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Further evidence for phonological constraints on visual lexical access: TOWED primes FROG

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If the phonological codes of visually presented words are assembled rapidly and automatically for use in lexical access, then words that sound alike should induce similar activity within the internal lexicon. TOWED is homophonous with TOAD, which is semantically related to FROG, and BEACH is homophonous with BEECH, which is semantically related to TREE. Stimuli such as these were used in a priming-of-naming task, in which words homophonous with associates of the target words preceded the targets at an onset asynchrony of 100 msec. Relative to spelling controls (TROD, BENCH), the low-frequency TOWED and the high-frequency BEACH speeded up the naming of FROG and TREE, respectively, to the same degree. This result was discussed in relation to the accumulating evidence for the primacy of phonological constraints in visual lexical access.

Research on recognizing and pronouncing printed words has been dominated in recent decades by the idea that two independent processes (often referred to as *routes*) govern access to the internal lexicon: a direct, visual process and a mediated, phonological process (Coltheart, 1978). The primary process of direct access is tantamount to an association between spelling and phonology-plus-meaning. Orthographic representations are mapped onto lexical representations, conceptualized as locations in a mental dictionary, by word-specific rules. Spelling features, perhaps abstract graphemes, comprise the orthographic representations; semantic interpretations, syntactic roles, phonological structure, frequency of occurrence, and the like, are coded in the lexical representation. The secondary access route is provided by the mediated process that involves a set of grapheme–phoneme correspondence rules turning spellings into phonological representations, and a subsequent mapping from these phonological representations onto lexical entries. According to this theory, the direct visual route is the principal route for exceptional spellings, and the phonological route is the principal route for new words and nonwords. Furthermore, according to the theory, both routes can effectively process familiar words but the faster visual route is preferred by the skilled reader, and the phonological route, if used at all, is too slow to influence the reading of familar words in the normal time course of word identification.

The results of recent experiments by Van Orden and colleagues (Van Orden, 1987; Van Orden, Johnston, & Hale, 1988) contradict the delayed-phonology hypothesis of dual-process theory and suggest that phonology's role in English word identification may be more pronounced than has been generally assumed (e.g., Humphreys & Evett, 1985). Van Orden (1987) demonstrated a significant production of false positives to homophones (e.g., BEATS) of exemplars (e.g., BEETS) compared with spelling controls for the homophones (e.g., BELTS), when the subject's task was to determine whether a presented letter string was a member of a given category (A Vegetable). The results showed that 18.5% of the responses to BEATS were false positives, whereas only 3% of the responses to BELTS were false positives. This contrast was attributed to the phonology of the homophonic foils. In an extension of the phenomenon to nonword homophones, Van Orden et al. (1988) found a 21.3% versus 3% contrast in false positives for contrasts such as SUTE (nonword homophone for SUIT) versus SURT (a spelling control), and a virtually identical 21.8% versus 2.3% contrast in false positives for word homophones and their spelling controls, suggesting that computed phonology was the source of miscategorization. In a further extension of the phenomenon, Van Orden et al. (1988) compared false-positive "yes" latencies with homophone foils like BEATS, and correct yes latencies with yoked category exemplars like CORN (for the category Vegetable). The two distributions of yes latencies exhibited a marked overlap with

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only a small difference in the proportion of outliers in their slow latency tails, contradicting the expectation from dual-route theory that the false-positive latencies should have been shifted in their distribution toward slower latencies compared with the correct yes latencies. The fact that they were not reinforces the conclusion that phonological codes are early (not late) and inevitable (not optional) sources of constraint on word recognition.

Recently, Jared and Seidenberg (1991) have questioned the capacity of data from the semantic categorization task to sustain such a broad interpretation of phonology's role. Their criticism focuses on the fact that many of the categories used in the Van Orden studies have a small number of exemplars (e.g., A Member Of A Convent; An Ancient Musical Instrument). The possibility is open, therefore, for the subject to activate all category members ahead of the target stimulus. If these preactivated representations are retained briefly in phonological form, then positive responses to stimuli homophonic with the exemplars might be expected. Through the use of categories prohibitive of preactivating all exemplars (e.g., Living Thing; Object), Jared and Seidenberg showed that the difference in false positives between a homophone and its visual control was restricted to low-frequency words. The interpretation of these results by Jared and Seidenberg is that phonological constraints on semantic categorization are less pervasive than has been argued by Van Orden and colleagues, and that the essential character of dual-route theory remains intact.

The advantage of the semantic categorization task for evaluating phonology's role is that it demands access to a word's meaning. If phonological influences show up in this task, then it may be presumed that phonology is involved in the word recognition processes of everyday reading, in which contact with the meanings of words is necessary for successful understanding. In contrast, the more commonly used tasks in word recognition studies—lexical decision and rapid naming—could proceed, in principle, without activation of meaning. There is, however, a definite disadvantage of the semantic categorization task: it requires subjects to respond *explicitly* to a word's meaning. As a rule of thumb, the best experimental procedures in psycholinguistics are those that reveal how a linguistic process is conducted without having the subjects attend directly to, and explicitly perform, that particular linguistic process. Satisfying this rule of thumb has been the long-term charm of the lexical decision and naming tasks in visual word recognition research. By clever manipulation of the stimulus conditions, subjects engaged in the relatively mechanical task of naming letter strings can provide data on orthographic, phonological, semantic, and syntactic processes. To be blunt, the ideal is a simple nonintellectual task that makes the underlying intellectual (cognitive) mechanisms transparent. As experimental tasks become more intellectually demanding, requiring more conscious effort on the part of the subject, the processes by which the task is satisfied become less coherent and less reflex-like, and the inferences made from the data concerning underlying mechanisms become less secure (Fodor, 1983; Marr, 1981). In the present article, we seek to replicate Van Orden's observation—that a visually presented word activates the meanings of its homophonous counterparts—by using a simple naming task in which any semantic processing that might occur is implicit rather than explicit.

Our methodological departure point is Lukatela and Turvey's (1991) examination of pseudohomophones in the role of associative primes in a rapid-naming task. Lukatela and Turvey found that (1) the priming due to associated pseudohomophones (e.g., TAYBLE–CHAIR) was equal in magnitude to that due to associated words (TABLE–CHAIR), (2) visual controls for the pseudohomophones (e.g., TARBLE) failed to prime, and (3) the pseudoassociative priming was the same for both long and short stimulus onset asynchronies. They argued that such outcomes would be expected if the lexicon was phonological rather than orthographic, and if lexical access occurred routinely through the phonological route of assembled or computed phonology. The lexical representations for the words *table* and *chair* are /table/ and /chair/, respectively; the assembled phonologies of the primes TABLE, TAYBLE, and TARBLE are /table/, /table/, and /tarble/, respectively. Given the primes TAYBLE and TABLE, /table/ is assembled and /chair/ is activated by the lexical entry /table/ through the associative network. Given the prime TARBLE, /tarble/ is assembled, the lexical entry /table/ is not activated, and the lexical entry /chair/ remains at its pre-TARBLE level of excitation.

Van Orden and his colleagues asked questions such as: Would BEACH be more likely to be falsely categorized as A Kind Of Tree than would the spelling control BENCH? If so, then it would suggest a mechanism by which the presentation of BEACH led to the assembling of the phonological code common to BEACH and BEECH and the activation of the lexical representations of *beach* and *beech*. The present experiment is directed at associative priming through homophones. Homophones such as TOWED and STEEL, and their spelling controls TROD and STEAK, are presented as primes for the pseudoassociated targets FROG and THIEF, which are to be named as rapidly as possible. Also included are homophones such as BEACH and BARREN, and their spelling controls BENCH and BARGAIN, presented as primes for the category types Tree and Nobleman. Paralleling the kind of question asked by Van Orden and colleagues, we ask: Will FROG be named faster following TOWED, a word homophonous with *toad*, a semantic relative of FROG, than it would following the spelling control TROD? Will TREE be named faster following BEACH, a word homophonous with *beech*, a type of tree, than it would following the spelling control BENCH? As in the research of Van Orden and colleagues, for such effects to occur, the phonological code of the context word would have to be assembled and used to access word meanings. Given the understanding, from dual-process theory, that assembled phonology is a slow process generally restricted to less common words, it is important to assess whether such effects (1) can be obtained when the time to process the context is sharply limited, and (2) depend on word frequency.

Consider the pseudoassociative pairs TOWED–FROG and BEACH–TREE, and their corresponding spelling control pairs TROD–FROG and BENCH–TREE, in which members of a pair are separated by only 100 msec. In comparative terms, BEACH (61 occurrences in a million) is a high-frequency homophone for the low-frequency BEECH (6), and TOWED (1) is a low-frequency homophone for the high-frequency TOAD (44). If frequency dictates type of processing, then the TOWED–FROG versus TROD–FROG contrast should be greater than the BEACH–TREE versus BENCH–TREE contrast. Compared with the low-frequency TOWED, the high-frequency BEACH is less likely to have its representation activated by the phonological route, rendering it less likely that its homophonous counterpart (*beech*) will be influential in the subsequent processing of the target. Further, if the phonological route is too slow to influence real-time word identification, then it is unlikely that any pseudoassociative priming would be seen under the temporal restriction of a 100-msec onset asynchrony between any context, of either low or high frequency, and its following target.

METHOD

Subjects

Twenty-two students of the University of Connecticut served as subjects. Each subject was assigned to one of two groups, according to his or her arrival at the laboratory, to give a total of 11 subjects per group.

Materials

Prior to the experiment, 148 printed words were presented to 16 undergraduate students. These words comprised 74 pairs of yoked English homophones (e.g., BEACH and BEECH, TOWED, and TOAD). The members of a given pair of yoked homophones were presented on separate sheets in a random order. Each of the 16 students was requested to write down, for each given printed test word, three different words as they came to mind. Each student was urged to respond quickly, without making corrections. A list of 60 pairs was assembled, using the most frequently and reliably associated pairs generated by the 16 students (e.g., BEECH–TREE, BEACH–SAND, TOWED–CAR, TOAD–FROG) and other similar pairs already identified in the literature. Each context word on this list of 60 was then replaced by its yoked homophone to produce the experimental list of 60 visually unrelated context-target pairs (e.g., BEACH–TREE, TOWED–FROG). The experimental list of 60 pairs formed two sublists. In Sublist A, the homophone context (e.g., TOWED) was lower in frequency than its counterpart (TOAD) with which the target was associated. In Sublist B, the homophone context (e.g., BEACH) was higher in frequency than its counterpart (BEECH) with which the target was associated. Additionally, the mean frequency of the homophone contexts in Sublist A was less than that of the homophone contexts in Sublist B. (All frequencies were determined from the Kučera & Francis, 1967 norms.)

A spelling control list of 60 unrelated context-target pairs was also created in which the word targets were the same as those in the homophone context-target pairs. Each spelling control was a word similar in form and frequency to the homophone that it was a control for, and was not a prominent associate of the corresponding target according to the preliminary testing discussed above. Each associated word, homophonic context, spelling control, and target,

Table 1
Experimental Stimuli, Frequencies of Occurrence of Homophones and Their Counterparts (in Parentheses), and Naming Latencies (in Milliseconds) in the Homophonic (L_H) and Spelling Control (L_{SC}) Contexts

Associated Context (Not Presented)	Homophone Context (Presented)	Spelling Control	Target	L_H	L_{SC}
		Sublist A			
BALL (110)	BAWL (1)	BAIL	BASKET	578	571
BEAR (57)	BARE (29)	BARK	BROWN	555	613
BLUE (143)	BLEW (12)	BREW	SKY	687	710
BOY (242)	BUOY (1)	BOG	GIRL	672	659
BREAD (41)	BRED (1)	BROOD	BUTTER	583	653
CEREAL (17)	SERIAL (7)	VERBAL	OATS	647	639
CREEK (14)	CREAK (1)	CHEEK	BROOK	656	684
FUR (13)	FIR (2)	FIN	WARM	609	581
GATE (37)	GAIT (8)	GALE	FENCE	614	610
GUEST (39)	GUESSED (15)	GUST	HOST	656	708
HEEL (9)	HEAL (2)	HELM	BOOT	562	693
HORSE (117)	HOARSE (5)	HOSE	PONY	558	685
LOAN (46)	LONE (8)	CONE	MONEY	611	655
MALL (3)	MAUL (1)	MOLE	SHOPPING	686	680
MEDAL (7)	MEDDLE (1)	MEDLEY	GOLD	565	617
PATIENTS (36)	PATIENCE (22)	PATENT	DOCTOR	553	617
PEAK (16)	PEEK (1)	PECK	TOP	645	637
PEARL (9)	PURL (1)	PERIL	GEM	685	699
PLANE (114)	PLAIN (48)	PLAY	FLY	632	625
POLE (18)	POLL (9)	POKE	FLAG	651	622
PRINCE (33)	PRINTS (10)	PRANCE	ROYALTY	642	619
RAIN (70)	REIN (3)	RUIN	MUD	595	615
RING (47)	WRING (2)	RINSE	WEDDING	607	589
ROAD (193)	RODE (40)	ROUND	STREET	691	681
ROUTE (43)	ROOT (30)	ROOF	HIGHWAY	590	684
SIGN (94)	SINE (4)	SIGH	STOP	706	709
SON (160)	SUN (112)	SIN	FATHER	576	613
TEA (28)	TEE (5)	TEN	COFFEE	636	686
TOAD (44)	TOWED (1)	TROD	FROG	591	643
WAY (909)	WEIGH (4)	NEIGH	TRAVEL	615	730
		Sublist B			
ALTAR (5)	ALTER (15)	AJAR	CHURCH	614	709
BARON (2)	BARREN (7)	BARGAIN	NOBLEMAN	653	660
BEECH (6)	BEACH (61)	BENCH	TREE	612	642
BRAKE (2)	BREAK (88)	BRAVE	PEDAL	625	617
DEW (3)	DUE (142)	DELL	WET	607	701
FAIRY (4)	FERRY (11)	FARCE	TALE	602	633
FEAT (6)	FEET (283)	FELT	DEED	652	642
FOWL (1)	FOUL (4)	FOIL	CHICKEN	603	609
HARE (1)	HAIR (148)	HARD	RABBIT	557	621
HOLE (58)	WHOLE (309)	WHOSE	GROUND	567	673
LUTE (1)	LOOT (3)	LORE	GUITAR	652	710
NUN (2)	NONE (108)	NON	MONK	609	612
PANE (3)	PAIN (88)	PAIR	WINDOW	554	563
PAWS (3)	PAUSE (21)	PURSE	CATS	615	664
PIECE (129)	PEACE (198)	PACE	PIE	633	683
PORE (2)	POUR (3)	PORT	SKIN	650	752
PROPHET (5)	PROFIT (28)	PROJECT	BIBLE	598	631
SAIL (12)	SALE (44)	SOUL	BOAT	556	602
SEAMS (9)	SEEMS (259)	SEEDS	STITCHES	708	748
SIGHT (86)	SITE (82)	SICK	VISION	596	655
SLEIGH (0)*	SLAY (3)	SLAM	SNOW	651	693
STEAL (5)	STEEL (45)	STEAK	THIEF	670	718
THRONE (5)	THROWN (40)	THROAT	KING	596	620
URN (2)	EARN (16)	URGE	ASHES	583	605
WAIST (11)	WASTE (35)	WANTS	LENGTH	552	573
WEAR (36)	WHERE (938)	THERE	CLOTHES	613	646
WEIGHT (91)	WAIT (94)	WAGE	HEAVY	564	587
WITCH (5)	WHICH (3562)	WHEN	BROOM	566	629
WOOD (55)	WOULD (2714)	COULD	FOREST	661	637
YOLK (1)	YOKE (3)	YELP	YELLOW	630	662

*Less than one in a million.

is presented in Table 1. A foil list was also created, comprising 50 unrelated context-target pairs. The foil words were nonhomophonic regular words selected with no specific constraints. For all stimulus pairs, the context stimuli were written in uppercase and the target stimuli were written in lowercase.

Design

The major constraint on the design was that a given subject never encountered a given word, either as a context or as a target, more than once. There were four (2×2) stimulus types (associative relation × sublist). Each subject was presented with 15 experimental word-word stimulus pairs from each of the four types. For example, if 1 subject received BAWL-BASKET, TROD-FROG, BEACH-TREE, COULD-FOREST, then another subject would receive BAIL-BASKET, TOWED-FROG, BENCH-TREE, WOULD-FOREST. In addition, each subject saw the foil set (the same for all the subjects) of 50 unrelated pairs. In total, each subject saw 110 stimulus pairs. The experimental trials were divided into five subsets, with a brief rest after each subset. Pair types were ordered pseudorandomly within each subset. The experimental trials were preceded by practice trials with 32 word-word pairs, 16 of which were associatively related.

Procedure

The subjects, who were run one at a time, sat in front of the CRT of an Apple IIe computer in a dimly lit room. A fixation point was centered on the screen. Each trial consisted of an auditory warning signal followed by a 40-msec presentation of an uppercase letter string (i.e., the context) at the fixation point. After an interstimulus interval of 60 msec, a lowercase letter string appeared at the fixation point for 400 msec. Each subject was told that he or she would be viewing two-word sequences, with the first word in uppercase and the second word in lowercase and that the task was to pronounce the lowercase letter string as quickly and as distinctly as possible. Latency from the onset of the letter string to the onset of the response was measured by a voice-operated key. Naming was considered erroneous when the word was mispronounced, or the pronunciation was not smooth (i.e., the subject hesitated after beginning to name).

RESULTS

Table 2 shows the mean naming latencies, mean errors, and the subject and item standard deviations of both measures, for the four types of context-target pairs. Table 1 shows the naming latencies to each target as a function of the homophonic and spelling control contexts. A 2×2 (associativeness × sublist) analysis of variance (ANOVA) on naming latencies, with subjects and stimuli as the error terms, revealed a significant main effect of associativeness (related = 624 msec vs. unrelated = 651 msec) [$F1(1,21) = 21.28, p < .001$; $F2(1,58) = 10.14, p < .01$; min $F(1,78) = 6.92, p < .01$]. The main effect of sublist (Sublist A = 639 msec vs. Sublist B = 639 msec) was not significant (both Fs < 1). The interaction between associativeness and sublist was not significant [$F1(1,21) = 1.5, p > .05$; $F2(1,58) < 1$]; numerically, however, it can be seen (Table 2) that the priming was greater for Sublist B. It will be recalled that the sublist variable identifies a difference in the homophone/associate frequency ratio (Sublist A < 1, Sublist B > 1), and a difference in the mean frequency of the context items (Sublist A < Sublist B). The insignificance of sublist suggests that frequency, of either the associate or the homophone, did not contribute to the present results. To further evaluate the role of frequency, simple regression analyses were performed with log homophone frequency and log associate frequency as the independent measures, and the BEACH-TREE versus BENCH-TREE difference as the dependent measure. Each of the simple linear regressions accounted for no more than 1% of the variance, and an additional multiple regression did no better, revealing an independence of priming from associate and homophone frequency. With respect to the error data, no significant effects were found in either the ANOVA or the regression analyses.

Table 2
Mean Naming Latencies (L; in Milliseconds) and Error Rate (ER; in %) With the Corresponding Standard Deviations by Subjects and by Items

	Context-Target Relation			
	Related		Unrelated	
	L	ER	L	ER
Sublist A				
M	629	5.24	649	3.98
SD by subjects	72	5.19	80	5.36
SD byitems	48	8.16	51	5.69
Sublist B				
M	619	3.17	654	4.83
SD by subjects	64	4.24	83	5.49
SD by items	36	7.73	60	7.06

DISCUSSION

The present experiment has demonstrated that a briefly presented context that is homophonic with a semantic relative of a quickly following target speeds up the naming of that target: TOWED primes FROG, BEACH primes TREE, THROWN primes KING, ROOT primes HIGHWAY, SUN primes FATHER, GUESSED primes HOST, and so on (see Table 1). Because spelling controls were used (e.g., BENCH for BEACH), it seems reasonable to attribute this associative effect through homophony to the phonological structure of the homophones. Because the effect held over context stimuli that varied in frequency across three orders of magnitude (see Table 1), it seems reasonable to argue that the influence of the phonological structure of the homophones was frequency independent. Because the context-target onset asynchrony was only 100 msec, it seems reasonable to claim that the phonological codes of the homophones became available rapidly as a source of influence on subsequent lexical processing.

Word recognition theories lacking a central role for assembled or computed phonology (e.g., Aaronson & Ferres, 1983; Humphreys & Evett, 1985; Kolers, 1970; McClelland & Rumelhart, 1981; Paap, Newsome, McDonald, & Schvaneveldt, 1982; Smith, 1971), and dual-route theories that assume effects of phonology only when responses are slow, as in the processing of low-frequency exception words and nonwords (e.g., Allport, 1977; Coltheart, 1978, 1980; Coltheart, Besner, Jonasson, & Davelaar, 1979; McCusker, Hillinger, & Bias, 1981; Norris & Brown, 1985; Seidenberg, 1985; Seidenberg, Waters, Barnes, & Tanenhaus, 1984), would be hard-pressed to address the present observation of an associative effect through homophony. They would similarly be hard-pressed to accommodate Lukatela and Turvey's (1991, in press) finding that associated pseudohomophones (e.g., TAYBLE–CHAIR) primed equally as well as associated words (TABLE–CHAIR) and that visual controls for the pseudohomophones (e.g., TARBLE) failed to prime. Because nonwords are not represented in the lexicon, the latter observations are inconsistent with the claim that there are only lexically accessed phonological codes. Other research on pseudohomophonic processing in English (Lukatela & Turvey, in press) provides results that are inconsistent with the claim that nonwords and words are processed in qualitatively distinct ways. Between the presentation and recall of one or five digits, subjects performed a secondary task of rapidly naming a pseudohomophone (e.g., FOLE, HOAP) or its real-word counterpart (FOAL, HOPE). Memory load was found to interact with frequency (HOPE vs. FOAL; HOAP vs. FOLE), but not with lexicality (HOPE vs. HOAP; FOAL vs. FOLE), contradicting the idea that nonwords are named by a slow (resource-expensive) process that assembles phonology, and words are named by a fast (resource-inexpensive) process that accesses lexical phonology (Paap & Noel, 1991). Pseudohomophones and their word counterparts seem to be processed in like fashion. The present results, together with those of Lukatela and Turvey (1991, in press) seem to implicate the following account of the priming of FROG by TOWED. The phonological code for TOWED is assembled automatically prior to lexical access; the word representations of *towed* and *toad* are activated through this phonological code; these activated representations feed excitation through the lexical network to their semantic relatives; the representation of *frog* is prominent among the lexical representations primed by *toad*; excitation from *frog* is fed back down to the level of phonological processing units; and the naming of the subsequent target FROG is, thereby, facilitated by the preactivation of its lexical representation and its phonological constituents.

The present experiment was motivated by research suggesting that phonological information is brought to bear automatically and early in the semantic categorization task (Van Orden, 1987; Van Orden et al., 1988). Corroboration of the latter conclusion has been provided by Peter and Turvey (1992), who found that the homophone versus spelling control difference in false positives was the same when the time available for processing was severely limited (a 40-msec exposure before pattern masking) as it was when the time available for processing was comparatively unlimited (a 500-msec exposure without pattern masking). These authors also examined false positives in the semantic categorization task under backward dichoptic masking by pseudowords, which were, in turn, masked monoptically by a pattern mask. Briefly exposed homophones (e.g., BOLL) masked by a homophonic pseudoword (*doal*), a graphemic control (*doil*), or an unrelated pseudoword (*dups*), were categorized as category exemplars (A Kitchen Utensil). The error rate of false positives was magnified in the BOLL–*doal* condition compared with the BOLL–*dups* condition, a result that Peter and Turvey (1992) interpreted as substantiating the claim that phonological codes provide immediately available constraints on lexical access. Their interpretation followed, in large part, from arguments advanced by Perfetti, Bell, and Delaney (1988) about the processes revealed through the backward homophonous masking task. If phonology is computed automatically, then phonological similarity between the mask and target will reduce the interruption of central processing normally induced by the mask. A phonologically similar mask will reinforce the phonological information partially activated by the target. In contrast, a phonologically dissimilar mask will partially activate other phonological information. If it is the case that lexical activation follows from phonological information, then a target preceding a phonologically similar mask will be identified better than will a target preceding a phonologically dissimilar mask. The idea is that lexical entries partially activated by a target will be activated further by a subsequent mask with common phonological properties. The outcomes of studies by Naish (1980), Perfetti et al. (1988), Perfetti and Bell (1991), and Lukatela and Turvey (1990a) were in agreement with this hypothesis. All of these studies showed significantly higher levels of target identification for homophonous masking than for nonhomophonous masking. Moreover, in the studies of Perfetti and colleagues, these higher levels were frequency independent.

Concluding Remarks

Consonant with the above findings, the present experiment underscores the prelexical and automatic assembling of phonology for words of any frequency and adds to the growing understanding that word phonology affects word identification (in English and other languages) within its normal time course (e.g., Lukatela, Carello, & Turvey, 1990; Lukatela & Turvey, 1990a, 1990b, 1991, in press; Perfetti, Zhang, & Berent, 1992; Van Orden, Pennington, & Stone, 1990). That is, the results point to assembled phonological codes as an early source of constraint on accessing knowledge about a word, contrary to the delayed-phonology hypothesis that is part and parcel of some versions of dual-route theory. The present results also provide further impetus (see Van Orden et al., 1990) for questioning the fundamental hypothesis of dual-route theory, namely, that there are separate processes of phonological mediation and direct access. Independent evidence for a direct visual process is difficult, if not impossible, to find in the vast experimental literature on visual word recognition. The stated evidence is usually in the form of an argument from other-than-positive results for visual coding: When an explicit phonological manipulation fails to affect word recognition, it is interpreted as evidence that word recognition proceeds primarily by the direct visual route; when an explicit phonological manipulation succeeds in affecting word recognition, it is interpreted as evidence that word recognition must have proceeded by the direct visual route at a pace equal to or slower than the phonological route. Perhaps the traditional strategy for adjudicating upon the mechanisms of word recognition should be turned on its head. Given that explicit unambiguous evidence can be provided for phonological mediation, the proper question may well be whether a demonstration of direct visual access can be given that is distinguishable from phonological mediation (Van Orden et al., 1990). Our inclination is to believe that such a demonstration is unlikely. The failure to provide it will encourage the abandonment of notions of separate, independent mechanisms and motivate the development of accounts in which multiple and varied lexical substructures are all activated through a common matrix of connection weights. Given the kind of evidence presented here, and that from analogous lines of research, it seems likely that phonological coding will play the leading role in the dynamics of this common mechanism (Carello, Turvey, & Lukatela, 1992; Van Orden et al., 1990).

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