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Strategic Effects in Word Naming: Examining the Route-Emphasis Versus Time-Criterion Accounts

Dan Chateau and Stephen J. Lupker
University of Western Ontario

K. Rastle and M. Coltheart (1999) demonstrated that both nonwords and low-frequency regular words are named more slowly when mixed with first-phoneme irregular word fillers (e.g., *CHEF*) than when mixed with third-phoneme irregular word fillers (e.g., *GLOW*). Those authors suggested that their effects were due to a strategic de-emphasis of the nonlexical route when first-phoneme irregular fillers were used. An alternative explanation is that these results simply reflect a more lax position of a time criterion (S. J. Lupker, P. Brown, & L. Colombo, 1997) in the first-phoneme irregular filler condition. We contrasted these 2 accounts in 4 experiments. In all experiments, target naming latencies were longer when the fillers were harder to name, regardless of whether the fillers were nonwords or exception words. These results strongly favor a time-criterion account of K. Rastle and M. Coltheart's effects.

One issue in word-recognition research that has garnered considerable attention in recent years is the issue of strategy effects in naming. Naming was once thought to be a task that operated in a fairly autonomous fashion, and, hence, any given word's latency reflected only the ease or difficulty of processing that particular word. However, early in the 1990s, a number of studies appeared in the literature indicating that the speed with which one named a word was affected by the nature of the other stimuli in the trial block. For example, Simpson and Kang (1994) demonstrated that adding regular word or nonword fillers to the trial block reduced the size of the word frequency effect when naming Korean words. Similarly, Tabossi and Laghi (1992) showed that putting nonword fillers into the trial block eliminated semantic/associative priming effects when naming Italian words. Baluch and Besner (1991) demonstrated that both frequency and semantic/associative priming effects were reduced for "transparent" Persian words when nonword fillers were added.

In most cases, the explanation offered by these investigators was framed in terms of Coltheart and colleagues' (e.g., Coltheart, Curtis, Atkins, & Haller, 1993) dual-route model. The most recent version of this model, the dual-route cascaded (DRC) model (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001), posits two distinct mechanisms for naming words: the lexical route and the grapheme–phoneme conversion (GPC), or nonlexical, route. Both of these routes have a common input, which is a set of letter units, and a common output, which is a set of phoneme units. In the lexical route, the letter units activate word level units in the same manner as in the interactive-activation model (McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1982). This route, in essence, looks up whole words' pronunciations directly in a mental dictionary. The nonlexical route, in contrast, uses a list of GPC rules to transform the graphemes of a word into its constituent phonemes, proceeding from left to right, considering, essentially, one letter at a time. The lexical route is frequency sensitive, and it is necessary for accurately naming exception words (e.g., *HAVE* or *PINT*) because the nonlexical route would produce the incorrect regularized pronunciation for these words. In contrast, the nonlexical route is necessary for naming nonwords or novel words that are not present in the reader's mental lexicon. In word naming, these two procedures both activate the phonemic system, with the lexical route generally being faster than the nonlexical route. Any disagreement between the two routes leads to slower naming times.

The explanation for strategy effects in naming produced by the researchers working in the early 1990s was that these effects were due to their participants changing the relative emphasis given to the two routes (referred to here as the *route-emphasis account*). Specifically, when nonwords were inserted in the trial block, the suggestion was that the emphasis given to the nonlexical route would increase, and, hence, overall naming performance would show a lesser influence of the lexical route. Specifically, semantic/associative priming effects and frequency effects, presumed markers of processing on the lexical route, would diminish or disappear, as was observed. In addition, stimuli that make use of the nonlexical route (e.g., low-frequency regular words and nonwords) should now be named more rapidly. (The assumption that it is the nonlexical route, rather than the lexical route, that is strategically altered—i.e., either emphasized or de-emphasized—is based on the notion that the lexical route is highly automatized and hence less susceptible to strategic influences—e.g., Paap & Noel, 1991. For the present discussion, we maintain this assumption.)

Dan Chateau and Stephen J. Lupker, Department of Psychology, University of Western Ontario, London, Ontario, Canada.

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Correspondence concerning this article should be addressed to Stephen J. Lupker, Department of Psychology, University of Western Ontario, London, Ontario N6A 5C2, Canada. E-mail: lupker@uwo.ca

More recently, Lupker and colleagues (Kinoshita & Lupker, in press-a, in press-b; Lupker, Brown, & Colombo, 1997; Taylor & Lupker, 2001) have proposed a rather different explanation of the nature of strategy effects in naming. According to this notion, what is being strategically adjusted is the point in time at which participants attempt to begin articulation, not the way in which letter strings are processed. This proposal has been termed the *time-criterion account*.

The basic idea is simply that participants set a time criterion for when they should respond on a trial. The position at which participants set this criterion is based on their prior latencies in the trial block. Participants then attempt to respond at approximately the point in time at which the criterion is set. If participants were always able to respond at precisely that point in time, of course, all the stimuli in the trial block would have essentially the same latency. Thus, there would be no mean differences between stimulus types (e.g., regular and exception words). The existence of these differences suggests that there are times when the stimulus is too difficult for the participant to be able to respond when the time criterion is reached. There are probably also times when participants are ready to respond well before the time criterion has been reached (i.e., when the stimulus is easy). On those trials, participants may not always hold their response until the time criterion is reached. However, the general trend is for all stimuli to be named faster when the other stimuli in the trial block are easy to name and to be named more slowly when the other stimuli in the block are difficult to name.

As is discussed in greater detail in the General Discussion section, this account provides a reasonable explanation of many of the results supporting the route-emphasis account. Thus, more recently, researchers have looked elsewhere for evidence that readers could shift route emphasis within a dual-route framework. One such example was reported recently by Rastle and Coltheart (1999).

Five years prior, Coltheart and Rastle (1994) had tried to demonstrate that they could strategically alter readers' route emphasis using exception words versus nonwords as fillers. As noted, exception words can only be named accurately via the lexical route, whereas nonwords can only be named accurately via the nonlexical route. Coltheart and Rastle made the standard assumption that when the fillers were nonwords, participants would be induced to put relatively more emphasis on the nonlexical route than when the fillers were exception words. As a result, the naming latencies for the target stimuli, which were low-frequency regular and exception words, would change in a predictable way. Specifically, the regularity effect (i.e., the difference between the low-frequency regular and exception words) would be larger in the nonword filler condition than in the exception word filler condition. As it turned out, however, the regularity effect was identical in the two filler conditions.

Rastle and Coltheart (1999) proposed that the reason that Coltheart and Rastle (1994) didn't observe their expected effect was that their exception words weren't potent enough because of the fact that the position of the irregularity in those words tended to be later in the word. Most exception words in English are exception words because they have a single grapheme that violates GPC rules. In some words, the violation is in the first phoneme position (e.g., *CHEF*), whereas in other words, the violation is later, for example, in the third phoneme position (e.g., *GLOW*). The argument was that because the nonlexical route works in a serial fashion, third position irregular words such as *GLOW* really do not cause naming difficulties. That is, by the time the nonlexical route would have produced the inappropriate regularized pronunciation for the third phoneme, the lexical route would have already produced the correct pronunciation for the word. Thus, using a large number of these types of words as exception word fillers, as was done by Coltheart and Rastle (1994), would not have provided much of an incentive to de-emphasize the nonlexical route.

Rastle and Coltheart (1999) tested this hypothesis by examining naming latencies for low-frequency regular words and nonwords, both of which make use of the nonlexical route, while manipulating the nature of the filler words included in the experiment. One set of fillers consisted of exception words such as *CHEF* that were irregular in their first phoneme. These fillers should induce subjects to put as little emphasis as possible on the nonlexical route in order to avoid the interference produced when that route generates the regular but inappropriate phoneme for the /CH/ grapheme. The other set of fillers consisted of exception words like *GLOW* that were irregular in their third phoneme. Because the position of the irregularity was later in these words, the nonlexical route should have little impact on their naming because it operates in a serial fashion. Thus, the nonlexical route should not be de-emphasized in the *GLOW*-type filler condition.

Rastle and Coltheart's (1999) expectation was that because of the relatively greater emphasis on the nonlexical route when *GLOW*-type fillers were used, both nonword and low-frequency regular word targets, stimuli that make use of the nonlexical route, should be named faster than when *CHEF*-type fillers were used. The results in their Experiment 2 were consistent with this prediction.

Rastle and Coltheart (1999) interpreted these results as support for the claim that one can shift route emphasis in a dual-route model sense. Once again, however, these results are also consistent with the time-criterion account. That is, *CHEF*-type exception words are inevitably harder to name than *GLOW*-type exception words. In fact, Rastle and Coltheart demonstrated that this was the case in their Experiment 1. The implication is that the filler latencies would have been much longer in the *CHEF* condition than in the *GLOW* condition. As a result, the time criterion would have been placed at a more lax position in the *CHEF* condition than in the *GLOW* condition, meaning that target latencies also would have been longer in the *CHEF* condition than in the *GLOW* condition, as was observed.

Experiment 1

The main purpose of the present research was to test between these two possible accounts of Rastle and Coltheart's (1999) data. The purpose of Experiment 1 was to determine whether Rastle and Coltheart's results would replicate with a different group of participants. We also wanted to verify that filler latencies indeed were shorter for the *GLOW*-type fillers than for the *CHEF*-type fillers as Rastle and Coltheart didn't report their filler latencies in their Experiment 2. Thus, the first experiment was as close a replication as we could produce of Rastle and Coltheart's experiment.

Method

Participants. Twenty-four undergraduate students at the University of Western Ontario participated in this experiment. Participants volunteered for the study as one method of earning credit in an introductory psychology class. All participants were native English speakers and had normal or corrected-to-normal vision.

Apparatus. Stimuli were presented on a TTX Multiscan Monitor. Presentation was controlled by an IBM-clone Trillium Computer Resources PC. A microphone attached to an electronic voice key relay was triggered by vocal responses allowing response latencies to be recorded.

Materials. The stimuli used in this experiment were the same as those used by Rastle and Coltheart (1999, Appendix E), with some minor exceptions. A total of 200 letter strings were presented to the participants. The target stimuli consisted of 50 regular words and 50 nonwords. The filler stimuli consisted of 50 first-phoneme irregular words (i.e., *CHEF*-type words) and 50 third-phoneme irregular words (i.e., *GLOW*-type words). Three of the first-phoneme irregular word fillers were changed for this experiment. The words *GAOL*, *GAOLS*, and *GAOLED* were replaced with *EARTH*, *WHOLE*, and *CZAR* because the Canadian spelling of the original words is *JAIL*, *JAILS*, and *JAILED*. Each group of 50 items was divided in half. For the target stimuli, half of each type (regular words and nonwords) was paired with first-phoneme irregular fillers and the other half was paired with third-phoneme irregular fillers, creating four blocks of 50 stimuli each: regular words with first-phoneme irregular word fillers, regular words with third-phoneme irregular word fillers, nonwords with first-phoneme irregular word fillers, and nonwords with third-phoneme irregular word fillers. Two lists of words were created by reversing the pairing of target stimuli with fillers. That is, the 25 regular words and the 25 nonwords that were paired with first-phoneme irregular word fillers in one list were paired with third-phoneme irregular word fillers in the other list and vice versa.

Procedure. Every participant was shown only one list, and the order of presentation of the four 50-item blocks was counterbalanced (in a Latin square fashion) so that each block was presented equally often at the start of the experiment. Within each block, the stimuli were presented in a different random order for each participant. Participants were first presented with instructions indicating that one letter string at a time would appear on the monitor and that they were to name each item as quickly and accurately as possible. The participants were then presented with 12 practice trials. The 200 experimental stimuli followed the practice trials after a short pause. For every trial, the stimulus remained on the screen until the participant voiced a response, and a 3-s intertrial interval followed.

Results

Incorrect pronunciations were recorded by hand, and latencies for those trials were eliminated from the analysis of naming latencies. Stutters and incomplete pronunciations were also considered errors. In addition, naming latencies greater than 1,500 ms or shorter than 250 ms were considered outliers and were also eliminated from the data set but were not considered errors if the item was correctly named. In total, approximately 1.3% of the naming latencies were eliminated using these cutoffs. Analyses of variance (ANOVAs) were conducted on the naming latency data and the error rate data for the target words and nonwords, separately considering subjects as a random factor (F_1) and considering items as a random factor (F_2). In the subjects analyses, List (1, 2) was analyzed as a between-subjects factor, and Filler Type (first-phoneme irregular, third-phoneme irregular) and Target Type (regular word, nonword) were analyzed as within-subjects factors. In the items analyses, List (1, 2) and Target Type (regular word, nonword) were analyzed as between-items factors, and Filler Type (first-phoneme irregular, third-phoneme irregular) was analyzed as a within-items factor. Similar ANOVAs were also conducted on the filler data. In the subjects analyses, the nestings were the same as for the analyses of the target data. For the items analyses, however, Target Type was the only within-items factor, whereas List and Filler Type were between-items factors. List was included as a factor in all these analyses in order to remove variance associated with the different pairings of target and filler stimuli. Because it is not of theoretical interest and there were few significant effects involving the List factor in any of the experiments, it is not discussed further. The mean naming latencies and error rates from the subjects analysis for each condition for the targets and fillers are presented in Table 1.[1]

Target data. In the analysis of target naming latencies, the main effect of Target Type was significant, with nonwords having longer naming latencies than words, $F_1(1, 22) = 36.96$, $p < .001$, $MSE = 16{,}778.46$; $F_2(1, 96) = 232.80$, $p < .001$, $MSE = 5{,}220.13$. The main effect of Filler Type was also significant, $F_1(1, 22) = 10.86$, $p < .01$, $MSE = 485.79$; $F_2(1, 96) = 8.43$, $p < .01$, $MSE = 2{,}857.66$. Target items paired with first-phoneme irregular word fillers were named more slowly (727 ms) than target items paired with third-phoneme irregular word fillers (712 ms). The interaction between Target Type and Filler Type was not significant: $F_1 < 1$; $F_2(1, 96) = 2.40$, *ns*, $MSE = 2{,}857.66$. In the analyses of error rates, neither of the main effects nor the interaction were significant (all Fs < 1.25).

Filler data. The analysis of filler latencies indicated that, as expected, there was a main effect of Filler Type, $F_1(1, 22) = 36.25$, $p < .001$, $MSE = 1{,}537.41$; $F_2(1, 96) = 13.11$, $p < .001$, $MSE = 9{,}639.57$, with first-phoneme irregular word fillers being named more slowly than third-phoneme irregular word fillers. This analysis also revealed a marginally significant 20-ms effect of Target Type, $F_1(1, 22) = 3.05$, $p = .09$, $MSE = 4{,}324.84$; $F_2(1, 96) = 3.56$, $p = .06$, $MSE = 9{,}255.53$. Both filler types were named faster when mixed with low-frequency regular word targets than when mixed with nonword targets. The interaction between Target Type and Filler Type was not significant ($F < 1.0$). No significant effects were found in the analysis of error rates.

Discussion

The results of this experiment provide a clear replication of Rastle and Coltheart's (1999) results. Although these results can be explained in terms of the route-emphasis account, they are also consistent with the time-criterion account. That is, it is quite

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[1] Although Clark (1973) has argued that items as well as subjects should be considered as a random factor in these types of analyses, the selection of items is seldom random in any sense of the term. That is, typically, the items used in these types of experiments have been selected because they satisfied a specific set of criteria. Such is also the case in the present experiments. As such, as Wike and Church (1976) and others (e.g., Cohen, 1976; Keppel, 1976; Smith, 1976) have argued, items analyses would clearly be inappropriate in the present situation for a number of reasons, not the least of which is their profound negative bias (see also Raaijmakers, Schrijnemakers, & Gremmen, 1999). Nonetheless, for the interested reader, the results of items analyses are reported. Conclusions, however, are based only on the results from the subjects analyses.

Table 1
Target and Filler Naming Latencies (and Error Percentages) in Experiment 1

	Target type	
Filler type	Nonwords	LF regular words
CHEF words	811 (7.1)	643 (5.3)
GLOW words	789 (5.4)	635 (3.8)
Filler-type effect	+22 (+1.7)	+8 (+1.5)

	Filler type	
Target type	*CHEF* words	*GLOW* words
Nonwords	747 (3.2)	699 (2.5)
LF regular words	727 (2.8)	678 (2.3)
Target-type effect	+20 (+0.4)	+21 (+0.2)

Note. The top part of the table presents target latencies, and the bottom part presents filler latencies. LF = low frequency.

possible that in both this experiment and in Rastle and Coltheart's experiment, words and nonwords were named faster in the presence of third-phoneme irregular word fillers than first-phoneme irregular word fillers because the third-phoneme irregular word fillers had shorter naming latencies than the first-phoneme irregular word fillers.

Also important for both accounts was the marginal effect of target type on filler latencies. According to the time-criterion account, filler latencies would be expected to vary as a function of the nature of the targets in the trial block. That is, both types of fillers should be named more rapidly when mixed with low-frequency regular words than when mixed with nonwords.

At a general level, the route-emphasis account would also be able to explain the effect of target type on filler latencies. That is, although both regular word targets and nonword targets would, in theory, benefit from an emphasis of the nonlexical route, nonwords would benefit more because they can only be named by this route. Thus, the motivation to emphasize the nonlexical route would have been higher in the blocks with nonword targets than in the blocks with regular word targets. The exception word fillers, which are, in general, harmed by an increased emphasis of the nonlexical route, should therefore be named more slowly when paired with nonword targets than when paired with regular word targets, as was observed.

Experiment 2

The data from Experiment 1 can be adequately explained by either the time-criterion account or the route-emphasis account. Experiment 2 was an attempt to distinguish between these two accounts. In this experiment, we varied one of the two aspects of the fillers that was varied in Experiment 1 (and in Rastle & Coltheart's, 1999, experiment)—their overall speed—while keeping the other—their qualitative nature—constant. To accomplish this, we used only nonword fillers. We were able to consult our database of nonword latencies and select two sets of 50 nonwords that, on the basis of those latencies, should produce a mean difference between sets of approximately 50 ms, the size of the difference between the two filler types in Experiment 1. These two sets of nonwords were used as the two filler types in Experiment 2.

According to the time-criterion account, because the two filler types differ in overall latency, the same pattern of effects should be seen as was observed in Experiment 1. The route-emphasis account, however, would not predict any difference in naming latencies for the target items as a function of the type of filler. Both sets of nonwords should lead to a heavy emphasis on the nonlexical route, independent of how fast they can be named. In addition, the two accounts make different predictions when considering the filler data. As in Experiment 1, the time-criterion account would predict that both filler types would be named more rapidly when mixed with the fast regular word targets than when mixed with the slow nonword targets. According to the route-emphasis account, however, because regular words can be named via the lexical route but nonwords cannot, if anything, the nonlexical route should receive greater emphasis in the block with nonword targets than in the block with regular word targets. Therefore, if there is a target type effect in the filler data, the effect would be that both types of nonword fillers would be named more rapidly when mixed with nonword targets than when mixed with word targets.

Method

Participants. Twenty-four undergraduate students at the University of Western Ontario participated in this experiment, none of whom had participated in Experiment 1. Participants volunteered for the study as one method of earning credit in an introductory psychology class. All participants were native English speakers and had normal or corrected-to-normal vision.

Apparatus and materials. The same apparatus that was used in Experiment 1 was used for this experiment. The target words and nonwords in this experiment were identical to those used in Experiment 1. The 50 fast nonword fillers and the 50 slow nonword fillers were taken from a database of nonword naming latencies developed by T. Taylor, P. Pexman, and S. Lupker (T. Taylor, personal communication, November 1999). The two sets of nonwords were approximately equal in terms of length—4.4 letters for the slow nonwords, 4.2 letters for the fast nonwords, $t(98) = 1.72$, *ns*—and Coltheart's N (Coltheart, Davelaar, Jonasson, & Besner, 1977)—5.4 for the slow nonwords, 6.4 for the fast nonwords, $t(98) = –1.06$, *ns*—although not in terms of mean bigram frequency—30,715 for the slow nonwords, 21,612 for the fast nonwords, $t(98) = 2.40$, $p < .05$. No attempt was made to match the sets of nonwords in terms of onset phonemes. The nonwords used in Experiment 2 are listed in Appendix A.

Procedure. The procedure for this experiment was identical to the procedure for Experiment 1.

Results

The data were analyzed in the same manner as in Experiment 1. The mean naming latencies and error rates from the subjects analysis for each condition for the targets and fillers are presented in Table 2.

Target data. In the analysis of naming latencies, the main effect of Target Type was significant, with nonwords having longer naming latencies than words, $F_1(1, 22) = 79.84$, $p < .001$, $MSE = 2{,}636.33$; $F_2(1, 96) = 129.08$, $p < .001$, $MSE = 3{,}362.70$. The main effect of Filler Type was also significant, $F_1(1, 22) = 5.69$, $p < .05$, $MSE = 2{,}440.60$; $F_2(1, 96) = 15.26$, $p < .001$, $MSE = 1{,}337.44$. Targets mixed with slow nonword fillers were named more slowly than targets mixed with fast nonword fillers.

Table 2
Target and Filler Naming Latencies (and Error Percentages) in Experiment 2

	Target type	
Filler type	Nonwords	LF regular words
Slow nonwords	699 (2.5)	614 (2.8)
Fast nonwords	683 (3.7)	582 (1.7)
Filler-type effect	+16 (−1.2)	+32 (+1.1)

	Filler type	
Target type	Slow nonwords	Fast nonwords
Nonwords	736 (2.8)	637 (4.3)
LF regular words	657 (3.3)	600 (3.8)
Target-type effect	+79 (−0.5)	+37 (+0.5)

Note. The top part of the table presents target latencies, and the bottom part presents filler latencies. LF = low frequency.

The interaction between Target Type and Filler Type was not significant, $F_1(1, 22) = 1.46$, *ns*, *MSE* = 1,028.72; $F_2(1, 96) = 2.14$, *ns*, *MSE* = 1,337.44. In the analyses of error rates, no effects were significant (all *F*s < 1.43).

Filler data. As expected, there was a main effect of Filler Type, $F_1(1, 22) = 34.29$, $p < .001$, *MSE* = 2,037.08; $F_2(1, 96) = 94.56$, $p < .001$, *MSE* = 2,907.76, with fast nonword fillers being named 78 ms faster than slow nonword fillers. This effect is slightly larger (about 29 ms larger) than the effect found for the fillers in Experiment 1, which suggests that our selection of nonwords was reasonably, although not perfectly, successful. The Target Type effect was also significant, $F_1(1, 22) = 22.62$, $p < .001$, *MSE* = 5,620.63; $F_2(1, 96) = 21.76$, $p < .001$, *MSE* = 2,228.71. The fillers were named more rapidly when mixed with regular word targets than when mixed with nonword targets. In addition, there was a significant interaction between Target Type and Filler Type, $F_1(1, 22) = 5.42$, $p < .05$, *MSE* = 1,724.52; $F_2(1, 96) = 7.63$, $p < .01$, *MSE* = 2,228.71. The effect of target type was greater for the slow nonwords (79 ms) than for the fast nonwords (37 ms). There were no significant effects in the error rate analyses (all *F*s < 1.32).

Discussion

The results of Experiment 2 are nicely consistent with the time-criterion account. Both targets and fillers were named more rapidly when mixed with stimuli that are easier to name than when mixed with stimuli that are harder to name. In contrast, these results are quite difficult to reconcile with the route-emphasis account. With respect to the target latencies, both types of fillers that were used were nonwords. Thus, the impact of the fillers should have been identical in all situations. Both filler types should have caused a considerable shift of emphasis to the nonlexical route. As a result, there should not have been an effect of filler type on target latencies.

These difficulties for the route-emphasis account become more pronounced when one considers the filler latencies. Here, both types of nonwords were named more rapidly when mixed with low-frequency regular words than when mixed with other nonwords. In general, the route-emphasis account should predict exactly the opposite. That is, because nonwords can only be named via the nonlexical route, whereas low-frequency regular words can be named by either route, the emphasis on the nonlexical route should have been greater when the filler nonwords were mixed with nonword targets than when they were mixed with word targets. Thus, the filler latencies should have been shorter when mixed with nonword targets than when mixed with word targets—the exact opposite of what was found.

If one were willing to make the assumption that low-frequency regular word targets create as much emphasis on the nonlexical route as the nonword targets, the route-emphasis account could be made to predict no effect of target type on filler latencies in Experiment 2. That is, with this assumption, the route-emphasis account could be made to predict no target type effects on the fillers as well as no filler type effects on the targets. Adopting a route-emphasis perspective, one could then argue that what the results of Experiment 2 really demonstrate is that the time-criterion can have a strong impact on naming latencies when route-emphasis is not altered. What those results would not demonstrate, however, is that route emphasis cannot be shifted when there truly is motivation to do so. Therefore, it’s quite possible that in our Experiment 1 and in Rastle and Coltheart’s (1999) experiment, both the time-criterion and route-emphasis shifting were at play. Experiment 3 provides some insight on this issue.

Experiment 3

In Experiment 3, the filler items were again changed so that the predictions of the route-emphasis account and the time-criterion account could be directly pitted against one another. One type of filler was exception words. Many of the first-phoneme irregular word fillers from Experiment 1 and some second-phoneme irregular word fillers from Rastle and Coltheart (1999) were used. These are the types of words that the DRC model has the most difficulty with because of the impact of the nonlexical route. The other type of filler was nonwords. The important point is that these nonwords were selected specifically with the expectation that they would have latencies that were considerably longer than those for the exception word fillers.

Because the exception word fillers should have shorter latencies than the nonword fillers, the time-criterion account would predict that both the regular word targets and nonword targets would be named faster in the presence of the exception word fillers than in the presence of the nonword fillers. If the route-emphasis account is correct, however, there should be a much greater emphasis on the nonlexical route in the nonword filler condition than in the exception word filler condition. Thus, at least the nonword targets (and presumably the low-frequency regular word targets as well) should be named faster when mixed with nonword fillers than when mixed with exception word fillers.

Method

Participants. Twenty-four undergraduate students at the University of Western Ontario participated in this experiment, none of whom had participated in Experiments 1 or 2. Participants volunteered for the study as one method of earning credit in an introductory psychology class. All participants were native English speakers and had normal or corrected-to-normal vision.

Apparatus and materials. The same apparatus that was used in Experiment 1 was used for this experiment. The target words and nonwords in this experiment were identical to those used in Experiment 1. Fifty first-phoneme irregular or second-phoneme irregular words formed one group of filler items, and 50 nonwords taken from T. Taylor et al.'s (T. Taylor, personal communication, November 1999) database of nonword naming latencies formed the second group of filler items. Although the point of selecting these nonwords was to create a set of difficult-to-name nonwords, all of the selected nonwords were orthographically legal. The relevant statistics for the nonword fillers are as follows: mean length = 4.7 letters, mean $N = 3.7$, and mean bigram frequency = 22,733. Both types of filler stimuli are listed in Appendix B.

Procedure. The procedure for this experiment was identical to the procedure for Experiment 1.

Results

The data for this experiment were analyzed in the same manner as in Experiment 1. The mean naming latencies and error rates from the subjects analysis for each condition for the targets and fillers are presented in Table 3.

Target data. In the analysis of naming latencies, the main effect of Target Type was significant, with nonwords having longer naming latencies than words, $F_1(1, 22) = 74.78$, $p < .001$, $MSE = 3{,}353.44$; $F_2(1, 96) = 142.96$, $p < .001$, $MSE = 3{,}120.78$. The main effect of Filler Type was also significant, $F_1(1, 22) = 9.61$, $p < .01$, $MSE = 1{,}016.04$; $F_2(1, 96) = 3.74$, $p = .056$, $MSE = 1{,}674.18$. Target items mixed with exception word fillers were named more rapidly than target items mixed with nonword fillers. There was no interaction between Target Type and Filler Type, $F_1 < 1$; $F_2(1, 96) = 1.43$, *ns*, $MSE = 1{,}674.18$.

In the analyses of error rates, only the effect of Target Type was significant, $F_1(1, 22) = 18.54$, $p < .001$, $MSE = 0.0327$; $F_2(1, 96) = 16.00$, $p < .001$, $MSE = 0.01066$. There were more errors on nonword targets than on regular word targets. Neither the effect of Filler Type nor the interaction were significant (both Fs < 1).

Filler data. There was a main effect of Filler Type on naming latencies of fillers, $F_1(1, 22) = 54.62$, $p < .001$, $MSE = 3{,}215.87$; $F_2(1, 96) = 89.66$, $p < .001$, $MSE = 3{,}139.23$. As expected, the exception word fillers were named considerably faster than the nonword fillers. Again, as predicted by the time-criterion account, there was a significant effect of Target Type on filler naming latencies, $F_1(1, 22) = 10.20$, $p < .001$, $MSE = 717.08$; $F_2(1, 96) = 11.64$, $p < .001$, $MSE = 1{,}528.83$. Filler items mixed with regular word targets were named more rapidly than filler items mixed with nonword targets. There was no interaction between Target Type and Filler Type (all Fs < 1).

Table 3
Target and Filler Naming Latencies (and Error Percentages) in Experiment 3

	Target type	
Filler type	Nonwords	LF regular words
Nonwords	690 (6.5)	590 (2.0)
Exception words	672 (7.2)	567 (2.5)
Filler-type effect	+18 (−0.7)	+23 (−0.5)

	Filler type	
Target type	Nonwords	Exception words
Nonwords	701 (7.5)	616 (4.8)
LF regular words	684 (8.9)	598 (5.5)
Target-type effect	+17 (−1.4)	+18 (−0.7)

Note. The top part of the table presents target latencies, and the bottom part presents filler latencies. LF = low frequency.

For filler error rates, only the effect of Filler Type was significant, $F_1(1, 22) = 12.70$, $p < .001$, $MSE = 0.01078$; $F_2(1, 96) = 12.49$, $p < .001$, $MSE = 0.02165$. There were more errors to nonword fillers than to exception word fillers. Neither the effect of Target Type nor the interaction were significant (all Fs < 1).

Discussion

Once again, the results of this experiment were consistent with the predictions of the time-criterion account. Both regular word and nonword targets were named more rapidly when mixed with more-rapidly-named exception word fillers than when mixed with the slower-to-name nonword fillers. Furthermore, both exception word and nonword fillers were named more rapidly when mixed with regular word targets than when mixed with nonword targets.

In contrast, there was no hint of support for the route-emphasis account. If this account were correct, both target types should have been named more rapidly when mixed with nonword fillers than when mixed with exception word fillers. The fact that exactly the opposite occurred is most damaging in the case of the nonword targets. According to the route-emphasis account, nonwords should never be named faster when mixed with exception words than when mixed with nonwords. The fact that they were appears to be almost impossible to reconcile with this account.

The only means by which the route-emphasis account could be saved would seem to be to argue that although a shifting of route emphasis can be accomplished, it is such a weak effect that it is simply overwhelmed by any effects of shifting the time criterion. Thus, one could never hope to observe effects of shifting route emphasis in a situation in which the time criterion would create the opposite effects. Experiment 4 examines this possibility.

Experiment 4

In Experiment 4, the filler items were changed so that the effects of the time criterion would be nonexistent, while at the same time, the route-emphasis account would make clear predictions. As in Experiment 3, both exception word fillers and nonword fillers were used. However, the nonword fillers were changed so that their average naming latency should be about equal to that of the exception word fillers. Thus, according to the time-criterion account, there should be no filler type effect on target latencies. There should, however, be a target type effect on filler latencies. As in all other experiments reported here, both types of fillers should be named more rapidly when mixed with regular word targets than when mixed with the relatively slower nonword targets.

The key issue here is the prediction made by the route-emphasis account with respect to target latencies. When the fillers are nonwords, there should be much more emphasis on the nonlexical route than when the fillers are exception words. If readers are able to shift route emphasis, naming latencies for both types of targets should be more rapid with nonword fillers than with exception word fillers.

Method

Participants. Twenty-four undergraduate students at the University of Western Ontario participated in this experiment, none of whom had participated in the previous experiments. Participants volunteered for the study as one method of earning credit in an introductory psychology class. All participants were native English speakers and had normal or corrected-to-normal vision.

Apparatus and materials. This experiment was run using an Apple PowerMac 6100/60, with a color Macintosh display monitor. Stimuli were presented in the exact same manner as in the previous experiments. A microphone was connected to a button box interfaced with the computer. The presentation of stimuli and timing of naming latencies were performed using PsyScope Version 1.01 (Cohen, MacWhinney, Flatt, & Provost, 1993). The target words and nonwords in this experiment were identical to the items used in Experiment 1. The same 50 first-phoneme irregular or second-phoneme irregular word fillers used in Experiment 3 formed one group of filler items. Fifty nonwords taken from T. Taylor et al.'s (T. Taylor, personal communication, November 1999) database of nonword naming latencies formed the second group of filler items. These nonwords were selected with the expectation that their average latency would be essentially the same as that of the exception word fillers. The relevant statistics for the nonword fillers are as follows: mean length = 4.2 letters, mean $N = 5.0$, and mean bigram frequency = 22,329. Both types of filler stimuli are listed in Appendix C.

Procedure. The procedure for this experiment was identical to the procedure for Experiment 1.

Results

The data for this experiment were analyzed in the same manner as in Experiment 1. The mean naming latencies and error rates from the subjects analysis for each condition for the targets and fillers are presented in Table 4.

Target data. In the analysis of target naming latencies, the main effect of Target Type was significant, with the nonword targets having longer naming latencies than the regular word targets, $F_1(1, 22) = 61.72$, $p < .001$, $MSE = 2{,}626.80$; $F_2(1, 96) = 103.76$, $p < .001$, $MSE = 4{,}490.28$. The main effect of Filler Type was not significant (both Fs < 1). The mean latency for target items paired with exception word fillers was 662 ms, and the mean latency for target items paired with nonword fillers was 664 ms. The interaction between Target Type and Filler Type was also not significant (both Fs < 1).

Table 4
Target and Filler Naming Latencies (and Error Percentages) in Experiment 4

Filler type	Target type: Nonwords	Target type: LF regular words
Nonwords	715 (9.8)	613 (3.7)
Exception words	710 (10.3)	614 (3.5)
Filler-type effect	+5 (−0.5)	−1 (+0.2)

Target type	Filler type: Nonwords	Filler type: Exception words
Nonwords	670 (6.7)	653 (4.3)
LF regular words	636 (6.8)	634 (6.8)
Target-type effect	+34 (−0.1)	+19 (−2.5)

Note. The top part of the table presents target latencies, and the bottom part presents filler latencies. LF = low frequency.

The analyses of error rates revealed an effect of Target Type, $F_1(1, 22) = 42.79$, $p < .001$, $MSE = 0.0024$; $F_2(1, 96) = 20.27$, $p < .001$, $MSE = 0.0107$. More errors were made to the nonword targets than to the word targets. Neither the effect of Filler Type nor the interaction were significant (all Fs < 1.03).

Filler data. In the analyses of the filler data, there was no main effect of Filler Type on naming latencies, $F_1(1, 22) = 1.58$, *ns*, $MSE = 1{,}390.92$; $F_2(1, 96) = 1.72$, *ns*, $MSE = 4{,}901.64$. The mean latency for the exception word fillers was 643 ms, and mean latency for the nonword fillers was 653 ms. There was, however, an effect of Target Type on filler naming latencies, $F_1(1, 22) = 7.48$, $p < .05$, $MSE = 2{,}262.86$; $F_2(1, 96) = 4.00$, $p < .05$, $MSE = 2{,}942.44$. Both filler types were named more rapidly when mixed with regular word targets than when mixed with nonword targets. The interaction between Target Type and Filler Type was not significant, $F_1(1, 22) = 1.67$, *ns*, $MSE = 731.47$; F_2 $(1, 96) = 1.20$, *ns*, $MSE = 2{,}942.44$. There were no significant effects in the error data.

Discussion

Once again, the results were nicely consistent with the predictions of the time-criterion account. As hoped, we were successful at selecting our two filler types to have essentially equivalent mean latencies. Thus, the time-criterion account would predict that there would be no effect of filler type on target latencies, as was observed. On the other hand, as in all other experiments, the low-frequency regular word targets were named more rapidly than the nonword targets. Thus, the time-criterion account would predict that both types of fillers would be named more rapidly when mixed with word targets than when mixed with nonword targets, as was also observed.

In contrast, the target results were again inconsistent with the route-emphasis account. The nonlexical route should have received much more emphasis when the fillers were nonwords than when they were exception words. In addition, because we selected our two filler types to have essentially equivalent latencies, the time criterion should not have differentially affected the two filler conditions. Thus, naming latencies for both target types should have been shorter with nonword fillers than with exception word fillers. The fact that they were not indicates that participants were not able to shift route emphasis in a way consistent with the route-emphasis account in response to our filler type manipulation. Thus, it seems unlikely to us that the results of the present Experiment 1 as well as the results of Rastle and Coltheart (1999) had anything to do with shifting route emphasis either.

General Discussion

In recent years, a number of investigators have proposed that readers have the ability to strategically alter the emphasis given to the nonlexical route when it is to their advantage to do so (e.g., Baluch & Besner, 1991; Monsell, Patterson, Graham, Hughes, &

Milroy, 1992; Simpson & Kang, 1994; Tabossi & Laghi, 1992; Zevin & Balota, 2000). Rastle and Coltheart (1999) have also made this claim on the basis of the fact that their participants were faster to name both low-frequency regular words and nonwords when those stimuli were mixed with third-phoneme irregular words than when they were mixed with first-phoneme irregular words. The purpose of the present investigation was to evaluate that claim.

The results of this investigation provided virtually no evidence that Rastle and Coltheart's (1999) effects were due to a shifting of route emphasis. Rather, their results were more likely due to the effects of changing the position of the time criterion. Specifically, in our Experiment 1, it was shown that the fillers that produced the shorter target latencies (i.e., the third-phoneme irregular fillers) also were named faster than the first-phoneme irregular fillers. Thus, those data could be explained by either the route-emphasis account or the time-criterion account. In Experiment 2, it was shown that two types of nonwords (with considerably different mean latencies) could produce the same effects as produced by the exception word fillers used in Experiment 1. Although this result is as predicted by the time-criterion account, it is not consistent with the route-emphasis account. In Experiment 3, it was shown that both low-frequency regular word targets and nonword targets were named faster when mixed with exception word fillers than when mixed with nonword fillers when the exception word fillers were named more rapidly than the nonword fillers. Again, this result is consistent with the time-criterion account; however, it is inconsistent with the route-emphasis account. Finally, Experiment 4 was designed to find some evidence supporting the route-emphasis account in a situation in which any effects of changing route emphasis would not be overwhelmed by effects of the time criterion. Experiment 4 produced no evidence of such effects, as both target types were named equally rapidly with exception word fillers versus nonword fillers. Thus, it seems unlikely that any of the effects observed here could possibly have been due to a shifting of route emphasis.

The Importance of Timing Operations in Reaction Time (RT) Tasks

Because the goal of the present research was to contrast the route-emphasis and time-criterion accounts using Rastle and Coltheart's (1999) experimental paradigm rather than to provide an elaboration of how participants use the time criterion, no such elaboration is presented here. However, two general points relating to the time-criterion account should be made. The first point is that the central claim of this account is that timing operations play a major role in RT tasks. With respect to simple RT tasks, the importance of timing operations has been appreciated for a long time (e.g., Kornblum, 1973; Ollman & Billington, 1972). Somewhat in contrast, the notion that timing operations are important in choice RT tasks has been less appreciated (although see Link, 1971; Link & Tindall, 1971; Rabbitt & Vyas, 1970). Lupker et al.'s (1997) time-criterion account is one example of the fact that there is now a growing appreciation of the importance of timing operations in choice, as well as simple, RT tasks (e.g., see also Grosjean, Rosenbaum, & Elsinger, 2001).

What should also be noted is that Grosjean et al. (2001) tested a version of the time-criterion proposal in their article. Their main interest was in the impact of a shift in the length of the response–stimulus interval on latencies in a two-choice RT task involving judgments of line position. Grosjean et al. derived a prediction based on both the time-criterion account and the additional assumption that what participants were trying to do in their task was to keep the interresponse interval constant (i.e., the time between successive button-press responses). That is, they adopted the assumption that timing begins at the point that the prior stimulus is responded to rather than when the current stimulus is presented. This version of the time-criterion account predicts that an unexpected change to a shorter intertrial interval should lead to a longer target latency and vice versa. The results were, in general, consistent with this prediction. However, the changes in latency did not fully make up for the changes in the response–stimulus interval, a fact that made Grosjean et al. prefer one of the other models they examined to their version of the time-criterion account.

In thinking about whether one should worry about resolving the possible discrepancy between Grosjean et al.'s (2001) results and the time-criterion account, two additional issues should be considered. First, even if one does assume, as Grosjean et al. did, that timing begins at the point that the response–stimulus interval begins, only a very strong version of the time-criterion account would predict that any changes in the length of the interval would be fully reflected in changes in target latency. Certainly, if the interval were to be dramatically increased, such that the size of the increase was larger than the mean target latency, no reasonable model would predict that participants would then generate a negative latency. Thus, it is possible that a more realistic version of the time-criterion account could explain even Grosjean et al.'s results.

Second, the version of the time-criterion account that is being offered in the present article is based on a different assumption, the assumption that participants begin timing at the point that the target stimulus is presented. Hence, this version of the time-criterion account would be completely unable to explain any of the response–stimulus interval effects that Grosjean et al. (2001) observed. Equally important, however, is that there is no reason to expect it to because its purpose was not to explain the nature of the processes that go on between trials. Thus, although it is quite likely that timing operations are at play during the response–stimulus interval, any inability of the present version of the time-criterion account to explain them would have little to say about the ability of that account to explain what it was intended to explain. In any case, regardless of whether Grosjean et al.'s preferred account or some version of the time-criterion account ultimately succeed or fail, the major point is that successful models of speeded choice responding need to pay more attention to timing issues.

Speed–Accuracy Trade-Off Issues

The second general point to make is that, as readers may have noted, although both target and filler latencies changed in the way predicted by the time-criterion account in all four experiments, these changes were never accompanied by significant changes in error rates. Most notably, when, for example, target latencies decreased because of using easier-to-name fillers, there were (at most) only small nonsignificant increases in target error rates, a result that is not uncharacteristic in these types of experiments. As Lupker et al. (1997) discussed, the implication is that the speed–accuracy trade-off function in the naming task has a long shallow asymptote, which allows participants considerable range to move their time criterion without suffering a cost in terms of errors.

Other experiments in which participants were required to name words considerably more rapidly than they wished to provide support for this conclusion. For example, Colombo and Tabossi (1992) demonstrated that, through a deadline procedure, they could induce participants to decrease their naming latencies by over 60 ms. If anything, error rates actually decreased in this speeded condition. Kello and Plaut (2000) reported similar results using their tempo-naming task. In this task, participants are required to give a naming response on tempo with a set of beeps. By varying the tempo created by the beeps, Kello and Plaut's participants were induced to produce naming responses over 100 ms prior to when they would under more normal circumstances. What Kello and Plaut observed was that they could decrease naming latencies by 50–100 ms (depending on the type of stimulus being named) without observing any noticeable changes in error rates. Thus, it isn't surprising that the somewhat smaller effects observed here (only one effect was larger than 37 ms) were not accompanied by changes in error rates.

This lack of evidence for a speed–accuracy trade-off in naming tasks does contrast with results in many other types of speeded-response tasks. For example, in Grosjean et al.'s (2001) two-choice button-press task, when latencies were induced to change as a function of changing the response–stimulus interval, clear evidence of speed–accuracy trade-offs emerged. The obvious implication is that participants operate at a different place on the speed–accuracy trade-off function in these tasks than they do in naming tasks. Interestingly, this difference may be due not only to participants using slightly different strategies in the two types of tasks but also to the fact that the shape of the speed–accuracy trade-off function is inevitably different in naming tasks than in most other speeded-response tasks. Using a picture-naming task and a sum-naming task, for example, Lupker, Kinoshita, Taylor, and Coltheart (2000) demonstrated the expected time-criterion type effects on latency but, once again, obtained no evidence of any speed–accuracy trade-offs. Thus, it appears that naming tasks, in general, have a speed–accuracy trade-off function that is characterized by a quick rise followed by a long asymptote.

In terms of processing, the implication is that when participants must generate a name for the presented stimulus, the appropriate phonological code is actually a reasonably clear winner very early in processing. Thus, the chances of actually producing the wrong response are quite small, even when a response is given substantially before the participant wishes to. As a result, response latencies become much more dependent on timing operations than on the quality of the emerging phonological representations. In contrast, when one must decide between two possible stimuli (or stimulus types) and respond with a clear button press (e.g., in Grosjean et al.'s, 2001, line position judgment task), the participant's task is a discrimination task. That is, all stimuli would provide at least some support for both responses, and the issue the participant has to deal with is which response is actually best supported by the presented stimulus. Hence, the build up to the point that an accurate discrimination could be made would be more drawn out. As such, participants may be more inclined to respond as soon as a winner emerges.

The Route-Emphasis Account

According to the DRC model, all nonwords, by definition, require the nonlexical route in order to be named accurately. Thus, a working assumption we have used throughout this research is that there was no distinction between nonword fillers in terms of the bias they would create toward using the nonlexical route. Still, according to the DRC model, some nonwords can benefit from activity on the lexical route, specifically, those nonwords that have a lot of lexical neighbors. Thus, one could, instead, assume that the motivation to emphasize the nonlexical route might be weaker when the nonwords have many neighbors than when they have few neighbors. A legitimate question, therefore, is whether making this assumption might allow the route-emphasis account to provide a better explanation of the present results.

The answer to this question is clearly no. To begin with, differences in neighborhood size for our nonword fillers were minimal (the average neighborhood sizes were 5.4 for the slow nonword fillers in Experiment 2, 6.4 for the fast nonword fillers in Experiment 2, 3.7 for the slow nonword fillers in Experiment 3, and 5.0 for the fast nonword fillers in Experiment 4). Equally important, these small differences are in the wrong direction. That is, in any relevant contrast between slow and fast nonword fillers, it is the slow nonword fillers that have the smaller neighborhood sizes, and, hence, it is the slow nonword fillers that could, potentially, cause more bias toward the nonlexical route. As such, our nonword targets should have benefited more from being mixed with slow nonwords than from being mixed with fast nonwords. As the results of Experiment 2 show, and as the contrast between Experiments 3 and 4 shows, exactly the opposite happens. That is, in Experiment 2, the nonword targets were named faster when mixed with fast nonword fillers than when mixed with slow nonword fillers. When contrasting Experiments 3 and 4, we find that the nonword targets were named as rapidly when mixed with fast nonword fillers as when mixed with the exception word fillers (Experiment 4), whereas when the nonword targets were mixed with slow nonword fillers, they were named more slowly than when mixed with those same exception word fillers (Experiment 3). Thus, it's clear that altering our working assumption in this fashion would not help the route-emphasis account explain the present results.

The complete lack of support for the route-emphasis account in the present experiments raises the larger question of whether readers actually do have control over the relative contributions of their two routes to pronunciation (assuming, of course, that there are two routes to pronunciation). As noted previously, there are now a number of reports in the literature indicating that when using fillers that are supposed to bias readers toward the nonlexical route, evidence of a relative increase in that route's activity can be found. Thus, it is perhaps useful to discuss these results in a bit more detail.

One type of result is that frequency effects for regular words (a supposed marker of processing on the lexical route) diminish (in some circumstances) when the fillers may provide a bias toward the nonlexical route (Baluch & Besner, 1991; Decker, Simpson, Yates, & Adamopolous, 1999; Kang & Simpson, 2001; Simpson & Kang, 1994). As noted by Kinoshita and Lupker (in press-a, in press-b), however, most of these effects are more easily interpreted in terms of a shift in the time criterion. Specifically, as Kinoshita and Lupker (in press-a) pointed out, frequency effects only diminish when the filler stimuli that create a bias toward the nonlexical route are easier to name than the filler stimuli that do not. Thus, for example, frequency effects for regular words decrease when regular word fillers are used (in contrast to when exception word fillers are used); however, frequency effects do not decrease when nonword fillers are used (in contrast to when exception word fillers are used). These results are inconsistent with a route-emphasis account because the motivation to alter route emphasis should be greater (and, hence, the reduction in the frequency effect should be more pronounced) when the fillers are nonwords rather than when they are regular words. In contrast, these results are consistent with a time-criterion account if one merely assumes that there is a psychological floor for the high-frequency words. That is, as the fillers get easier, there is a limit to how much faster naming latencies for high-frequency words get. As a result, the size of the frequency effect diminishes with easy-to-name fillers.

A second type of result is that semantic/associative priming effects (again, supposed markers of processing on the lexical route) diminish when nonwords are included among the targets. There are now two demonstrations of these types of effects in the literature (Baluch & Besner, 1991; Tabossi & Laghi, 1992). What is interesting is that both of these experiments involved languages other than English. Attempts to demonstrate parallel effects in English have been unsuccessful (Keefe & Neely, 1990; Tabossi & Laghi, 1992; West & Stanovich, 1982). Although there may be clear differences between languages (which could account for the different results), the most straightforward implication of these results would be that one cannot alter route emphasis in English by using nonword fillers. What also needs to be noted, however, is that there is a methodological issue that complicates the interpretation of both experiments. In both cases, when the nonwords were added, it doubled the number of targets in the experiment while at the same time reducing the proportion of related pairs from .50 to .25 (because nonwords are, by definition, not related to their primes). Thus, it's possible that both of these effects were relatedness proportion effects (see Neely, 1991) rather than effects due to the introduction of nonword targets in particular.

A third effect that is taken as a marker of lexical processing is the regularity effect. If the route-emphasis account is correct, regularity effects should be increased when there is a bias toward the nonlexical route. At present, however, there is no evidence that the regularity effect can be altered at all by a filler type manipulation (Coltheart & Rastle, 1994; Woollams & Kinoshita, 1997).

In contrast, Zevin and Balota (2000) used a somewhat different manipulation that did produce evidence suggesting that the regularity effect can be altered in a way that is broadly consistent with the route-emphasis account. In their experiments, the manipulation designed to alter route emphasis was a priming manipulation in which participants saw five primes prior to naming a target. Those primes were either five nonwords (to produce a shift toward the nonlexical route) or five exception words (to produce a shift away from the nonlexical route). Results indicated that the regularity effect increased following nonword primes, as would be predicted by a route-emphasis account.

Even Zevin and Balota's (2000) data, however, can provide only limited support for the route-emphasis account. To begin with, Zevin and Balota's effect was due to the fact that the latencies for the low-frequency regular words were faster following nonword primes than following exception word primes. In contrast, latencies for low-frequency exception words were completely unaffected by the nature of the primes (although regularization error rates did increase slightly—nearly one more error per participant—in the nonword prime condition). If readers really were shifting route emphasis, one would have expected that low-frequency exception words, words that are actually harmed by the nonlexical route, would have shown considerable benefit when the primes were changed from nonwords to exception words. They clearly did not. Second, Kinoshita and Lupker (in press-b) attempted to replicate Zevin and Balota's results using Zevin and Balota's priming methodology with a set of words that should be even more likely to show a modulation of the regularity effect. As in Coltheart and Rastle's (1994) and Woollams and Kinoshita's (1997) filler experiments, no such modulation was found.

Kinoshita and Lupker (in press-b) were also not able to show the small increase in regularization errors for the exception words following nonword primes that was reported by Zevin and Balota (2000). In fact, Zevin and Balota's experiment is actually the only experiment clearly showing such an effect. Monsell et al. (1992, Experiment 2) did report that in a nonword filler environment, there was an increase in the number of regularization errors; however, as pointed out by Lupker et al. (1997), there was not an increase in the proportion of regularization errors in Monsell et al.'s data. There was also not an increase in the proportion of regularization errors in Lupker et al.'s exact replication (with twice as many participants) of Monsell et al.'s experiment. Thus, at present, there is very little evidence that a nonword context does alter the naming of low-frequency exception words.[2]

Alternative Strategies

Taken together, then, there is little evidence that route emphasis can be shifted in the way proposed by the route-emphasis account. However, this does not mean that the only strategy available in a naming task is shifting the time criterion. For example, in Lupker et al. (1997, Experiment 1), there was a pattern that was not explicable in terms of either the movement of the time criterion or a shifting of route emphasis. Even though nonwords and exception words had similar latencies when presented by themselves in pure blocks, when they were mixed together, the nonword latencies increased and the low-frequency exception word latencies decreased. Lupker et al. explained this as being due to a "lexical checking" strategy. When participants know that all the responses will be words (the pure block of exception words), they may check to make certain that the generated phonological code has a repre-

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[2] There was also no evidence for a change in the proportion of regularization errors in the one instance in which this issue was evaluated in the present set of experiments. Specifically, when considering the exception word fillers in Experiment 3, the proportion of exception word errors that were regularization errors in the nonword target condition (18/29 = 62%) was actually smaller than the proportion of errors that were regularization errors in the regular word target condition (24/33 = 73%). In any case, however, this type of comparison, which is the only type the present set of experiments allow, doesn't provide a particularly strong test because a nonword context condition is being compared to a regular word context condition rather than to an exception word context condition as in Monsell et al.'s (1992) and Lupker et al.'s (1997) experiments.

sentation in the phonological output lexicon, a process that takes a small amount of time. When they know that all the responses will be nonwords, they would never invoke this lexical checking strategy. In a mixed block of words and nonwords, presumably, the strategy might be used some of the time. The result would be longer latencies for nonwords in mixed blocks but shorter latencies for low-frequency exception words in mixed blocks, just as observed. More recently, Kinoshita and Lupker (in press-b) have observed additional evidence for the use of this particular strategy and have suggested that it may explain one of Zevin and Balota's (2000) results as well.

It is important to note that this lexical checking strategy really is a third type of strategy as it is not a strategy involving an adjustment of route emphasis or a strategy involving an adjustment of a time criterion. Whether it will prove to be an adequate explanation of changes in latencies for nonword targets as a function of context is, of course, a question for future research. Interestingly, as Rastle and Coltheart (1999) noted, adjustments to the DRC model's parameters that may reflect what happens when route emphasis is shifted actually have a much larger effect on predicted latencies for nonwords than on predicted latencies for words. In fact, these adjustments actually produce very little change in predicted latencies for low-frequency regular words. Hence, the model actually doesn't do an adequate job of predicting the speedup for the low-frequency regular word targets in Rastle and Coltheart's Experiment 2, which was the focus of the present research. The essence of the problem is that in the current instantiation of the DRC, these words are named mainly via the lexical route. Thus, increasing the emphasis placed on the nonlexical route does not have a substantial impact on their processing. This may change, of course, in future versions of the DRC. However, for the present, the implication is that if evidence supporting the route-emphasis account can be found, it is more likely to be found when examining performance with nonword targets rather than when examining performance with word targets.

At present, then, the evidence supporting the route-emphasis account appears to be minimal. What needs to be made clear, however, is that even if readers are not able to adjust their route emphasis, this conclusion would not have any implications for the viability of the DRC model per se. Readers' ability to shift the emphasis of processing between the two routes is not a core component of the model and, hence, the assumption that they can do so can easily be discarded. In contrast, on the basis of the mounting evidence indicating the importance of timing operations in choice RT tasks, it would seem that the adequacy of the DRC model would be noticeably enhanced by incorporating a time-criterion mechanism. Given the theory neutrality of the time-criterion concept, it would seem to be a concept that could be incorporated into the DRC model without altering any of its major principles.

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Appendix A

Filler Stimuli Used in Experiment 2

Slow nonword fillers		Fast nonword fillers	
KECK	LOAK	MECK	MISP
FRUNK	HELT	WERT	LUND
PLAMP	NEEK	RISH	LOSP
FEAP	WUP	CATH	DOKE
SEFT	LOSH	CLACH	YAKE
HAIP	TUND	TIVE	WEMP
CHEAB	NILT	PASK	WUCK
FIPE	DAPE	SIM	MUNT
WOIF	PASH	DOAD	NAFT
CHED	WUFF	WELB	NURCH
SHET	WEM	SPAIL	GARK
LEAMP	YETCH	TEP	WIKE
PRUCH	CLUM	FAMP	WINT
CLAIL	GLIM	FRENT	WEP
NAICK	FREET	THARK	WUNG
VILTH	PAPE	EATH	LOAST
PEASH	CAG	GLEST	TICE
SOUCH	HEAB	NOST	GOSP
YOWND	RAK	FOAF	MABE
GICE	TEASP	NONK	TISP
GRULP	FREEP	FROPE	DARR
BRUVE	TEASH	GROUNT	RAME
THAYL	TRAIP	THRAG	MEAP
LIGE	THIPE	TROAR	NEEB
SHOFE	SOINT	PRORE	LOTE

Appendix B

Filler Stimuli Used in Experiment 3

Exception word fillers		Nonword fillers	
ACHE	ACHES	BRUVE	CAG
AISLE	AISLES	CHEAB	CHED
ALMS	AUNT	CLAIL	EATH
AUNTS	BIND	FEAP	FERSE
BULL	BUSH	FIPE	FOAF
BUTCH	CHEF	FREEP	FREET
CHORD	CHORDS	FROPE	FRUNK
CHROME	CHUTE	GICE	GROACH
COMBS	COUGH	GRULP	HAIP
EARL	EARLS	KECK	LEAMP
EARN	EARNED	LIGE	NAICK
EARNS	EARTH	PAPE	PEASH
EARTHS	GEAR	PHOAD	PLAMP
GEARED	GEARS	POURSE	PRUCH
GELDS	GIN	RAK	RENGTH
ISLE	NINTH	SEFT	SHET
ONES	OWNED	SHOFE	SKAL
OWNS	PEARL	SOUCH	SOUSH
PINT	ROUGE	SPAIL	TAIGE
ROUTES	SHOE	TEASH	TEASP
SOUP	THEE	THARK	THAYL
THINE	WHOLE	THIPE	THRAG
WHOLES	WHORE	TRAIP	TROAR
WHORES	WOLF	VILTH	WHIGE
WOMB	YACHT	WOIF	YOWND

Appendix C

Filler Stimuli Used in Experiment 4

Exception word fillers		Nonword fillers	
ACHE	ACHES	CATH	CLACH
AISLE	AISLES	DARR	DOKE
ALMS	AUNT	EATH	FOAF
AUNTS	BIND	FREEP	FREET
BULL	BUSH	FROPE	GARK
BUTCH	CHEF	GLEST	GOSP
CHORD	CHORDS	GRONT	HEAB
CHROME	CHUTE	LEMP	LOAST
COMBS	COUGH	LOSP	LOTE
EARL	EARLS	LUND	MABE
EARN	EARNED	MEAP	MECK
EARNS	EARTH	MISP	MUNT
EARTHS	GEAR	NAFT	NEEB
GEARED	GEARS	NONK	NOST
GELDS	GIN	NURCH	RAK
ISLE	NINTH	RAME	RISH
ONES	OWNED	SHET	SHOFE
OWNS	PEARL	SONT	SPAIL
PINT	ROUGE	TEASP	THARK
ROUTES	SHOE	TICE	TISP
SOUP	THEE	WEMP	WEP
THINE	WHOLE	WERT	WIKE
WHOLES	WHORE	WINT	WUCK
WHORES	WOLF	WUNG	WUP
WOMB	YACHT	YAKE	YETCH

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