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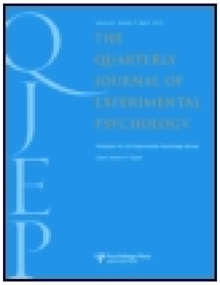

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The serial nature of the masked onset priming effect revisited

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The serial nature of the masked onset priming effect revisited

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Reading aloud is faster when target words/nonwords are preceded by masked prime words/nonwords that share their first sound with the target (e.g., *save*-SINK) compared to when primes and targets are unrelated to each other (e.g., *farm*-SINK). This empirical phenomenon is the masked onset priming effect (MOPE) and is known to be due to serial left-to-right processing of the prime by a sublexical reading mechanism. However, the literature in this domain lacks a critical experiment. It is possible that when primes are real words their orthographic/phonological representations are activated in parallel and holistically during prime presentation, so *any* phoneme overlap between primes and targets (and not just initial-phoneme overlap) could facilitate target reading aloud. This is the prediction made by the only computational models of reading aloud that are able to simulate the MOPE, namely the DRC1.2.1, CDP+, and CDP++ models. We tested this prediction in the present study and found that initial-phoneme overlap (*blip*-BEST), but not end-phoneme overlap (*flat*-BEST), facilitated target reading aloud compared to no phoneme overlap (*junk*-BEST). These results provide support for a reading mechanism that operates serially and from left to right, yet are inconsistent with all existing computational models of single-word reading aloud.

Keywords: Masked onset priming effect; Theories of reading aloud; Computational models of reading aloud

Our understanding of the mental processes underlying reading has increased remarkably in the last two decades thanks to the development of computational models that offer explicit and testable accounts of how people recognize printed words and read them aloud (e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Harm & Seidenberg, 2004; Perry, Ziegler, & Zorzi, 2007, 2010; Plaut, McClelland, Seidenberg, & Patterson, 1996). Perry et al. (2007, 2010) identified a number of state-of-the-art benchmark effects in the reading aloud domain that the next generation of computational models of reading should account for. The Masked Onset Priming Effect (MOPE) is one of them.

This empirical phenomenon, which has been replicated in several laboratories and in a number of languages (e.g., Dimitropoulou, Duñabeitia, & Carreiras, 2010; Forster & Davis, 1991; Kinoshita, 2000; Mousikou, Coltheart, Saunders, & Yen, 2010; Schiller, 2004), refers to the finding that reading aloud of a target letter-string (e.g., SINK) is faster when the target is preceded by a briefly-presented letter string (masked prime)

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that shares its first phoneme with the target (e.g., *save*), compared to when the prime is unrelated to the target (e.g., *farm*). The reason why the MOPE has attracted reading researchers' interest is because it is considered to provide evidence for serial processing in reading aloud, and therefore can be used as a tool to adjudicate between theories of reading which assume the existence of a sublexical reading mechanism that operates serially and from left to right across letter strings (e.g., Coltheart et al., 2001; Perry et al., 2007, 2010), and theories which postulate that such a mechanism does not exist and that the orthography to phonology translation occurs strictly in parallel (e.g., Harm & Seidenberg, 2004; Plaut et al., 1996).

In particular, the MOPE is thought to occur because in the limited time that the prime is presented skilled readers have time to process serially, in a left-to-right manner, only its first letter or sometimes the first two (see Mousikou, Coltheart, Finkbeiner, & Saunders, 2010), and translate it into its corresponding phoneme. Thus, when the target appears, readers will be faster in reading aloud the target if its first phoneme has been preactivated by the preceding onset-related prime, compared to when the preceding prime is onset-unrelated to the target (Forster & Davis, 1991; Mousikou, Coltheart, Saunders, & Yen, 2010). This account of the MOPE assumes that the effect is due to the serial processing of the prime by a sublexical reading mechanism. However, the mere finding that SINK preceded by *save* is read aloud faster than SINK preceded by *farm* does not rule out the possibility that prime processing may occur in parallel. In other words, parallel processing of the prime *save* would also be expected to yield faster reading aloud of the target SINK compared to *farm*-SINK, because *save* shares a phoneme with SINK but *farm* does not; the fact that the shared phoneme is the first might be irrelevant. So on what grounds is the MOPE attributed to serial left-to-right processing of the prime by a sublexical reading mechanism?

Some empirical evidence offers support for this claim. In their seminal study on the MOPE, Forster and Davis (1991) investigated whether it is just initial-phoneme overlap between primes and targets that causes the MOPE, or whether *any* phoneme overlap facilitates target reading aloud compared to no overlap. If the effect is limited to first phoneme overlap between primes and targets then it must be due to serial left-to-right processing of the prime. Accordingly, Forster and Davis observed a naming latency benefit in the onset-related condition (e.g., *best*-BONE), but not in the rhyme-related condition (e.g., *lone*-BONE) when these two conditions were compared to an unrelated condition (e.g., *cart*-BONE). However, final-phoneme overlap between the primes and the targets in the rhyme-related condition was not always position specific in this study (e.g., some of the pairs in the rhyme-related condition were *eye*-SKY, *flea*-KNEE, *oaks*-HOAX, *lie*-CRY, etc.), and so if position of phoneme overlap between prime and target matters then a potential rhyme-priming effect could have been obscured.

Another study that specifically investigated whether body overlap between primes and targets (e.g., *need*-WEED) facilitates target reading aloud compared to no overlap (e.g., *help*-WEED) was carried out by Montant and Ziegler (2001). In agreement with Forster and Davis (1991), no difference was observed between the two conditions; however, when the onset of the prime was replaced with a per cent sign, the body-related condition (e.g., *%eed*-WEED) yielded faster target reading aloud latencies than the unrelated condition (e.g., *%elp*-WEED). Unfortunately, an onset-related condition (e.g., *w%ed*-WEED) was not included in this study, and so these results do not allow us to answer the question of whether the onset effect is due to serial left-to-right processing of the prime. For example, if it turned out that WEED is read aloud faster when preceded by *w%ed* compared to when preceded by *%eed* it could only be because the prime is processed in a serial left-to-right manner. In contrast, if the two conditions yielded similar naming latencies then evidence for parallel processing of the primes would be provided.

Kinoshita (2000) also conducted a study that directly addressed the question of whether the MOPE is due to initial-phoneme overlap or any phoneme overlap between primes and targets. The results showed a naming latency benefit only when primes and targets shared their initial sound (*suf*-SIB $<$ *mof*-SIB) but not when they shared their last sound (*mub*-SIB $=$ *mof*-SIB), offering support for the claim that the effect must be serial in nature. However, this study used nonword stimuli, and so it still remains possible that when real words are used, prime processing may not be serial and so a priming effect may arise because of phoneme overlap between the prime and the target at any position.

Although Kinoshita's (2000) results alone provide evidence for a mechanism in the reading system that operates serially and from left to right, investigating whether it is *any* and not just initial-phoneme overlap between word primes and targets that facilitates target reading aloud compared to no phoneme overlap is particularly interesting for evaluating the adequacy of extant computational models of reading that claim to offer a valid account of the MOPE (e.g., the DRC, CDP+, and CDP++ models). These models are computational instantiations of the so called dual-route theory of reading (Coltheart et al., 2001), and therefore consist of a lexical procedure that operates in parallel across letter strings supporting the reading of real words, and a sublexical procedure that operates serially, in a left-to-right manner, supporting primarily the reading of nonwords. According to these models, if the primes are real words and have letters/phonemes in common with their targets in the same position (e.g., *flat*-BEST), the orthographic/phonological representations of the primes get holistically activated via the lexical procedure and boost the activation of targets with an identical letter/phoneme in the same position, thus facilitating target reading aloud compared to an unrelated condition (e.g., *junk*-BEST).[1] In the present study we investigated these models' predictions.

EXPERIMENT

Method

Participants

Twenty-four undergraduate students from Macquarie University participated in the study for course credit. Participants were native speakers of Australian English and reported no visual, reading, or language difficulties.

Materials

A total of 60 regular monosyllabic words consisting of four letters and four phonemes each served as target items. Another 180 words with similar characteristics served as onset-related, end-related, and unrelated primes. The items were selected from the CELEX word database (Baayen, Piepenbrock, & Van Rijn, 1993). Mean frequency and N (Coltheart, Davelaar, Jonasson, & Besner, 1977) were respectively 14.1 and 6.3 for the onset-related primes, 14.2 and 6.5 for the end-related primes, and 14.9 and 6.9 for the unrelated primes (both $Fs < 1$). Mean frequency and N for the targets were 30.2 and 7.6 respectively. Three groups of 60 prime-target pairs were formed, with the targets remaining the same in all groups. Primes and targets shared only their first letter and phoneme in the onset-related condition (e.g., *blip*-BEST), only their last letter and phoneme in the end-related condition (e.g., *flat*-BEST), and had no letters/phonemes in common in the unrelated condition (e.g., *junk*-BEST). The prime-target pairs used in the experiment are listed in the Appendix. In addition to the 180 prime-target pairs that formed the experimental stimuli, five pairs of primes and targets were selected as practice items using the same criteria.

Design

Each experimental condition consisted of 60 prime-target pairs for a total of 180 trials per participant in a fully counterbalanced design. This meant that every participant saw the 60 targets three times, each time preceded by a different type of prime. The 180 trials were divided into three blocks so that the same target would not appear more than once within the same block. A short break was administered between the blocks. Additionally, the blocks were constructed so that at least 30 trials intervened before the same target could reappear. Three lists (A, B, C) were

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[1] We verify this by simulations, which we report later in this paper.

Table 1. *Human RTs (in ms) and computational RTs (in cycles) with standard deviations (in parentheses) and per cent error rates (%E)*

	Human data		*Computational data*				
	RTs (SDs)	*%E*	*DRC* *RTs (SDs)*	*%E*	*CDP+* *RTs (SDs)*	*%E*	
Condition							Examples
Onset-related	435.8 (70.5)	1.6	66.9 (1.6)	0.0	84.3 (5.3)	0.0	*blip*-BEST
End-related	456.3 (69.0)	2.5	66.6 (2.4)	0.0	84.7 (5.2)	0.0	*flat*-BEST
Unrelated	455.4 (68.2)	1.8	68.9 (2.4)	0.0	86.4 (5.2)	0.0	*junk*-BEST
Onset effect	19.6		2		2.1		

constructed to counterbalance the order of block presentation, so if *blip*-BEST appeared in the first block in list A, it would appear in the second block in list B and in the third block in list C. An equal number of participants ($N = 8$) were tested on each list.

Apparatus and procedure

Participants were tested individually, seated approximately 40 cm in front of a Dell CRT monitor in a dimly-lit room. Stimulus presentation and data recording were controlled by DMDX software (Forster & Forster, 2003). Verbal responses were recorded by a microphone fitted to each participant by means of a headset. Participants were told that they would see a series of hash tags (####) followed by words presented in uppercase letters. Their task was to read aloud the words as quickly and as accurately as possible. The presence of primes was not mentioned to the participants. Stimuli were presented to each participant in a different random order, following five practice trials. Each trial started with the presentation of a forward mask (####) that remained on the screen for 500 ms. The prime was then presented in lowercase letters for 50 ms (five ticks based on the machine's refresh rate of 10 ms), followed by the target that was presented in uppercase letters and acted as a backward mask to the prime. The target words appeared in white on a black background (12-point Courier New font) and remained on the screen for 2000 ms or until participants responded, whichever happened first. The order of trial presentation within blocks and lists was randomized across participants.

Human results

Participant responses were hand marked using CheckVocal (Protopapas, 2007). Incorrect responses, mispronunciations, and hesitations (5.9% of the data) were treated as errors and discarded. To control for temporal dependencies between successive trials (Taylor & Lupker, 2001), the reaction time (RT) of the previous trial and trial order were taken into account in the analyses, so trials that were presented first, or trials whose previous trial corresponded to an error (6.3% of the data), were discarded.[2]

The RT analyses were performed using linear mixed effects modelling (Baayen, 2008; Baayen, Davidson, & Bates, 2008). A linear mixed-effects model using the *lme4* (Bates, Maechler, Bolker, & Walker, 2013) and *languageR* packages (Baayen, 2008) implemented in R (version 3.0.2, R Core Team, 2013) was created using a backward stepwise model selection procedure. Model comparison was performed using chi-squared log-likelihood ratio tests with regular maximum likelihood.

The model we report included inverse RT (−1000/RT) as the dependent variable, and prime type (onset-related vs. end-related vs.

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[2] Although the error rate in this study seems to be very high, a close inspection of the data revealed that it is due to a small number of participants (six in total) who mispronounced over 15 words. When these participants were excluded from the analyses, the overall error rate decreased to 3.9%, yet the critical differences between the three conditions remained the same.

unrelated), RT of previous trial, and trial order as fixed effects. Intercepts for subjects and items were included as random effects, and so were by-subject random slopes for the effect of the prime type to remove the assumption that all participants showed the same amount of priming in the three prime type conditions (invrt ~ prime type + PrevRT + TrialOrder + (prime type| subject) + (1 | target)). Outliers with a standardized residual greater than 2.5 standard deviations from zero were removed from the fitted model (2.1% of the data). The results showed a significant MOPE, so that reading aloud latencies were faster in the onset-related condition compared to the unrelated condition ($t = 8.8$, $p < .001$). The onset-related condition also yielded significantly faster reading aloud latencies than the end-related condition ($t = 9.8$, $p < .001$). However, the end-related and unrelated conditions did not differ significantly from each other ($t = 0.3$, $p = .8$). Mean RTs (calculated from 3728 observations) and percentage of errors (based on the total number of trials), for each condition, are presented in Table 1.

Simulation results

We ran the simulations using the default parameters of the DRC1.2.1 (http://www.cogsci.mq.edu.au/~ssaunder/DRC/2009/10/drc-1–2–1/) and CDP+ models. Primes were presented for 26 cycles in the DRC1.2.1 model (as in Mousikou, Coltheart, & Saunders, 2010) and for 25 cycles in the CDP+ model (as in Perry et al., 2007).[3] Repeated-measures analyses of the DRC1.2.1 naming latencies revealed a significant main effect of condition, $F(2{,}118) = 24.25$, $p < .001$, while pairwise comparisons (Bonferroni adjusted) indicated a significant difference between the onset-related and unrelated conditions, and the end-related and unrelated conditions (both $ps < .001$), but no difference between the onset-related and end-related conditions. For the CDP+ model, there was a significant main effect of condition, $F(1.75{,}103) = 634.2$, $p < .001$ (Greenhouse-Geisser corrected), while pairwise comparisons (Bonferroni adjusted) showed that the differences between all conditions were significant (all $ps < .001$). All target words were pronounced correctly by the models. The models' latencies (in cycles) are presented in Table 1.[4]

GENERAL DISCUSSION

Computational models of single-word reading have offered precise accounts of a wide range of empirical phenomena observed in the domain of reading aloud. One such phenomenon is the MOPE. The reason why this effect has attracted a lot of interest in reading research is because it has been offered as evidence for serial processing in reading aloud, thus proving to be a suitable paradigm for adjudicating between theories of reading which assume a serially-operating sublexical mechanism in the reading system and theories which posit that processing across letter strings occurs only in parallel. In particular, the DRC, CDP+, and CDP++ computational models of reading have been able to simulate the MOPE because of their implemented sublexical reading component, which operates serially and from left to right.

However, the literature in this domain lacked a critical experiment. If the prime-target pairs are

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[3] Following a reviewer's suggestion, in an attempt to attenuate the influence of end-related primes on target reading aloud we parametrically decreased the prime duration in the CDP+ model from 20 cycles to 1. Only when the prime duration was as short as 1 and 2 cycles did the model successfully simulate the human data. However, at these short prime durations it is questionable whether the model would be able to simulate any other masked onset priming effects reported in the literature. In the present paper we only report the results at a prime duration of 25 cycles because this is the prime duration that Perry et al. used to simulate the human data from the Forster and Davis (1991) seminal study on the MOPE.

[4] We also ran the simulations with the CDP++ model, which is a disyllabic version of the CDP+ model. The results were identical to those produced by the CDP+ model in terms of the differences between the three conditions, yet naming latencies were overall much faster in the disyllabic model (63.6, 64.5, and 66.2 for the onset-related, end-related, and unrelated conditions respectively). We only report the simulation results from the monosyllabic model because they are directly comparable to the DRC1.2.1 model, which is also limited to monosyllables.

real words that share a phoneme in *any* position (e.g., *flat*-BEST) then target reading aloud could be facilitated compared to when primes and targets share no phonemes in the same position (e.g., *junk*-BEST). This is because the orthographic/phonological representations of the primes are likely to get activated very quickly via the lexical procedure, which is known to operate in parallel across letter strings, thus boosting the activation of targets with identical letters/phonemes in the same position as the primes. Indeed, this is a prediction made by the only models that have successfully simulated the MOPE to date, namely the DRC, CDP+, and CDP++ models.

We tested this prediction in the present study and found no evidence for facilitation in target reading aloud when word primes and targets shared their last letter/phoneme in the same position, which suggests that whole-word phonology may not be sufficiently activated via the lexical procedure at a prime duration of 50 ms. Our results corroborate the claim that the MOPE is serial in nature and provide additional evidence for a serial reading mechanism that operates in a left-to-right manner. Furthermore, our data imply that in the human reading system, activation of the first phoneme of a letter string via the sublexical procedure is faster than activation of any phoneme via the lexical procedure.

Critically, our findings falsify the way the DRC1.2.1, CDP+, and CDP++ models simulate the MOPE with word stimuli. Although it is likely that slowing down the speed of processing of the lexical procedure in these models may prevent the rapid activation of the orthographic/phonological representations of the prime words, so that *flat* no longer facilitates the activation of BEST, the principle of nested incremental modelling, to which both of these groups of modellers adhere, requires that any modifications to the models are backwards compatible (Jacobs & Grainger, 1994). As a result, if adjustments to the speed of processing of the lexical procedure of these models were made, the modellers would need to investigate whether their models could still simulate all of the reading phenomena that they were able to simulate before they were modified. As it stands, the present results are inconsistent with all existing computational models of single-word reading aloud.

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REFERENCES

Baayen, R. H. (2008). *Analyzing linguistic data: A practical introduction to statistics using R*. Cambridge: Cambridge University Press.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*, 390–412.

Baayen, R. H., Piepenbrock, R., & Van Rijn, H. (1993). The *CELEX* lexical database. On *Linguistic data consortium* [CD-ROM]. Philadelphia: University of Pennsylvania.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2013). lme4: Linear mixed-effects models using Eigen and S4 (R package Version 1-0.5). Retrieved from http://CRAN.R-project.org/package=lme4

Coltheart, M., Davelaar, E., Jonasson, J. T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and performance VI* (pp. 535–555). London: Academic Press.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, *108*, 204–256.

Dimitropoulou, M., Duñabeitia, J. A., & Carreiras, M. (2010). Influence of prime lexicality, frequency, and pronounceability on the masked onset priming effect. *The Quarterly Journal of Experimental Psychology*, *63*, 1813–1837.

Forster, K. I., & Davis, C. (1991). The density constraint on form-priming in the naming task: Interference effects from a masked prime. *Journal of Memory and Language*, *30*, 1–25.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods Instruments and Computers*, *35*, 116–124.

Harm, M. W., & Seidenberg, M. S. (2004). Computing the meanings of words in reading: Cooperative division of labor between visual and phonological processes. *Psychological Review*, *111*, 662–720.

Jacobs, A. M., & Grainger, J. (1994). Models of visual word recognition: Sampling the state of the art. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 1311–1334.

Kinoshita, S. (2000). The left-to-right nature of the masked onset priming effect in naming. *Psychonomic Bulletin & Review*, *7*, 133–141.

Montant, M., & Ziegler, J. C. (2001). Can orthographic rimes facilitate naming? *Psychonomic Bulleting and Review*, *8*, 351–356.

Mousikou, P., Coltheart, M., Finkbeiner, M. & Saunders, S. (2010). Can the dual-route cascaded computational model of reading offer a valid account of the masked onset priming effect?. *Quarterly Journal of Experimental Psychology*, *63*, 984–1003.

Mousikou, P., Coltheart, M., & Saunders, S. (2010). Computational modelling of the masked onset priming effect in reading aloud [Special Issue]. *European Journal of Cognitive Psychology*, *22*, 725–763.

Mousikou, P., Coltheart, M., Saunders, S., & Yen, L. (2010). Is the orthographic/phonological onset a single unit in reading aloud?. *Journal of Experimental Psychology: Human Perception and Performance*, *36*, 175–194.

Perry, C., Ziegler, J. C., & Zorzi, M. (2007). Nested incremental modeling in the development of computational theories: the CDP+ model of reading aloud. *Psychological Review*, *114*, 273–315.

Perry, C., Ziegler, J. C., & Zorzi, M. (2010). Beyond single syllables: Large-scale modeling of reading aloud with the Connectionist Dual Process (CDP++) model. *Cognitive Psychology*, *61*, 106–151.

Plaut, D. C., McClelland, J. L., Seidenberg, M. S., & Patterson, K. E. (1996). Understanding normal and impaired word reading: Computational principles in quasi-regular domains. *Psychological Review*, *103*, 56–115.

Protopapas, A. (2007). CheckVocal: A program to facilitate checking the accuracy and response time of vocal responses from DMDX. *Behavior Research Methods*, *39*, 859–862.

R Core Team. (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from http://www.R-project.org/

Schiller, N. O. (2004). The onset effect in word naming. *Journal of Memory and Language*, *50*, 477–490.

Taylor, T. E., & Lupker, S. J. (2001). Sequential effects in naming: A time-criterion account. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *27*, 117–138.

APPENDIX: PRIME-TARGET PAIRS USED IN OUR EXPERIMENT

Primes			
Onset-related	*End-related*	*Unrelated*	*Targets*
brim	quid	rapt	BEND
bulb	grit	flak	BENT
blip	flat	junk	BEST
brat	stud	wisp	BOND
blot	clod	silt	BRED
bran	trek	snot	BULK
blob	tent	yelp	BUST
club	gulp	drug	CAMP
clog	stub	lent	CRAB
cult	damp	link	CROP
dent	bloc	frog	DISC
duct	clip	vest	DROP

(*Continued overleaf*)

Appendix Continued.

Primes			
Onset-related	*End-related*	*Unrelated*	*Targets*
dank	slam	span	DRUM
dint	slip	crag	DUMP
drab	mink	plot	DUSK
fret	snug	skip	FLAG
fend	rump	dust	FLAP
font	pond	sank	FLED
film	bled	quip	FOND
gwen	pact	punk	GIFT
gilt	snob	kelp	GRAB
gulf	stem	tank	GRIM
gust	clap	smut	GRIP
honk	flip	list	HUMP
hemp	mist	grid	HUNT
jest	snap	send	JUMP
kink	lilt	fund	KEPT
lust	prop	risk	LAMP
lisp	trod	prig	LEND
land	nest	cram	LIFT
lank	stop	gent	LIMP
loft	snip	rant	LUMP
musk	zest	brag	MINT
pimp	tint	zinc	PEST
pomp	twig	yank	PLUG
plop	glum	slut	PRAM
pelt	swum	bank	PRIM
rink	flop	sled	RAMP
rusk	hast	quod	RIFT
romp	clot	wind	RUST
self	held	belt	SAND
slog	flit	grub	SECT
silk	quit	plum	SENT
stab	mend	pulp	SKID
step	flan	weld	SKIN
sunk	crib	prod	SLAB
skim	drip	quiz	SLAP
snag	punt	funk	SLIT
snub	tuft	pink	SLOT
sift	gram	trad	SLUM
swim	lint	hulk	SOFT
smug	vent	flog	SPAT
swig	rand	kilt	SPED
slug	glut	clam	SPIT
sink	rent	hunk	SPOT
twit	helm	glen	TRAM
tact	scum	hank	TRIM
test	pump	desk	TRIP
trot	scan	plod	TWIN
wept	sulk	drat	WINK