Effects of association and imageability on phonological mapping

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In two experiments, we examined the influence of semantic activation on the generation of a phonological code, testing the interactivity assumption common to both dual-route and interactive-activation models. In Experiment 1, subjects named regular and irregular targets preceded by related and unrelated primes. In Experiment 2, these variables and target imageability were manipulated. Both relatedness and imageability interacted with regularity, indicating that semantic activity speeds access to a phonological code.

Most printed word recognition models assume interactivity at the lexical level among phonological, orthographic, and semantic representations (e.g., Coltheart, Curtis, Atkins, & Haller, 1993; Seidenberg & McClelland, 1989). In other words, activation at one level of representation can affect the generation of a code at other levels (Seidenberg & McClelland, 1989). Despite this assumption of interactivity, however, little research has been done to examine specific relationships among sources of information activated during recognition. In the present experiments, we investigated the extent to which activation at the semantic level can influence phonological generation.

There is one recent study that has explicitly examined the relationship between semantic activation and phonological generation in single-word naming (Strain, Patterson, & Seidenberg, 1995). In a word-naming experiment that manipulated the imageability and spelling-to-sound regularity of target words, Strain et al. found that naming latencies for low-imageable irregular words (e.g., *caste*) were longer than those for high-imageable irregular words (e.g., *comb*). For regular words, there was no imageability effect. Strain et al. interpreted their results in terms of the Seidenberg and McClelland (1989) model, which conceives of word recognition as an interactive process associating a set of orthographic inputs with phonological outputs. The model assumes that interactivity also exists between these systems and a semantic system, allowing semantic activation to affect phonological computation. Strain et al. concluded that semantic activation shows its effects on phonological computation especially strongly when such computation is slow (e.g., with irregular words). Therefore, activation from the semantic level is

observed for high-imageable irregular words due to activation generated by the image of the referent of the word. In contrast, low-imageable irregular words do not possess as rich a semantic representation and, therefore, do not receive the benefit that high-imageable words do. With regular words, phonological computation is relatively fast, and the effect of imageability is diminished.

EXPERIMENT 1

The purpose of the present research was to test the generality of the relationship between meaning and phonology, using a priming paradigm. The use of a priming paradigm to examine the meaning-phonology relationship is critical for at least two reasons. First, imageability is highly correlated with other variables, such as concreteness and categorizability (Toglia & Battig, 1978). For this reason, it is unclear whether imageability or one of the correlated variables is responsible for influencing phonological generation (a point acknowledged by Strain et al.). The priming method, on the other hand, allows us to assess the contribution of information from the semantic level over a constant set of words, preceded by associated or unrelated primes. Second, the priming procedure may be more powerful than imageability for testing the relationship between semantic and phonological information, because the former involves semantic activation before the target is presented. If the interaction between semantic and phonological information found by Strain et al. arises because imageable words possess an especially rich semantic representation, then providing semantic or associative information for all words, via a prime word, may diminish this interaction. Such a result would compromise the generality of the meaning-phonology relationship claimed by Strain et al.

Method

Subjects. Thirty undergraduates from the University of Kansas participated in the experiment for course credit. All were native speakers of English, and all reported having normal or corrected-to-normal vision.

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Design. The design for the experiment was a 2×2 within-subjects factorial. The factors were spelling-to-sound regularity of the targets (regular vs. irregular) and associative relatedness of the prime-target pairs (related vs. unrelated). Unrelated pairs were formed by re-pairing primes and targets.

Stimuli. The stimuli are provided in Appendix A. Only monosyllabic words with a printed frequency of less than 26 per million words (Carroll, Davies, & Richman, 1971) were used as targets, because the regularity effect is usually stronger for low-frequency words (Seidenberg, Waters, Barnes, & Tanenhaus, 1984). Forty-eight targets were selected. Each subject saw the same 48 targets, but related and unrelated word pairs were counterbalanced across two lists so that half of the subjects saw a given target in a related context (e.g., *quart-pint*) and half of the subjects saw the same target in an unrelated context (e.g., *saber-pint*). Of the 48 targets, 24 were regular words and 24 were irregular words. Words were defined as irregular if they violated spelling-to-sound correspondence rules as defined by Venezky (1970). In addition, each irregular word was considered irregular as determined by GPC rules (Coltheart et al., 1993). Determination of relatedness was made from the word association norms of Nelson, McEvoy, and Schreiber (1993). Regular and irregular words were compared, using *t* tests on frequency (regular mean = 9.1, range = 1.8–22.6; irregular mean = 9.6, range = 1.7–25.7; $t < 1$), word length in letters (regular mean = 4.3, range = 3–6; irregular mean = 4.4, range = 3–6; $t < 1$), and mean summed bigram frequency [Solso & Juel, 1980; regular mean = 4.326, range = 279–12,870; irregular mean = 4.829, range = 68–10,889; $t(47) = 1.1$, $p > .20$]. Prime-target associative strength (defined as the probability that the target would occur as a response to the prime in the Nelson et al., 1993, norms) was also equated (regular mean = .256, range = .014–.757; irregular mean = .251, range = .014–.521; $t < 1$).

Procedure. Stimuli were presented with a microcomputer running the Micro Experimental Laboratory (MEL) software (Schneider, 1990). On each trial, a fixation stimulus was presented for 500 msec; the prime followed and appeared for a duration of 200 msec. The prime was masked by a series of asterisks for 33 msec, and the target followed immediately. Therefore, the stimulus onset asynchrony (SOA) was 233 msec. This relatively short SOA was chosen to allow automatic activation to occur from the prime word. The target remained on the screen until a naming response was given. A millisecond timer interfaced to the computer began when the target was presented and recorded the time between the onset of the target and the initiation of the naming response. The subjects were instructed that, on every trial, a pair of words would be presented, one at a time, and that they were to name the second word as quickly as possible. They were also told to attend to the first word because it could help them identify the second. The session was made up of 12 practice trials and 48 experimental trials.

Results and Discussion

The data from eight trials across all subjects (0.5%) were excluded from the analysis either because the microphone failed to detect the participant's voice response or because some extraneous noise (e.g., throat clearing) activated the microphone. Mean naming latencies and error proportions are shown in Table 1. Analyses of variance (ANOVAs) by subjects and items (Clark, 1973) were performed on naming latencies and errors. Each analysis was a 2 (regularity) $\times$ 2 (relatedness) factorial analysis. Both factors were within subjects in the analysis of subjects (F_1). Regularity was treated as between

words and relatedness was treated as within words in the analysis by items (F_2).

There were significant main effects for both regularity and relatedness. Regular words were named in less time than were irregular words [$F_1(1,29) = 22.21$, $p < .01$; $F_2(1,46) = 11.28$, $p < .01$]. Related words were named faster than were unrelated words [$F_1(1,29) = 13.26$, $p < .01$; $F_2(1,46) = 10.67$, $p < .01$]. Regularity and relatedness did not interact for either subjects or items (both $F_s < 1$).

The subjects made more errors for irregular words than for regular words [$F_1(1,29) = 7.12$, $p < .02$; $F_2(1,46) = 6.16$, $p < .02$]. Also, there were more errors for unrelated words than for related words [$F_1(1,29) = 13.7$, $p < .05$; $F_2(1,46) = 2.93$, $p < .10$]. (Note that F_2 was only marginally significant.) The interaction between regularity and relatedness was also significant [$F_1(1,29) = 10.88$, $p < .01$; $F_2(1,46) = 4.34$, $p < .05$]. This interaction is due, at least in part, to a ceiling effect for regular words. Simple effects show that, for irregular words, the subjects made more errors for unrelated irregular targets than for related irregular targets [$t(1,29) = 4.07$, $p < .01$]. For regular words, there was no difference between unrelated and related words ($t < 1$). The pattern of errors resembles that seen in the latency data; therefore, there is no sign of a speed-accuracy tradeoff in the data. It should be noted that most of the errors committed on irregular words were regularization errors (e.g., pronouncing *pint* as though it rhymes with *mint*) and that such errors were far more common in the unrelated condition.

EXPERIMENT 2

The results regarding the interaction of semantic and phonological information were equivocal in Experiment 1. Although the error rates did show that the accuracy advantage for naming targets in a related context was greater for irregular words, this interaction did not obtain for naming latencies. There may be several reasons that this interaction failed in Experiment 1. First, presenting associative information in advance of the target may make it available in enough time to be used for target recognition regardless of regularity. The priming paradigm allows this early availability of information at the semantic level, whereas the imageability manipulation of Strain et al. (1995) does not. A second possibility is that imageability and associative relatedness tap two different types of semantic information, and that these have different effects on a phonological code. Therefore, in Experiment 2, in addition to relatedness and regularity, we reintroduced the imageability manipulation of Strain et al. (1995). A final possibility concerns the nature of the naming task itself and characteristics of the stimuli. In Experiment 1, 14 of the 24 irregular items began with nonplosive initial consonants (e.g., fricatives, glides, or nasals). Kawamoto, Kello, and Jones (1994) reported that words beginning with plosive phonemes (i.e., oral stop consonants) provide stronger regularity effects. For words beginning with nonplosives, it is pos-

Table 1
Naming Latencies (RTs, in Milliseconds), Standard Deviations (SDs), and Mean Proportion of Errors in Experiment 1

Word Type	Related			Unrelated			Facilitation
	RT	SD	Error	RT	SD	Error	
Regular	503	49.8	.01	516	61.8	.01	13
Irregular	520	56.1	.02	537	66.7	.07	17

sible to begin the pronunciation of the target before the complete phonological code is constructed. Therefore, the targets in Experiment 2 began with plosive phonemes.¹

In Experiment 2, we also included an SOA manipulation, because a recent experiment (Hess & Foss, 1994) yielded more priming for inconsistent words (i.e., irregular words such as *bear*, or regular words that have irregular neighbors such as *cone*) using an SOA of 500 msec. Therefore, we cannot discount the possibility that a longer SOA would yield the critical interaction in this experiment.

Again, an interactive model (e.g., Seidenberg & McClelland, 1989) predicts that phonological generation will be influenced by activation at the semantic level, leading to interactions between regularity and imageability (replicating Strain et al., 1995), and between regularity and relatedness. If relatedness and imageability affect the system in the same way (e.g., by providing a richer set of connections between units in the semantic system and those in the phonological processor), then we might further expect a three-way interaction of relatedness, imageability, and regularity, such that the effect of an associative prime would be mostly restricted to low-imageable irregular targets. The representation of high-imageable words would be rich enough so that it would derive less additional benefit from an associated prime. On the other hand, if imageability and relatedness tap different types of semantic information, we would expect these two variables to have independent effects on naming time.

Method

Subjects. One hundred thirty-two undergraduate psychology students from the University of Kansas participated in the experiment for course credit. Seven of an original 139 subjects were eliminated because their error rates exceeded 15%. All were native speakers of English, and all had normal or corrected-to-normal vision.

Design. The design for the experiment was a $2 \times 2 \times 2 \times 2$ mixed factorial. Regularity (regular vs. irregular), relatedness (related vs. unrelated), and imageability (high vs. low imageable) were manipulated within subjects, and SOA (233 vs. 533 msec) was manipulated between subjects.

Stimuli. The items used in Experiment 2 can be found in Appendix B. The targets consisted of monosyllabic and bisyllabic low-frequency words (the printed frequency for all words was less than 20 per million; Carroll et al., 1971). Each target was defined as phonologically regular or irregular as in Experiment 1.

To determine imageability, 33 subjects rated 205 words on a 7-point scale. Target words were chosen from these words.² Regular and irregular words were rated for familiarity by a separate norming group of 33 subjects. Items were equated for frequency (high-imageable regular

mean = 6.8, range = 1.3–18.1; low-imageable regular mean = 7.5, range = 0.6–18.3; high-imageable irregular mean = 7.7, range = 1.0–19.0; low-imageable irregular mean = 5.4, range = 2.5–7.7), mean summed bigram frequency (high-imageable regular mean = 3,258, range = 53–5,856; low-imageable regular mean = 3,188, range = 279–7,673; high-imageable irregular mean = 3,913, range = 1,718–7,211; low-imageable irregular mean = 4,366, range = 773–10,916), word length (high-imageable regular mean = 4.8, range = 4–6; low-imageable regular mean = 4.9, range = 3–7; high-imageable irregular mean = 5.0, range = 4–8; low-imageable irregular mean = 4.4, range = 4–5), and associative strength (high-imageable regular mean = .200, range = .094–.500; low-imageable regular mean = .230, range = .029–.493; high-imageable irregular mean = .210, range = .050–.594; low-imageable irregular mean = .251, range = .072–.435). A series of ANOVAs, with regularity and imageability as between-items factors, were performed on these variables and on neighborhood size (i.e., Coltheart's *N*), familiarity, and number of syllables. There were no significant main effects or interactions in any of these analyses. In addition, imageability ratings for high-imageable words did not differ between regular and irregular words; this was true for low-imageable words as well ($F_s < 1$).

Thirty-two targets were used in the experiment. Each subject saw the same 32 targets, but related and unrelated word pairs were counterbalanced so that half of the subjects saw a given target in a related context (e.g., *quart–pint*) and half of the subjects saw the same target in an unrelated context (e.g., *metal–pint*).

Procedure. For the 233-msec SOA condition, the procedure was the same as for Experiment 1. For the 533-msec SOA condition, the only difference was that the prime appeared for 500 msec instead of 200 msec. There were 16 practice and 32 experimental trials in Experiment 2.

Results and Discussion

The data from 79 trials (1.8%) were excluded from the analysis either because the microphone failed to detect the subject's voice or because of some extraneous noise. Also, responses beyond 2.5 standard deviations of the mean for each condition were classified as outliers and were removed from the analysis for both subjects and items. Finally, the data from 7 subjects were not included in the analysis because their error rates exceeded 15%. The latency and error data are presented in Table 2.

An ANOVA by subjects and items was performed on naming latencies and errors. In the latency data, regular words were named more quickly than were irregular words [$F_1(1,130) = 99.96, p < .01$; $F_2(1,28) = 7.60, p < .01$], and high-imageable words were named in less time than were low-imageable words [$F_1(1,130) = 21.52, p < .01$], though this effect was not significant by items [$F_2(1,28) = 1.9$]. Related words were named faster than were unrelated words [$F_1(1,130) = 60.75, p < .01$; $F_2(1,28) = 19.93, p < .01$]. The interaction between regularity and relatedness was significant by subjects

Table 2
Naming Latencies (RTs, in Milliseconds), Standard Deviations (SDs), and Mean Proportion of Errors in Experiment 2 (Collapsed Across SOA)

Word Type	Related			Unrelated			Facilitation
	RT	SD	Error	RT	SD	Error	
Regular							
High Imageable	506	55.0	.01	513	60.2	.01	7
Low Imageable	506	57.6	.01	518	63.1	.01	12
Irregular							
High Imageable	513	60.8	.06	530	70.9	.10	17
Low Imageable	523	63.5	.09	547	73.4	.15	24

$[F_1(1,130) = 7.59, p < .01]$, though only marginally significant by items $[F_2(1,28) = 2.96, p < .10]$. Simple effects show that there were significant priming effects both for irregular words $[t_1(131) = 6.46, p < .01; t_2(15) = 3.56, p < .01]$ and for regular words $[t_1(131) = 4.25, p < .01; t_2(15) = 2.79, p < .02]$. In other words, the common priming effect was present for all stimuli but was substantially larger for irregular words (20.5 msec) than for regular words (9.5 msec).

The regularity and imageability interaction was significant by subjects $[F_1(1,130) = 12.55, p < .01]$, but not by items $[F_2(1,28) = 1.29]$. Simple effects show that among irregular words, high-imageable stimuli were named in less time than were low-imageable stimuli $[t_1(131) = 5.15, p < .01]$, whereas the imageability effect for regular words was not significant $[t_1(131) = 1.17]$. Also, a marginal two-way interaction was observed between relatedness and imageability $[F_1(1,130) = 3.42, p < .10]$, but the effect was not significant by items $[F_2(1,28) = 1.6]$. There was a tendency for the subjects to respond in less time in the 533-msec SOA condition than in the 233-msec SOA condition (513 vs. 525 msec), but SOA was not significant $[F_1(1,130) = 2.39, p > .12; F_2(1,28) = 104.37, p < .01]$, and SOA did not interact with any variables. Accordingly, the data in Table 2 are collapsed across SOA.

In the error analysis, there were main effects of regularity $[F_1(1,130) = 180.66, p < .01; F_2(1,28) = 9.16, p < .01]$, imageability $[F_1(1,130) = 5.55, p < .01]$; but the effect was not significant by items, $F_2 < 1$, and relatedness $[F_1(1,130) = 29.95, p < .01; F_2(1,28) = 5.71, p < .03]$. An interaction between regularity and relatedness was observed $[F_1(1,130) = 30.01, p < .01; F_2(1,28) = 4.73, p < .04]$. Simple effects show that, for irregular words, more errors were made on unrelated words than on related words $[t_1(1,131) = 5.84, p < .01; t_2(1,15) = 2.41, p < .03]$, whereas there was no difference between related and unrelated regular words (both t 's < 1). As in Experiment 1, this interaction is traceable partly to a ceiling effect for regular words. The interaction between regularity and imageability was also significant $[F_1(1,130) = 4.53, p < .01]$, but the effect was not significant by items ($F_2 < 1$). Simple effects show that more errors were made for low-imageable irregular words than for high-imageable irregular words $[t_1(131) = 2.42, p < .01]$. Finally, the interaction between imageability and SOA was significant by subjects $[F_1(1,130) = 6.37, p < .01]$, but not by items ($F_2 < 1$). Simple effects show that more errors were created for low-imageable words than for high-imageable words at the 233-msec SOA $[t_1(65) = 3.43, p < .01]$, whereas there was no difference at the 533-msec SOA ($t < 1$). No other effects were significant. As in Experiment 1, most of the errors committed on irregular words were regularization errors.

The predicted interaction of regularity and relatedness, which we did not find in Experiment 1, was obtained in Experiment 2. We attribute the difference be-

tween the two results to a more careful selection of stimuli (using plosive-initial targets) in Experiment 2. Regularity also interacted with imageability in Experiment 2, consistent with the results reported by Strain et al. (1995). The weaker results of the item analysis we attribute to the low number of words in each condition (eight), brought about by the restrictions on the stimuli, in terms of frequency, familiarity, bigram frequency, neighborhood size, association strength, length, and initial phoneme.

GENERAL DISCUSSION

The results of Experiment 2 show that a related prime speeds the naming of both regular and irregular targets. This result is hardly surprising, given the rich literature on associative priming effects. However, the interaction of relatedness and regularity shows that this priming effect was significantly greater for irregular words than for regular words. This pattern confirms the prediction of Strain et al. (1995) that information active at the semantic level will have greater effects when the generation of a phonological code is slow. It is not clear at this point whether this result reflects a specific relationship between semantic and phonological information or whether it is an example of a more general (and well-established) pattern in which slowed processing (see, e.g., via stimulus degradation) results in larger associative priming effects (e.g., Becker & Killion, 1977; Simpson, Lorschach, & Whitehouse, 1983; Stanovich & West, 1979). Both positions are consistent with the idea of fully interactive lexical processes, in which the activity of each processor (orthographic, phonological, and semantic) is affected by the activity of the others. It is difficult to speculate on the nature of a more specific effect of meaning on phonological processes, since the semantic component remains unimplemented in the Seidenberg and McClelland (1989) model, and relations between phonology and semantics are usually discussed only in very general terms (e.g., Seidenberg & Harm, 1995). At present, it seems most parsimonious to consider the results here in terms of a more general interactivity among all components of the word recognition system.

The results of Experiment 2 also indicate that phonological generation may be facilitated by prior presentation of an associated word, or by semantic (imageability) information present in the target itself. We are not able to determine at this point whether these sources of semantic input are independent of each other. Although there was a slight tendency for the relatedness effect to be larger for low-imageable words, this interaction was only marginally significant in the subjects' analysis. Perhaps independent effects of these two semantic factors should not be surprising, considering that a prime may allow partial activation of the target before that word itself is presented, whereas imageability can only begin to affect activation after partial target processing.

It should be noted that, although the discussion has thus far been couched in terms of the Seidenberg and McClelland model, dual-route approaches (e.g., Coltheart et al., 1993) can also account for the interaction of semantic and phonological information. Within the dual-route scheme, a lexical procedure generates the phonological code by addressing a word's entry in lexical memory, whereas the phonological procedure constructs the pronunciation from sublexical units (e.g., by grapheme-phoneme conversion). The speed of the lexical path is presumed to be faster and to depend partly on word frequency. Higher frequency words are found in the lexicon faster than are low-frequency words. Regularity effects occur because of competition between the two routes for irregular words. For example, the word *pint* generates the correct pronunciation by the lexical route but an incorrect pronunciation by the phonological path (i.e., one rhyming with *mint*), because the rule for *i* in this context yields the phoneme /ɪ/. The conflict in the output of the two routines therefore slows the naming response for this and other low-frequency irregular words. Responses for regular words are faster because both routes arrive at the same pronunciation. The regularity effect is not seen for high-frequency words because, here, the lexical route

yields the correct pronunciation early enough to avoid competition with the output of the phonological path.

Similarly, because semantic information also is defined at the word level (as opposed to a sublexical level), it should also have its effects by speeding access through the lexical route. In the case of the priming paradigm, the presentation of associated information facilitates the search for the target in the lexicon. Likewise, since high-imageable words are proposed to have richer semantic representations, they could be hypothesized to be more easily processed by the lexical path than are low-imageable words. This benefit of meaning-related information should be greater among irregular words, because these words lead to conflicting output from the two routes. Consequently, the interactions between semantic and phonological variables can be accommodated by such a model.

Finally, it is also interesting to note that the results reported here within a language are also reminiscent of the results of several cross-language studies concerned with "orthographic depth," the degree to which phonological information is available from print. In those studies (e.g., Frost, Katz, & Bentin, 1987; Tabossi & Laghi, 1992), priming effects are much smaller in shallower orthographies (i.e., those with few irregularities) than in deeper ones. This result is usually discussed in terms of the dual-route model. Because processing via the lexical route is said to dominate in a deep orthography, priming effects will be relatively large. In a shallower orthography, however, phonological processing dominates, and priming effects are diminished. The orthographic depth results can also be discussed within the connectionist framework (Seidenberg, 1992), in much the same terms as used to account for the present findings. In both cases, where phonological processing is slow (either for the language generally or for specific words within the language), associative priming effects are larger.

The conclusion from the present research, then, is that the availability of semantic information can affect the generation of a word's phonological code, particularly when the development of such a code is slow because of phonological irregularity. Even when this semantic information is available well in advance of the target's presentation, the benefit is especially great for irregular words, confirming the fundamentally interactive nature of lexical access processes.

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NOTES

1. One exception to this convention was made for the irregular word *aunt*. The irregularity of the word *aunt* occurs for the grapheme *au*, which corresponds to the initial phoneme of the word. In this instance, if subjects initiate the pronunciation before phonological information about the *au* grapheme is complete, the result would be a regularization error. These responses would not be included in the reaction time analysis because the analysis is conducted on correct responses only. The correct response for the word *aunt* cannot be made until phonological information about the grapheme *au* is completed. Therefore, although this word does not begin with a plosive phoneme, it was determined acceptable for avoiding the problem of beginning the pronunciation before the phonological code is complete.

2. Imageability ratings for three of the regular words came from the Toglia and Battig (1978) norms (the instructions used for the ratings that we conducted were practically identical to the instructions used by Toglia & Battig). These words were used to replace items that did not fit within one or more of the stimulus constraints of the experiment.

APPENDIX A
Related Word Pairs Used in Experiment 1
and Their Strength of Association

Regular (Prime-Target)		Irregular (Prime-Target)	
Pair	Strength	Pair	Strength
paste-glue	.630	shrub-bush	.503
cavity-tooth	.543	boat-yacht	.031
plead-beg	.493	monastery-monk	.462
pour-spill	.150	lodge-ski	.090
balance-beam	.171	push-shove	.418
reach-grab	.255	bomb-threat	.078
manager-boss	.284	sneeze-cough	.348
worship-pray	.076	relative-aunt	.169
pattern-maze	.023	brush-comb	.163
roost-perch	.064	meat-steak	.181
club-golf	.041	spirit-soul	.112
roof-tile	.024	slug-worm	.117
arithmetic-math	.757	stitch-sew	.521
dawn-dusk	.448	bedroom-suite	.014
fork-spoon	.441	bread-dough	.058
coral-reef	.337	strange-weird	.426
edge-cliff	.182	chest-breast	.070
block-brick	.100	foot-shoe	.337
hitch-hike	.342	saber-sword	.330
disguise-mask	.230	quart-pint	.152
bang-boom	.159	plum-pear	.087
razor-shave	.172	chicken-soup	.090
worry-scorn	.014	mummy-tomb	.084
cook-bake	.079	mute-deaf	.435

APPENDIX B
Related Word Pairs Used in Experiment 2
and Their Strength of Association

Low Imageable		High Imageable	
Pair	Strength	Pair	Strength
Regular			
hint-clue	.344	casket-coffin	.100
dawn-dusk	.448	oyster-clam	.359
fad-trend	.129	knife-blade	.122
English-grammar	.029	floor-tile	.170
tradition-custom	.041	branch-twigg	.094
blackmail-bribe	.166	pail-bucket	.500
plead-beg	.493	bishop-pope	.144
selfish-greed	.184	dig-ditch	.113
Irregular			
anarchy-chaos	.137	mitten-glove	.594
quart-pint	.152	rock-boulder	.038
mute-deaf	.435	relative-aunt	.169
guide-tour	.206	stripe-plaid	.050
sneeze-cough	.348	brush-comb	.163
dig-bury	.072	plum-pear	.087
disgusting-gross	.193	shrub-bush	.503
owe-debt	.162	muffin-biscuit	.072

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