutions, and 2 similar written and spoken neologisms. In stark contrast to the pattern observed in the say-then-write naming condition, only 2 (1%) lexically inconsistent sequences were observed when ECA was asked to write and then to speak his response (see Appendix B). To the picture of a boxer, ECA wrote *buzo* (probably misspelled for *boxe*, boxing), then produced the correct word ("pugile"). To the picture of the Italian flag, ECA wrote *bamniera*, then said "/bin'di/ ... /tri'o/ ... /tri'co/ [probable attempts at saying "tricolore", three-coloured flag, the popular name of the Italian flag] ...la nostra (ours)". Note in the last sequence that, although our subject ended up producing a different word altogether, the first fragmented attempt (/bin'di/) was close to the target /ban'dyɛra/, the word just selected for writing. It would not be unreasonable to score this sequence as lexically consistent. However, since the orthographic form selected by ECA as the spoken response differed from that selected for writing, the sequence was scored as inconsistent.

ECA also produced three "unclassifiable" sequences. To the picture of a pitcher, he wrote *ventro con aqua* (presumably for *vetro con acqua*, glass with water), and said "acqua" (water); that is, he used the last word of the written circumlocution as the spoken response. The other two sequences resulted in a partial written response to lampadario (lamp) and spazzola (hairbrush), followed by the complete, phonemically distorted spoken response (lampadario → *lampia* ...; /lampa/ ... /lampa'taryo/; spazzola → *spa* ... ; /'spattora/). Since in these three sequences the spoken response results in a word (in the first sequence) or in a word fragment (in the other two) identical to that selected for writing, they should probably be scored as lexically consistent. Also in this case, however, a conservative decision was adopted, and these sequences were excluded from further analyses.

Summary of Performance in the Two Double-naming Conditions

ECA's performance in producing written and spoken responses under experimental conditions that did not allow him to see his written response is comparable across experimental conditions, both quantitatively and qualitatively, except for the relatively higher incidence of segmental errors in writing than in speaking. Lexically consistent responses (the sum total of twice correct responses and of twice incorrect responses resulting in the selection of the same lexical item) accounted for 153/210 (72.9%) sequences in the say-then-write condition, and for 205/210 (97.6%) sequences in the write-then-say condition. Conversely, lexically inconsistent responses (the sum total of correct-then-incorrect, incorrect-then-correct, and twice incorrect responses resulting in the selection of different words) were produced to 55 (26.2%) stimuli in the say-then-write naming condition, and to 2 (1%) stimuli in the write-then-say condition. This difference is highly significant (χ^2 = 54.7 P < .001).

The results are consistent with the hypothesis that spared grapheme-phoneme conversion prevents the occurrence of lexically inconsistent responses in the write-then-say naming condition. And since they were obtained in an experimental condition in which the subject could not see his own written production, they eliminate the possibility that the results merely reflect the subject's good reading performance.

The discrepancy in the occurrence of lexically inconsistent responses in the say-then write condition when compared with the write-then-say condition is overwhelming. For the present project, our subject produced 130 double naming sequences during which he was allowed to see the written response, and 210 double naming sequences during which he could not see the written response, with identical results—many inconsistent responses in the say-then-write, very few (if any) in the write-then-say condition. When the two double naming tasks are considered together, ECA produced overall 75/340 (22.1%) lexically inconsistent responses in the say-then-write condition, but only 2/340 similar responses (0.6%) in the write-then-say condition. This difference is highly significant (χ^2 = 77.65; P < .001). The pattern of results documented for ECA strongly suggests that the orthographic form selected for the written response can be used to constrain the selection of the corresponding phonological form when sublexical grapheme-phoneme conversion processes are (mostly) intact.

DISCUSSION

Previous research had shown that three subjects with damage to the semantic component who produced inconsistent lexical responses in double naming tasks were also impaired in sublexical conversion processing (Beaton et al., 1997; Miceli et al., 1997; Rapp et al., 1997). Furthermore, two other subjects with damage to the semantic component who did not produce inconsistent lexical responses in double naming tasks were not impaired in sublexical conversion processing (Miceli & Capasso, 1997). These patterns of results invite the empirical generalisation that the integrity of sublexical conversion mechanisms is a key determinant of whether or not a subject with damage to the semantic component will produce inconsistent lexical responses in double naming tasks.

These earlier reports of performance in the double naming tasks involved subjects who had damage to both the grapheme-phoneme and the phoneme-grapheme conversion processes or to neither. This fact may account for the symmetry of performance in the say-then-write and the write-then-say naming tasks. That is, it may account for the fact that PW, WMA, and MGK produced inconsistent lexical responses in both tasks, and PGE and GIM failed to produce inconsistent lexical responses in either task. A prediction that may be derived from this generalisation is that damage to only the phoneme-grapheme or only the grapheme-phoneme conversion process should result in inconsistent lexical responses in only the say-then-write or only the write-then-say naming condition, respectively. The basis for this prediction is that damage to only one of the sublexical conversion mechanisms should affect the interaction between modality-specific lexical forms in only one direction—in the direction of the damaged sublexical conversion mechanism.

The performance observed in ECA is clearly consistent with the derived expectations. ECA, who has damage to the semantic system and to phoneme-grapheme conversion procedures (but not to grapheme-phoneme conversion procedures), produced inconsistent lexical responses to 20/130 (15.4%) pictures in the unconstrained say-then-write naming condition, but did not produce inconsistent lexical responses in the unconstrained write-then say naming condition. In the latter task, ECA might have failed to produce inconsistent responses in the write-then-say condition because he could have adopted the strategy of reading aloud his written responses instead of naming the picture. However, an even larger difference was observed in an experimental condition in which the subject could not see his written responses. With this procedure, ECA produced very many (55/210, or 26.2%) lexically inconsistent responses in the critical say-then-write experimental condition, while producing only 2 (1%) lexically inconsistent responses in the write-then-say condition. These results provide further support for the view that phonological and orthographic word forms are independently represented and accessed from semantics—if this were not the case, inconsistent responses should never occur. Furthermore, the results suggest that the selection of a lexical form for output in one modality may be constrained, in circumstances such as those required by performance on a double naming task, by the selection of a lexical form for output in the other modality through input from sublexical conversion processes.

In the framework of lexical interactions adopted here, the discrepancy observed in ECA's performance on double naming tasks is explained by the co-occurrence of damage to the semantic system and to phoneme-grapheme conversion procedures, in the presence of spared grapheme-phoneme conversion processes. Damage to phoneme-grapheme conversion processes prevents the conversion of the selected phonological lexical form (whether correct or incorrect) into graphemic information that could be used to constrain the subsequent selection of an orthographic lexical form. By the same reasoning, the availability of relatively intact grapheme-phoneme conversion processes allows the conversion of the selected orthographic lexical form into a phonological representation that can be used to constrain the subsequent selection of a phonological lexical form. This configuration of spared and damaged sublexical conversion processes allows the production of inconsistent lexical responses *only* in the say-then-write picture naming task.

To illustrate this argument, consider the following example as it might apply to ECA. Suppose that because of damage to the semantic system the picture of a chair activated the phonological lexical form "sofa" more than "table," "stool," and "chair." Suppose also for the same reason that the orthographic lexical form *stool* received more activation than *table*, *sofa*, and *chair*. In the write-then-say naming task, *stool* (the most active orthographic form) is produced as the first response. Having selected *stool*, the orthographic form is converted into a phonological form (e.g. /s/, /t/, /u/, /l/) by means of the spared grapheme-phoneme conversion procedures. This sublexical phonological information interacts with the phonological lexical forms activated by the semantic system (i.e. the summation hypothesis: Hillis & Caramazza, 1991; Patterson & Hodges, 1992). The contribution of the sublexical conversion process can have the effect of boosting the activation of "stool," thus leading to its selection despite the fact that "sofa" was the phonological lexical form that received the most activation from the damaged semantic system. In this way, consistent lexical responses are produced in the write-then-say naming task even though the initially most active lexical forms in the orthographic and phonological lexicons were not the same word.

Consider now the expected performance in the say-then-write naming task. In this case, the lexical form that is selected first is "sofa." However, because of the documented damage to the phoneme-grapheme conversion process, the selected phonological lexical form cannot be converted into a useful graphemic representation that could be used to constrain the selection of an orthographic lexical form. Thus, the word form most active in the orthographic lexicon will be the one that receives the most activation from the damaged semantic system. This form will be selected for output. In this example, the orthographic form *stool* will be selected, leading to inconsistent phonological ("sofa") and orthographic (*stool*) lexical responses.

In conclusion, we have documented the selective (asymmetric) occurrence of inconsistent lexical responses in the say-then-write condition of a double naming task. This pattern of performance contrasts with the performance of brain-damaged subjects who either produce inconsistent lexical responses in both say-then-write and write-then-say naming conditions, or in neither. The factor that seems to determine whether or not a subject with damage to the semantic system produces inconsistent naming responses is the integrity of sublexical conversion processes: When the latter processes are severely damaged, the subject produces inconsistent lexical responses; when they are spared, the subject does not produce inconsistent lexical responses; when only one of the sublexical conversion procedures is damaged (e.g. phoneme-grapheme conversion), inconsistent lexical responses are produced in only one direction (e.g. say-then-write) in the double-naming task. This configuration of results provides clear support for the hypothesis that modality-specific lexical components interact through sublexical conversion processes.

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REFERENCES

Allport, D.A., & Funnell, E. (1981). Components of the mental lexicon. *Philosophical Transactions of the Royal Society of London*, *B295*, 397–410.

Beaton, A., Guest, J., & Ved, R. (1997). Semantic errors of naming, reading, writing, and drawing following left-hemisphere infarction. *Cognitive Neuropsychology*, *14*, 459–478.

Bub, D., & Kertesz, A. (1982). Deep agraphia. *Brain and Language*, *17*, 147–166.

Cappa, S.F., Ielasi, W., Gorno Tempini, M.L., & Miozzo, A. (1996). Deep dysphasia: A study of errors in oral and written production. *Neurocase*, *2*, 213–220.

Caramazza, A., & Hillis, A.E. (1990). Where do semantic errors come from? *Cortex*, *26*, 95–122.

Caramazza, A., & Hillis, A.E. (1991). Lexical organization of nouns and verbs in the brain. *Nature*, *349*, 788–790.

Coltheart, M., Patterson, K.E., & Marshall, J.C. (1980). *Deep dyslexia*. London: Routledge & Kegan Paul.

Coltheart, V., Patterson, E.K., & Leahy, J. (1994). When a ROWS is a ROSE: Phonological effects in reading comprehension. *Quarterly Journal of Experimental Psychology*, *47A*, 917–955.

Ellis, A.W. (1982). Spelling and writing (and reading and speaking). In A.W. Ellis (Ed.), *Normality and pathology in cognitive functions*. NY: Academic Press.

Ellis, A.W., Miller, D., & Sin, G. (1983). Wernicke's aphasia and normal language processing: A case study in cognitive neuropsychology. *Cognition*, *15*, 111–144.

Ferreres, A.R., & Miravalles, G. (1995). The production of semantic paralexias in a Spanish-speaking aphasic. *Brain and Language*, *49*, 153–172.

Hillis, A.E., & Caramazza, A. (1991). Mechanisms for accessing lexical representations for output: Evidence from a category-specific semantic deficit. *Brain and Language*, *40*, 106–144.

Hillis, A.E., & Caramazza, A. (1995). Converging evidence for the interaction of semantic and sublexical phonological information in accessing lexical representations for spoken output. *Cognitive Neuropsychology*, *12*, 187–227.

Hillis, A.E., Rapp, B.C., Romani, C., & Caramazza, A. (1990). Selective impairment of semantics in lexical processing. *Cognitive Neuropsychology*, 7, 191–244.

Howard, D., & Franklin, S. (1988). *Missing the meaning?* Cambridge, MA: MIT Press.

Job, R., & Sartori, G. (1984) Morphological decomposition: Evidence from crossed phonological dyslexia. *Quarterly Journal of Experimental Psychology*, *36A*, 435–458.

Katz, R.A., & Goodglass, H. (1990). Deep dysphasia: Analysis of a rare case of repetition disorder. *Brain and Language*, *19*, 175–199.

Kohn, S.E., & Goodglass, H. (1985). Picture-naming in aphasia. *Brain and Language*, *24*, 266–283.

Lecours, A.R., & Lhermitte, F. (1979). *L'aphasie*. Paris: Flammarion.

Marshall, J.C., & Newcombe, F. (1973). Patterns of paralexia: A psycholinguistic research. *Journal of Psycholinguistic Research*, *2*, 175–199.

Miceli, G., Benvegnù, B., Capasso, R., & Caramazza, A. (1997). The independence of phonological and orthographic lexical forms: Evidence from aphasia. *Cognitive Neuropsychology*, *14*, 35–70.

Miceli, G., & Capasso, R. (1997). Semantic errors as evidence for the independence and the interaction of orthographic and phonological word forms. *Language and Cognitive Processes*, *12*, 733–764.

Miceli, G., Capasso, R., & Caramazza, A. (1994). The interaction of lexical and sublexical processes in reading, writing, and repetition. *Neuropsychologia*, 32, 317–333.

Miceli, G., Giustolisi, L., & Caramazza, A. (1991). The interaction of lexical and non-lexical processing mechanisms: Evidence from anomia. *Cortex*, *27*, 57–80.

Newcombe, F., & Marshall, J.C. (1980). Transcoding and lexical stabilisation in deep dyslexia. In M. Coltheart, K.E. Patterson, & J.C. Marshall (Eds.), *Deep dyslexia*. London: Routledge & Kegan Paul.

Nolan, K. A., & Caramazza, A. (1983). An analysis of writing in a case of deep dyslexia. *Brain and Language*, *20*, 305–328.

Patterson, K.E., & Hodges, J.R. (1992). Deterioration of word meaning: Implications for reading. *Neuropsychologia*, *10*, 1025–1040.

Patterson, K.E., & Shewell, C. (1987). Speak and spell: Dissociations and word-class effects. In M. Coltheart, G. Sartori, & R. Job (Eds.), *The cognitive neuropsychology of language*. London: Lawrence Erlbaum Associates Ltd.

Rapp, B.C., Benzing, L., & Caramazza, A. (1997). The autonomy of lexical orthography. *Cognitive Neuropsychology*, *14*, 71–104.

Ruiz, A., Ansaldo, A.I., & Lecours, A.R. (1994). Two cases of deep dyslexia in unilingual Hispanophone aphasics. *Brain and Language*, *46*, 245–256.

Saffran, E.M. (1985). Lexicalisation and reading in surface dyslexia. In K.E. Patterson, M. Coltheart, & J.C. Marshall (Eds.), *Surface dyslexia*. London: Lawrence Erlbaum Associates Ltd.

Snodgrass, J., Vanderwart, M. (1980). A standardised set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, *6*, 174–215.

Williams, S., & Canter, G. (1982). The influence of situation context on naming performance in aphasic syndromes. *Brain and Language*, *17*, 92–106.

Wydell, T.N., Patterson, K.E., & Humphreys, G.W. (1993). Phonologically mediated access to meaning for Kanji: Is a rows still a rose in Japanese Kanji? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*, 491–514.

APPENDIX A

Corpus of the Lexically Inconsistent Responses Produced by ECA During the Spoken-then-written Condition of the Unconstrained Double-naming Tasks

Stimulus	*Spoken Response*	*Written Response*
1. Correct (or minimal phonemic distortion), then semantic substitution (N = 2)		
baffi (moustache)	+	*barba* (beard)
pompiere (fireman)	+	*vigili* (policemen)
2. Incorrect, then correct (or orthographically distorted) response (N = 6)		
zucchero (sugar)	caffè (coffee)	+
gallina (chicken)	gallo (rooster)	+
tigre (tiger)	leone (lion)	+
sciatore (skier)	sci (ski)	**scitore* (*sciatore*, skier)
ambulanza (ambulance)	macchina (car)	**ama_mza*
chitarra (guitar)	*carì ... con la 'c' (/ka'ri/ ... with a 'c')	**chia_ta*
3. Anomia before or after a semantic error (N = 6)		
maglione (sweater)	–	*camicia* (shirt)
mandolino (mandolin)	con la 'm' ... (with an 'm')	**mandorino*
elicottero (helicopter)	con la 'e' e 'l' (with an 'e' and an 'l')	*aero* (airplane)
cacciatore (hunter)	l'uomo (the man)	–
arpa (harp)	violino no, non è chitarra (not a violin, not a guitar)	–
sgabello (stool)	tavolo no, no sedie ... (table, no! not chairs ...)	**sca...*
4. Two semantic substitutions (N = 6)		
panino (sandwich)	dolce (cake)	*pane* (bread)
ananas (pineapple)	frutto (fruit)	*limone* (lemon)
funivia (cable car)	aereo (airplane)	*cabine* (shacks)
gondola (gondola)	Venezia (Venice)	*barca* (boat)
organo (organ)	chiesa (church)	*pianoforte* (piano)
canguro (kangaroo)	Australia	*cane* (dog)
5. Unclassifiable (N = 1)		
carciofo (artichoke)	*carciofio (/kar'tchofyo/)	*cio ...*

Responses preceded by * contain phonemic or orthographic distortions of the target; whenever the word produced by ECA differs from the expected target, the correct spelling of the target word is also provided.

APPENDIX B

Corpus of the Lexically Inconsistent Responses Produced by ECA During the Double-naming Tasks for Which He Was Asked to Write Without Seeing His Handwriting

Spoken-then-written Naming Condition

Stimulus	*Spoken Response*	*Written Response*
1. Correct (or minimal phonemic distortion), then semantic substitution or no response (N = 8)		
baffi (moustache)	+	*barba* (beard)
bottone (button)	+	*bo …*
occhio (eye)	+	**occhili* (*occhiali*, glasses)
pattumiera (garbage can)	secchio (+)	–
sciarpa (scarf)	sciar … *sciarfa	*scialla* (shawl)
pugile (boxer)	pìgi … ca … *pùgine	*boxe* (boxe)
coccodrillo (crocodile)	girocrillo	*grillo* (cricket)
molletta (clothespin)	*savvetta	*i panni* (the laundry)
2. Incorrect (semantic substitution, circumlocution, anomia, fragment), then correct (or spelling error) (N = 16)		
pollice (thumb)	pil.. dito (finger)	+
capelli (hair)	vestì…, donna, vestito (woman, dress)	**cappelli* (hair)
autobus (autobus)	autotrè.. tram, metro	+
divano (sofa)	salone (living room)	+
porta (door)	portone o un cancello (gate)	+
bambola (doll)	bambina di donna (baby of woman)	+
farfalla (butterfly)	*zerra (zebra)	+
giacca (jacket)	vestito (suit)	+
mucca (cow)	bue (ox)	*vacca* (+)
nuvola (cloud)	cielo (sky)	*nubi* (clouds)
fiocco (ribbon)	i regazzini pe' la scuola (the kids for school)	**fiocchio*
culla (cradle)	go.. can.. per i bambini (for the children)	**calla*
ananas (pineapple)	al…	+
pianoforte (piano)	forte	+
cestino (wastebasket)	–	+
farfalla (butterfly)	–	+
3. Both semantically incorrect (at times also with phonemic or orthographic distortions) (N = 6)		
ambulanza (ambulance)	autobus (bus)	*auto* (car)
caviglie (ankles)	la gamba (the leg)	*anca* (hip)
cervo (deer)	pecora (sheep)	*capra* (goat)
corona (crown)	re (king)	*trono* (throne)
cammello (camel)	cavallo (horse)	**cancure* (*canguro*; kangaroo)
gorilla (gorilla)	*gongùlo, *congùro, canguro (kangaroo)	**smimma* (*scimmia*; monkey)
4. No response or fragment, then incorrect response (N = 14)		
pentola (pan)	–	*sugo* (sauce)
carciofi (artichokes)	–	*campagna* (country)
guanto (glove)	–	*guanti* (gloves)
imbuto (fennel)	–	*vi … acqua* (water)
maniglia (handle)	–	*chiave* (key)
stampella (hanger)	–	*abito* (suit)
elicottero (helicopter)	–	**aeri* (*aerei*; airplanes)

brocca (pitcher)	–	**bicchiri* (*bichieri*; glasses)
asparagi (asparagus)	–	**vertura* (*verdura*; greens)
scatola (box)	–	**carto ... cassa* (paper ... case)
como' (chest of drawers)	–	**armario* (*armadio*; cabinet)
tamburo (drum)	–	**tromele* (neol)
camicia (shirt)	–	**maccina* (neol)
fisarmonica (accordion)	fra.. fro..-	*arca* (arpa; harp)
5. Incorrect response, then no response (N = 5)		
gomito (elbow)	anca (hip)	–
fragole (strawberries)	fioraio (flower seller)	–
sgabello (stool)	legno (wood)	–
spazzola (hairbrush)	le donne, per le donne (women, for women)	–
mestolo (ladle)	*moglione (neol)	–
6. Other lexically inconsistent responses (N = 6)		
sedano (celery)	de fuori e se mangia (outdoors and you eat it)	*orto* (garden)
posacenere (ashtray)	*sigherette fuori (sigarette; cigarettes out)	*portafumo* (neol compound; smoke-carrier)
maestro (teacher)	mèo.. professore (professor)	*dottore per* **nuniri* (*numeri*; doctor for numbers)
cucchiaio (spoon)	*buccìno (neol)	**covlimo*; *caffè col latte* (coffee with milk)
flauto (flute)	un pezzo di ferro pe' fà.. che sta dentro questa (a piece of iron to do ... that is inside this - points to pen)	*penna* (pen)
sigaro (cigar)	sigarette (cigarettes)	*gesso* (chalk)
7. Unclassifiable response (N = 2)		
casa (house)	+	**cassetta* (*casetta*, little house)
candela (candle)	+	**candenina* (*candelina*, little candle)

Written-then-spoken Naming Condition

Stimulus	*Written Response*	*Spoken Response*
1. Lexically incorrect sequences (N = 2)		
pugile (boxer)	*buzo* (*boxe*, boxing)	+
bandiera (flag)	**bamniera*	bindì ... triò ... trico ... la nostra (ours)
2. Unclassifiable (N = 3)		
brocca (pitcher)	**ventro con* **aqua* (*vetro con acqua*, glass with water)	acqua (water)
lampadario (lamp)	**lampia...*	lampa... lampatario
spazzola (hairbrush)	**spa...*	spattora

Responses preceded by * contain phonemic or orthographic distortions of the target; whenever the word produced by ECA differs from the expected target, the correct spelling of the target word is also provided.