“Twisting fingers”: the case for interactivity in typed language production

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Abstract

Despite the obvious linguistic nature of typing, current psychological models of typing are, to a large extent, divorced from models of spoken language production. This gap has left many questions regarding the cognitive architecture of typing unanswered. In this paper, we advocate the use of a psycholinguistic framework for studying typing by showing that such a framework could reveal important similarities and differences between spoken and typed production. Specifically, we investigated the interaction between lexical and post-lexical layers using a phenomenon known in spoken production as the "repeated phoneme effect". Participants typed four-word sequences of "finger-twisters" (equivalent to tongue-twisters in spoken production) in which the vowel in the last two words was either repeated (e.g., "fog top") or not (e.g., "fog tip"). We found reliably more migration errors between the consonants of the two typed words when the vowel was repeated, even after the effect of phonology was accounted for. This finding is compatible with an interactive typing system in which post-lexical representations send feedback to lexical representations, and shows similar dynamics in spoken and typed production. Additional analyses showed further similarities to spoken production, such as distinct lexical and post-lexical error categories, but also revealed that typing errors were much more likely than spoken errors to violate phonotactic constraints. These results provide the first demonstration of feedback between post-lexical and lexical layers in typing and more generally demonstrate the utility of adopting a psycholinguistic framework tailored specifically to the study of typing.

Keywords: typing error, interactivity, segmental representation, repeated phoneme effect

Most of us spend a good portion of the day typing our thoughts either for professional assignments or to connect with others via texting, chatting, and social media. However, we rarely think about the challenges embedded in this seemingly simple activity: a message must be constructed, the right word(s) must be selected, the correct spelling must be retrieved, and the correct keys must be pressed in just the right order. Despite the increasing role of typing in everyday activities, research on typed language production remains scarce. In particular, the cognitive processes underlying typing and the degree of their similarity to spoken production are not fully understood. In this paper, we examine the architecture of the typing system from the perspective of psycholinguistic models of spoken word production, with a special emphasis on the degree of interactivity between the layers in the system.

Architecture of the typing system

The most widely accepted model of typing is probably Logan and Crump's (2011) hierarchical processing model. Logan and Crump (2010) found that typists (implicitly) slowed down after a typing error but no such slowing was observed when errors were artificially slipped into the visual feedback stream despite the fact that typists (explicitly) accepted the artificial errors as their own. This dissociation was implemented in Logan and Crump's (2011) model by two informationally-encapsulated loops. The outer loop is considered a central process responsible for organizing the plan to type, mapping the target text to word representations in copy-typing, and processing the visual feedback. The inner loop is thought to be responsible for mapping words onto letters and keystrokes, controlling the serial activation of keystrokes, navigating the fingers to the correct locations, and processing the proprioceptive feedback (Yamaguchi, Crump, & Logan, 2013). While the model neatly explains the interaction between central and local (motor) control processes, it is not concerned with the details of the linguistic architecture behind typing.

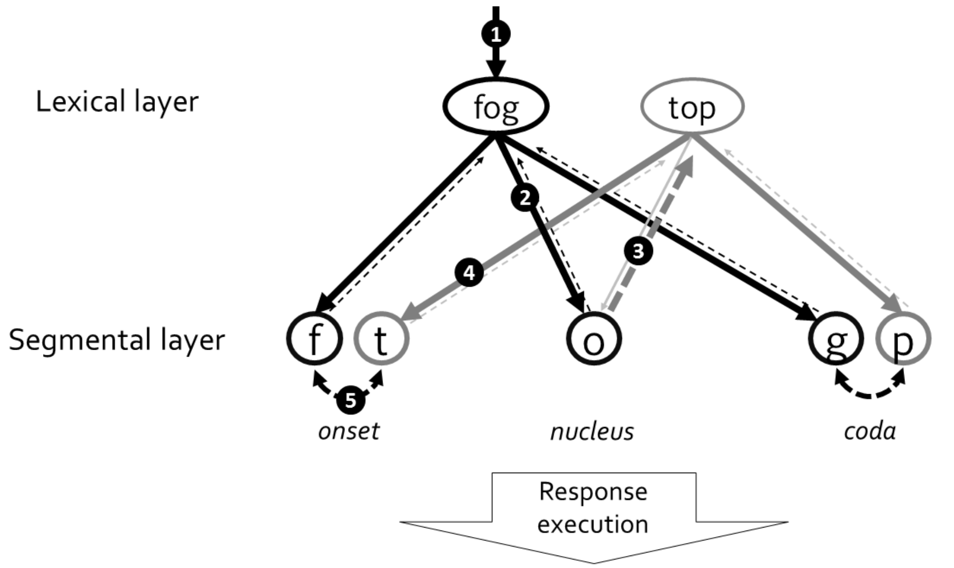
A computational implementation of a typing model has also been proposed by Rumelhart and Norman (1982), consisting of “word schema”, “keystroke schemata”, and a “response system”. The retrieved word schema activates the associated keystroke schemata, which are then mapped onto their target hand/finger positions on a keyboard in the response system. This model successfully simulates the performance of a skilled typist in terms of errors and timing. While there are some differences between these two models, such as separate (Yamaguchi et al., 2013) vs. combined (Rumelhart & Norman, 1982) letter and keystroke representations, both models agree that letters/keystrokes are post-lexical *segmental* representations. In addition, in their current form, both models view the flow of information as strictly feedforward from the lexical to the segmental level(s), with no feedback (even though Rumelhart and Norman’s (1982) model contains feedback connections between the response system and the keystroke schemata). This architecture is strikingly similar to the general backbone of a feedforward model of spoken production (e.g., Levelt, Roelofs, & Meyer, 1999).

In spoken production, however, there is now substantial evidence for feedback between segmental and lexical layers. For example, semantic slips have a tendency to also exhibit phonological similarity to the target word (cat → rat; Dell et al., 1997), and phonological slips tend to create more lexical than non-lexical items (e.g., Nozari & Dell, 2009). Both patterns are most parsimoniously explained by feedback from the segmental to the lexical layer (see Dell, Nozari, & Oppenheim, 2014 for a review). If typing is similar to spoken production, then the assumption of feedforward connections between lexical and segmental levels in typing is questionable. In this study, we test for the presence of feedback from the segmental to the lexical layer in typing using an experimental phenomenon that we refer to as "the repeated letter effect".

The repeated letter effect

The "repeated letter effect" in typing is akin to what Dell (1984, 1986) described as the "repeated phoneme effect" in spoken production (see Figure 1). The repeated phoneme effect refers to the observation that the presence of a repeated phoneme increases the chance of migration of non-repeated phonemes between two words (Dell, 1984, 1986). For example, "fog top" is more likely to be produced as "tog fop" than "fig top" as "tig fop". In his interactive two-step model of production, Dell (1986) explains this finding as follows: During production of sequences such as "fog top/tip", both words are pre-activated. Activation of the first word ("fog") activates its segments ("f", "o", "g") through feed-forward connections. Feedback connections from the segmental to the lexical level then send activation back to the word nodes that contain those segments. This means that when the two words share a segment ("fog top"), the shared segment ("o") in one word (e.g. "fog") also feeds back to the other word ("top"), which in turn activate its own segments by forward propagation. This leads to competition between the unshared segments of the two words, increasing the chance of migration errors such as "fog" (top) → "tog". On the other hand, if the two words do not share any segments ("fog tip"), feedback connections only project to the originally activated word without activating the other word and its segments, and no additional opportunities are created for migrations between the consonants of the two words. Thus the “repeated phoneme effect”, which stems directly from the feedback from the phonological to the lexical layer, predicts an increased probability of migration errors between two words when they share a phoneme compared to when they do not. In a system with no feedback, on the other hand, phonological repetition should have no effect on the migration rate of non-repeated phonemes.

In the current study, we propose that the similarity between representational layers in spoken and typed production should make it possible to probe the interaction between lexical and post-lexical layers in typing using a conceptually similar effect that we call the “repeated letter effect”. The repeated phoneme effect was originally elicited using the SLIP paradigm (Baars, Motley, & Mackay, 1975; Dell, 1984), in which participants silently read word-pairs in quick succession and were occasionally prompted to produce the last pair they read out loud. However, the effect does not depend on the specifics of the SLIP paradigm; any paradigm that entails multi-word production and elicits a reasonable number of errors should produce the same effect. We, thus, implemented the manipulation of the repeated letter in a 4-word finger-twister task, adapted from the oral versions of tongue-twister tasks that have been previously used to elicit between-word migrations (e.g., Nozari & Dell, 2012). Participants typed, under time pressure, four-word sequences of monosyllabic “finger-twisters” (equivalent to tongue-twisters in spoken production) in which the last two words either did or did not share the vowel. If there is feedback from the post-lexical to lexical layer, we would expect higher migration rates in typing errors on the non-repeated consonants in the pairs with a repeated vowel. Recall that for the repeated phoneme effect, this was due to feedback from phonemes to lexical items. In typing, this feedback would be from letters/keystroke schemata to lexical items. To control for the effect of phonology, participants also completed an oral version of the task. If the origin of the repeated letter effect is purely phonological, covarying out the errors in speech should remove any potential effect of repeated letters in typing.



1. Activation of the lexical item “fog”
2. Feed-forward activation of segments of “fog”
3. Feedback from segments to the lexical item “top” (in addition to “fog”)
4. Feed-forward activation of segments (top)
5. Competition between segments

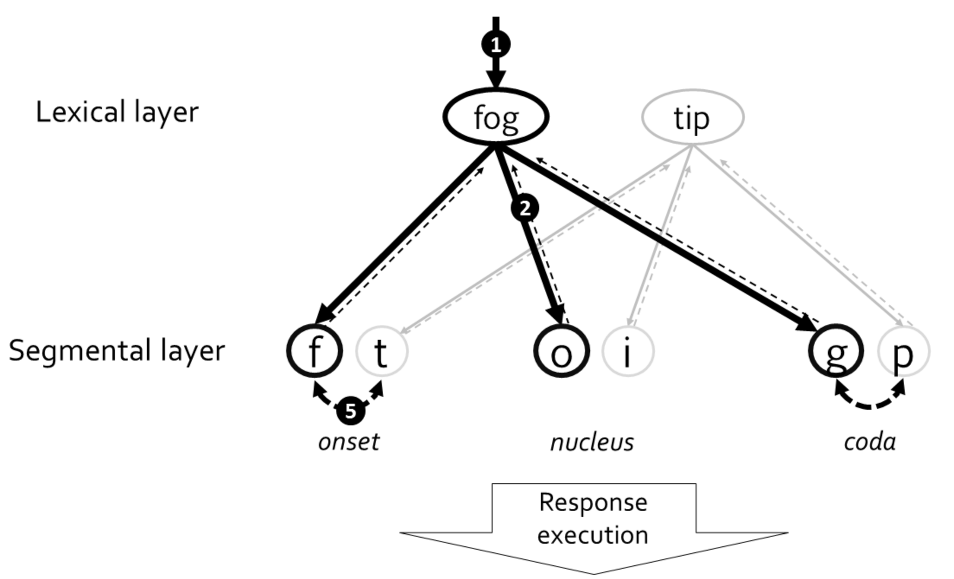


Figure 1. A schematic of interactive mapping between lexical and segmental representations in typing a 2-word sequence. Target sequence is "fog top" (upper panel) or "fog tip" (lower panel) and network activation is shown when the first word "fog" is to be produced. Numbers indicate the time-course of spreading activation. Critically, steps 3 and 4 are missing when the vowel is not repeated (lower panel). Onset consonants (F/T) are chosen as an example to demonstrate the mechanism, but similar processes apply to codas (G/P).

Method

Participants

Forty-two native English speakers (35 females; age: mean = 20.3 (±2.95), range = 18-32) participated for payment. Consent was obtained under a protocol approved by the Institutional Review Board of Johns Hopkins School of Medicine. Their mean typing speed was 83.3 (±17.5) wpm (range = 50-118) as measured by a copy-typing task.

Materials

Forty-four “finger twister” sequences were created with an ABBA pattern of onset consonants (e.g. “tank fed fog top”, see Appendix). The last two words of the sequence had either a repeated vowel (e.g., fig/tip, fog/top) or a non-repeated vowel (fig/top, fog/tip), resulting in 176 variations in total. The first two words of the sequence were the same for all four variations and did not share any segment with the final words other than the onset consonants.

We created four lists comprising an equal number of sequences with repeated and non-repeated vowels (44 trials in total). Only one variation from each sequence (i.e., one list) was presented to any individual participant. Lists contained an equal number of 3- and 4-letter words, and were balanced on the number of onset consonants typed by same/different hand(s), the number of uni-/bimanual intervals (between onset consonant and vowel), and the lexicality of the errors that would be produced by an onset consonant exchange.

Procedure

Participants were seated approximately 25 inches from a 15-by-12 inch Dell monitor, and typed their responses on a DirectIN PCB v2016 Empirisoft keyboard (millisecond accuracy), or spoke into a digital recorder (Sony ICD-PX333). The experiment comprised two 35-50 minute sessions—typing and speaking—performed on different days in counterbalanced order. Each participant was presented with two to three practice trials followed by one of the four experimental lists (kept the same in both sessions) divided into three experimental blocks.

Materials were presented using MATLAB PsychToolBox (Kleiner, Brainard, & Pelli, 2007). Each trial in the typing session consisted of three phases: acquisition, rehearsal, and test. In the acquisition phase, participants copied a target sequence at their own pace. In the rehearsal phase, the target sequence was presented for two seconds, and upon its disappearance, participants typed it from memory at their own pace. Once ready, they entered the test phase where they typed the sequence as fast and as accurately as possible four times in a row, each time within a 3.5 second window marked by two beeps, with one second between repetitions. Participants were free to correct their answer as they were typing. The spoken version was identical to the typed version, except that participants orally recited the sequence, and the deadline for repetitions during the test phase was shortened to 1.5 seconds to adjust for the difference in speed between typing and speaking. Only data from the test phase were analyzed, which resulted in 7,392 typed and 7,392 spoken trials.

Results

Data were collected for each keystroke. Any difference between typed responses and target sequences (addition, deletion, or substitution of a letter) was coded as an error, including the use of the backspace key. We report errors both at the level of 4-word sequences (7,392 opportunities), and at the level of individual words (29,568 opportunities). In the typing session, 2,427 sequences contained errors (33%), distributed over 3,373 erroneous words (11%). Spoken responses were double-transcribed offline by two independent raters, and discrepancies were resolved between the two. The spoken version yielded 692 erroneous sequences (9%) distributed over 931 erroneous words (3%).

General characteristics of typing errors

Given the scarcity of reports on the linguistic patterns of typing errors, we first present some general characteristics of the errors in our dataset, followed by a discussion of a few aspects of the data that help in localizing the source of the majority of the errors and assessing the potential influence of spoken production on typed production.

Of 2,427 incorrect trials, 1,112 (45%) contained at least one backspace, indicating an attempt at correction. The average typing rate was significantly slower for incorrect responses (149.7 ± 27.8 ms/keystroke)—with or without correction attempts—than correct trials (125.7 ± 21.6 ms/keystroke; $z = -5.65$, $p < 0.001$; Figure 2). Longer (four-letter) words were significantly more error-prone than shorter (three-letter) words (12 ± 7 % vs. 11 ± 6 %, $z = -2.22$, $p = 0.026$). Spaces between words were also subject to errors: 187 (6%) of word errors involved a space error (e.g., intrusion in a word, doubling, or deletion).

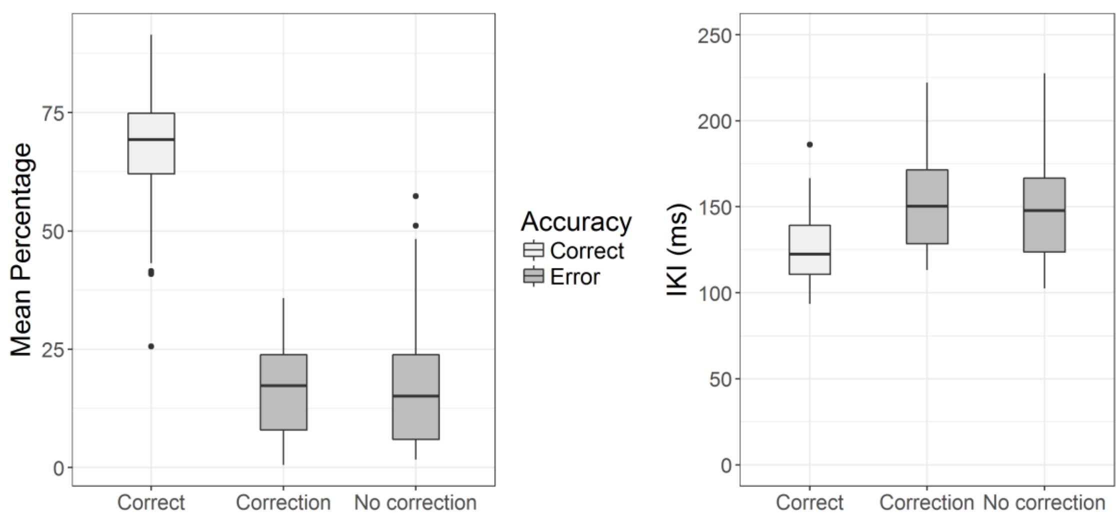


Figure 2. Accuracy and typing speed for correct and error responses. Left: Boxplot of percentage of correct trials and error trials with and without correction. Right: Boxplot of interkeystroke intervals (IKI). The horizontal line represents the median, the box goes from the first to the third quartile, and vertical lines extend to 1.5 times the inter-quartile range.

Table 1. Subtypes of lexical and segmental errors and their frequency in the typing data.

Target	**tank fed fog top**	
Lexical errors		32% of all errors
Addition	tank ***tank/tan***[a] fed fog top	7%
Deletion	____ fed fog top	13%
Substitution	***fed/tan***[a] fed fog top	75%
Exchange	tank ***fog fed*** top	5%
Segmental errors		68% of all errors
Addition	tank***g***/tank***c*** fed fog top	32%
Deletion	_ank fed fog top	25%
Substitution	tank fed ***t***og/***y***og[a] top	36%
Exchange	tank fed ***g***o***f*** top/***t***og ***f***op/fo***p*** to***g***[b]	7%

[a] The two examples show errors originating from within vs. outside the sequence. [b] Segments may be exchanged within a word or between two words.

Error types were coded according to the rules used in previous tongue-twister studies (e.g., Nozari & Dell, 2012, see Table 1). Any error (e.g., addition, deletion, substitution or exchange) that resulted in a word was counted as a lexical error. Any letter addition, deletion, substitution or exchange that did not result in a word was counted as a segmental error. There were significantly more segmental (2,276; 68%) than lexical (1,097; 32%) errors (z = -5.4, p < 0.001), indicating that the majority of typing errors originated in the segmental level (or later motor processes)[1].

To examine the influence of phonology on typing errors, we investigated phonotactic violations in typing errors. In spoken production, these errors (e.g., erroneous production of /ŋ/ for an onset) are extremely rare (<1%; Warker & Dell, 2006). In our

[1] Note that this is a conservative estimate, because some of the lexical errors might indeed be segmental errors, e.g., mud rag → mug rag, caused by the migration of segments from other words in the sequence. In fact, 56% of lexical errors in this experiment were compatible with this mechanism, further increasing the proportion of segmental errors.

typing data, however, 677 (30%) of the segmental errors violated phonotactic constraints, a rate much higher than that reported for spoken production.

In summary, the predominance of segmental over lexical errors suggests that the majority of errors in this paradigm arise at the post-lexical level, which makes the paradigm suitable for studying the interaction between lexical and post-lexical levels. Moreover, the much more frequent violation of phonotactic constraints in typing than in speech suggests that typing errors are not simply phonological errors that emerge during typing; they reflect the specific dynamics of a unique production system, which must be studied in its own right.

The repeated letter effect

We tested for the repeated letter effect on the third and fourth words of the sequence, comparing cases in which the vowel was repeated (fog top; N = 185) to those in which it was not (fog tip; N = 142; Figure 3). Anticipations (e.g., fog top → tog top, fop top; 61%), perseverations (e.g., fog top → fog fop, fog tog; 27%), and exchanges (e.g., fog top → tog fop; 1%) were included in the analysis. Analyses were carried out using a logistic multilevel mixed model (MLM; lme4 package, Bates, Mächler, Bolker, & Walker, 2015, R version 3.3.2). Fixed effects included condition (repeated vs. non-repeated), and speech errors in spoken production as a covariate to control for the effect of phonology. Random effects included random intercepts for subjects and items, as well as random slopes for condition by subject. Table 2 shows the results of this analysis. When all trials were included in the model (i.e., contrasting migration errors to trials with correct or other error responses), there were significantly more migration errors in sequences with repeated segments, $z = 2.201$, $p = 0.027$. The pattern of speech errors did not reliably predict the pattern of errors in typing. We repeated this analysis, this time including only trials with errors (migrations of interest vs. other error types) to ensure that potential differences in the overall accuracy rate between conditions did not confound the results. The results were similar, $z = 1.979$, $p = 0.048$[2]. A direct comparison of the error rates in the repeated and non-repeated conditions using the Wilcoxon Signed-Rank[3] test confirmed the findings of the MLM, $z = -2.16$, $p = 0.031$. The effect size phi (square root of chi-square divided by the number of observations) yielded 0.36, which constitutes a medium effect size. To summarize, we found a robust medium-sized repeated letter effect in our dataset that was not driven by phonology.

Table 2. Results of the repeated segment analysis.

Fixed effects	Estimate	SE	*z* value	Pr(>|z|)	*(sig)*
(Intercept)	-4.155	0.136	-30.5	<0.001	***
Repeated letter	0.332	0.151	2.20	0.0277	*
Speech errors	-0.0764	0.441	-0.173	0.863	
Random effects	Variance				
Subject intercept	0.200				
Repeated letter | subject	0.262				
Item intercept	0.376				

[2] We have reported two-tailed p values for all tests, but since the hypothesis of the experiment is directional, technically, a one-tailed p value (i.e., half the size of the reported p values) accurately represents the probability that the effect is due to chance.
[3] The pattern of results was similar whether speech errors were or were not subtracted from typing errors in this analysis.

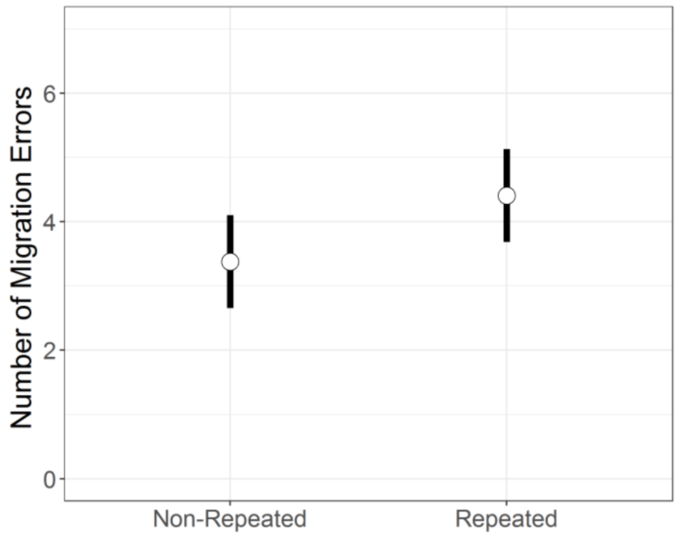


Figure 3. Mean number of migration errors by condition. Error bars represent 95% CIs corrected for within-subject variability (Loftus & Masson, 1994).

By a similar logic, one might expect that the interference created due to the feedback from the shared vowel would slow down the production of the consonants on correct trials, even though no overt errors have surfaced. Indeed, there was a small, but significant effect on the typing durations such that the intervals leading up to the onset and coda consonants were slowed down in the repeated letter condition (M = 142 ms ± 31.2) compared to the non-repeated letter condition (M = 138 ms ± 26.8). An MLM analysis performed on onset and coda intervals confirmed the pattern observed on migration errors, $\beta = 3.89$, $t = 2.87$, p = 0.008, using a similar structure than for errors with individual bigrams as random effects (Pinet, Ziegler, & Alario, 2016).

General discussion

We found a significant repeated letter effect in our data: there were more migration errors between consonants and consonants were typed more slowly when sequences contained repeated vowels than when they did not. The effect on error rates persisted after accounting for errors made in speaking, which ensured that it was not solely of phonological origin. Moreover, errors had been recorded while sequences were being recalled from memory, in the absence of any visual representation of the words: this ensured that the effect was independent of visual processes. This finding can thus be taken as evidence for feedback from the post-lexical to the lexical level in typing. To our knowledge, this is the first demonstration of interactivity within the typing system. However, several studies have probed a related issue, namely the modularity of response selection and execution, i.e., whether execution starts before response selection is over (e.g., Damian & Freeman, 2008). One line of research that has tested the issue of modularity has reasoned that in a non-modular system, the duration of response execution should be affected by factors influencing lexical selection. The majority of such studies have focused on the effect of word frequency on response latency or duration. It is not clear, however, whether word frequency is the appropriate variable. Drawing on findings from spoken production, there is little doubt that word frequency—and similarly Age of Acquisition—is reflected in the strength of lexical-phonological mappings (even though word frequency has an additional possible influence on lexical selection; Kittredge, Dell, & Schwartz, 2008). Therefore, such variables do not necessarily—or exclusively—index lexical selection, but are expected to influence segmental encoding directly. Additionally, higher frequency words are likely to be typed more frequently, i.e., have more practiced motor plans. It is thus difficult to pin down the effect of frequency to a certain part of the system. Given these issues, it is not surprising that different studies have reached different conclusions regarding the effect of frequency on response execution times (Baus, Strijkers, & Costa, 2013; Pinet et al., 2016; Scaltritti, Arfé, Torrance, & Peressotti, 2016; Torrance et al., 2017).

A more careful test of the influence of lexical selection on response execution durations was carried out by Damian and Freeman (2008), who used a version of the Stroop task to manipulate the difficulty of lexical selection. They found longer response latencies, but not longer response durations, in the incongruent condition, where lexical selection was more difficult. The absence of an effect on durations was taken as evidence for modular response selection and execution processes. Note, however, that this approach skips segmental encoding by directly linking lexical selection to response execution. An alternative interpretation is that there is interaction between lexical selection and segmental encoding, but not between segmental selection and response execution, at least not in a form that would affect the timing of individual key presses (O'Seaghdha & Marin, 2000). Viewed in this light, our current results would point specifically to feedback between segmental (either letter or keystroke) and lexical representations.

Finally, our results may also have implications for the encapsulation of the inner and outer loops in Logan and Crump’s (2011) model. In this model, lexical representations constitute the interface between the two loops and are thus involved in processes related to both stages. If the claim is that lexical selection takes place as part of the processes in the outer loop, however, then the current results are incompatible with the two loops being informationally encapsulated. Previous results have also suggested that post-lexical information that should be contained within the inner loop (kinesthetic feedback or motoric features) could actually be accessed by the outer loop and might influence response selection (Cerni, Velay, Alario, Vaugoyeau, & Longcamp, 2016; Kalfaoğlu & Stafford, 2014; Pinet et al., 2016; Topolinski, 2011).

Parallels between speaking and typing

It is not uncommon to dismiss the study of written/typed production as either irrelevant to spoken production (i.e., as a motor task that has little in common with speaking), or as superfluous to spoken production (i.e., as exactly the same as speaking but carried out by the hands). The current results argue against both of these extreme views by demonstrating that, while the general cognitive architecture of typing has many parallels with spoken production, it also has unique characteristics. Similarities between the two systems can be inferred from the presence of similar sub-types of lexical and segmental errors in typing and speaking, which suggests similar stages of semantic-to-lexical and lexical-to-segmental mapping. Moreover, as argued above, the presence of the repeated letter effect indicates that the system shows properties such as interactivity just like the spoken production system (Dell, 1986; Rapp & Goldrick, 2000). Quite remarkably, the repeated phoneme effect reported by Dell (1984) yielded an effect size of 0.34 and 0.38 for the first and second experiments respectively, comparable to our reported effect size of 0.36 for the repeated letter effect. These similarities suggest that a psycholinguistic model is quite appropriate for the investigation of the mechanisms underlying typing.

At the same time, however, there are clear differences between typing and spoken production, an example of which is the violation of phonotactic rules in typing errors demonstrated in the current study. Such differences necessitate the study of typing as an independent system that is related—but not identical—to spoken production (see Rapp & Fischer-Baum, 2014 for similar arguments about handwriting). In this vein, it will be important to elucidate the exact nature of post-lexical representations in typing. As alluded to in the Introduction, the two current dominant models of typing disagree on whether letter and keystroke representations are distinct or not (see also a discussion in Scaltritti, Longcamp, & Alario, 2017). The conclusion drawn from our findings does not critically depend on the number of post-lexical layers of representation, but the question must be answered before a complete model of typing can be constructed, leaving room for further studies. A psycholinguistic framework might be helpful in shedding light on such matters (e.g., McCloskey, Macaruso, & Rapp, 2006; Pinet et al., 2016).

Conclusion

This is the first demonstration of feedback between post-lexical and lexical layers in typed production similar to that found in spoken production. More generally, the similarities in error patterns in spoken and typed production motivate a psycholinguistic framework for studying the cognitive architecture of typing, complemented by research on specific aspects of typing not shared with spoken production.

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Appendix:

Sequences used as material for the present study. Four different variations of each sequence were created from the combination of words 3 and 4.

Sequence	Word 1	Word 2	Word 3	Word 4
1	cow	bill	bat/but	cap/cup
2	rib	mess	mad/mud	rag/rug
3	bond	sum	sat/sit	bag/big
4	pry	hem	hat/hit	pan/pin
5	few	bud	ban/bin	fat/fit
6	bun	way	wet/wit	bed/bid
7	him	rave	rob/rub	hot/hut
8	tank	fed	fig/fog	tip/top
9	ray	pull	pet/pot	red/rod
10	gas	pro	pen/pun	get/gut
11	ten	hill	ham/hum	tab/tub
12	bad	nip	net/nut	beg/bug
13	hold	tug	tan/tin	hap/hip
14	cut	milk	map/mop	cab/cob
15	cry	pug	pad/pod	cat/cot
16	dew	lap	lit/lot	dig/dog
17	fuzz	howl	has/his	fan/fin
18	let	curb	can/con	lag/log
19	week	fur	fall/fill	wash/wish
20	lid	men	math/moth	lack/lock
21	man	set	sick/suck	mill/mull
22	born	leg	last/lust	back/buck
23	ball	dorm	deck/duck	best/bust
24	rum	dock	dash/dish	rang/ring
25	fun	peg	pack/pick	fast/fist
26	day	meek	mist/must	dill/dull
27	fry	bang	beet/boot	feel/fool
28	pig	dawn	deem/doom	peel/pool
29	sip	fax	feed/food	seen/soon
30	lump	fawn	feet/foot	leek/look
31	may	rid	reef/roof	meet/moot
32	less	bye	bait/bout	laid/loud
33	lush	mitt	mean/moon	leap/loop
34	bird	tuck	teal/tool	beam/boom
35	pit	hung	head/hood	pear/poor
36	try	long	lake/like	tame/time
37	push	bot	bake/bike	pale/pile

38	mug	root	race/rice	make/mike
39	weep	surf	sale/sole	wake/woke
40	sub	toy	tale/tile	sane/sine
41	run	mat	mile/mole	rise/rose
42	low	rush	rate/rite	lace/lice
43	past	rung	ride/rode	pike/poke
44	bull	mix	made/mode	bane/bone