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Lic. en Comunicación

Acceptability in typos: Analysis of reading times of sentences with typographic mistakes in native Spanish speakers

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Buenos Aires, 16 de abril de 2018

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Agradecimientos

Este trabajo es un accidente feliz, resultado, por un lado, de cuatro años de estudio y por otro, de un momento de verdad espontánea. El estudio fue esta carrera de Comunicación, que elegí medio de casualidad y en la que me fui hallando de a poquito, y la revelación fue de un día cualquiera del 2016, en el que decidí dejar de darme vueltas y entregarme a lo que siempre supe: que a mí lo que me gustan son las palabras. Ninguna de estas dos cosas hubiera sido posible sin el esfuerzo, la compañía y el cariño de las siguientes personas.

Gracias a mi mamá y a mi papá, que se esforzaron toda la vida por abrirme puertas y me enseñaron que solo por tener los pies en la tierra no significa que no pueda alcanzar bien alto, sino al revés: que cuanto más claro tenga dónde piso, más fácil va a ser crecer. A mis hermanos, que casi siempre logran hacerme sentir que les interesa lo que tengo para decir, hasta en esos temas donde ni la genética nos acerca. A mis abuelos, Cora y Enrique, que desde acá o desde allá se han ocupado de tirarme flores, aún cuando tuve que explicar más de una vez qué era eso que estaba estudiando, y así enseñándome el verdadero significado de la palabra “incondicional”.

Gracias a mis amigas, porque crecer en grupo es mejor que crecer sola, y jamás me han dejado dudar de su compañía. A Cami, que nunca me dejó desconfiar de mí misma, o se encargó de que al menos pudiera confiar en ella cuando yo me fallaba. A Pali, con quien un día comenzamos a compartir días de estudio y descubrimos, de a poquito y de a montón, que compartíamos mucho más que eso, y sin cuya compañía no estaría presentando este trabajo. A Chantal, que me eligió por mi acento porteño y hoy me edita el inglés a cambio de mi receta de empanadas.

Finalmente, muchísimas gracias a Charly Gelormini Lezama, mi mentor, de cuya inagotable paciencia vengo abusando hace meses y quien a cambio me ha ofrecido más de la cuenta: enseñanzas, chistes, notas de voz, aliento y hasta su oficina. Gracias también a aquellos profesores de la carrera que me enseñaron que la investigación y la docencia son fuentes inagotables de riqueza. Y especialmente a Eugenia Mitchelstein, de quien aprendí que investigar algo que me gusta puede ser serio y divertido a la vez.

Acceptability in typos: Analysis of reading times of sentences with typographic mistakes in native Spanish speakers

INTRODUCTION

On January 29th, 2018, members of the House of Representatives of the United States of America were invited to attend the 2018 State of the Uniom Address. If nothing about that sentence catches your eye, it is because typographic mistakes are commonly made and commonly processed. With a careful reread, we'll see that *Uniom* with an M replaced *Union* with an N. The Office of the Sergeant at Arms and Doorkeeper, in charge of tickets, quickly corrected the mistake and sent out new invitations with the right spelling (Patton, 2018), but by then, the typo was already making headlines. This mistake is significant for two reasons: firstly, because of the kind of mistake that it is: a typographic error made by pressing the wrong key—specifically, the key *right next* to the correct one; and secondly, because someone read over the text at least once, did not register the mistake and sent it to print.

Typos have become ubiquitous. Reading habits are no longer—if they ever were—circumscribed to texts that have undergone rigorous copywriting processes. Books, newspapers and magazines, usually thoroughly edited and corrected, account for only a part of our textual intake. Modern digital communication technologies, i.e. smartphones and other screens, use the written word as their most basic unit. Texting, emailing, tweeting, posting, captioning, tagging, commenting, online sharing, etc. are all actions that involve both reading and writing, and are performed on a daily basis by billions of people. Of course, written language forming part of our day-to-day is not necessarily a new thing, but what is relatively new is our relationship with these "textual devices": over two thirds of adults across 40 countries reported owning a smartphone or using the internet at least occasionally, a number that grew by over 30% in some countries, such as Brazil and Malaysia, from 2013 to 2015 (Pew Research Center, 2016). Furthermore, modern smartphones, computers and tablets favor a particular format: the keyboard. Keyboard layout is arbitrarily determined by tradition, functionality and language-specific variations. The QWERTY keyboard used across most languages with Latin-script alphabets is a modified version of a design originally meant to reduce typewriter jams caused by the clashing of the letter metal arms. This keyboard has become the universal mediating tool between us and written communication, effectively working as a fixed-design serving tray, from which we mix and match letters, numbers and symbols.

Along with the invention of type, and eventually the keyboard, came the inevitability of typographic mistakes. Of course, typographic and spelling mistakes borne of human error have been an inevitable companion to writing for as long as writing has existed, and have sometimes become either a point of contention for historians or simply a good story to tell at parties (bible errata, for example, have ranged from the innocent, such as the 1806 printing of the King James Bible saying that "fishes shall stand" rather than "fishers", to the outright blasphemous, like a 1632 printing that preaches "thou shalt commit adultery", the "not" sacrilegiously forgotten [Barker, 2010]). However, the reason they become especially relevant for linguistic research is because of the number of typos found in everyday communications. The relationship that readers and writers have with typos, as well as with the devices that generate them, must be studied if only because of how commonly they occur.

Spelling errors have commonly been studied in relation to language acquisition (Treiman, 1992, 1994) and language processing (Treiman, 1997; Kay, Lesser & Coltheart, 1996). While rationalist and Chomskyan views posit that language is an innate human ability, the same cannot be said for reading. Instead, reading is an acquired skill that must be taught. There are several different models proposing a developmental sequence for how children learn how to read (Ehri, 1992, 1997; Frith, 1985), very often related to an initial grapheme-phoneme correspondence that later progresses into the reading comprehension of a normal adult. In the so-called alphabetic phase, the connections between letters and sounds are established. Through practice, words can be recognized by sight, and read without sounding out and converting sounds to letters. In the consolidated alphabetic phase, recurrent letter patterns become familiar and easily accessible to the reader. A key part of this process is practice and repetition. Teaching how to read can rely on different methods, but regardless of whether it focuses on word patterns or on grapheme-phoneme conversion, it still requires external stimuli.[1]

Several studies have shown the relevance of exposure to print on cognitive abilities such as declarative knowledge (Stanovich, West & Harrison, 1995) and on reading skills in particular

[1] For a review of the literature on written language acquisition, see Smith, F. (2004). *Understanding reading: A psycholinguistic analysis of reading and learning to read*. London: Routledge.

(Levy, Gong, Hessels, Evans & Jared, 2006). Levy et al. discussed how learning to read in children involves a stage at which printed letters are recognized as such: images, defined by a fixed set of rules and following a language-specific, orthographically acceptable pattern. What children consider to be acceptable writing varies as they move along their development; children aged 3, for example, are more likely to accept nonalphabetic displays—such as squiggles, drawings and pictures—as readable, than 5-year-olds (Bialystok, 1995), which "may indicate that while listening to adults read, pictures and print are confused, with the children not knowing what part of the display the adults are actually reading" (Levy et al., 2006, p. 67). Essentially, their exposure to the devices and elements of reading and writing affect how they think of and process reading and writing themselves; reading, as a process, is at least partly dependent on the visual tools it relies on. Studies focused on child literacy often include some insight into the child's home literacy habits and exposure, and while there is no obvious correlation between being read aloud to and increased literacy (Sénéchal & LeFevre, 2002; Scarborough & Dobrich, 1994; Evans, Shaw, & Bell, 2000; Meyer, Wardrop, Stahl, & Linn, 1994), there is a difference between involving children in active manipulation of print as opposed to, for example, storybook time or any other passive exposure (Levy et al., 2006). Keyboard use is, at its most basic, print manipulation, and a common practice to which children are now exposed to from an early age, through observation of their parents and other surrounding adults. In studying typographic mistakes, we are focusing on a specific type of exposure to print and to print manipulation.

Research on spelling has focused on the production of mistakes and how our brains process words and letters. In contrast, typographic errors represent something quite different: on the production side—the typist—, a relationship with technological devices, the ergonomics of keyboard design, maybe even something about dexterity and object perception. On the perception side—the reader—, if we find that there is measurable and observable behavior related to reading typos, then this might suggest something about how technology is shaping our habits and cognitive skills.

There are different common spelling mistakes according to orthographic depth across languages (Abu-Rabia & Siegel, 2003; Abu-Rabia & Taha, 2004; Georgiou, Torppa, Manolitsis, Lyytinen & Parrila, 2012). Spanish is an orthographically shallow language, with high correspondence between phonemes and graphemes. Spelling mistakes are often related to the wrong selection between two possible encodings of the same phoneme (Suárez-Coalla, Villanueva, González-Pumariega, & González-Nosti, 2016; Cuetos & Suárez Coalla, 2009)—such as /b/ which can represented by graphemes B and V—and the lack of grammatical rules to establish the correct use in all situations (primary school children are taught that B usually goes after M, but what about words with no such sequence, like *barco* or *abuelo*?). Typographic mistakes are entirely unrelated to grapheme-phoneme correspondence. They are closer to absolute randomness, but they have become so commonplace that it might be worth looking into whether our perception of them follows a certain logic.

For the purpose of serious study, typographic errors, or typos, cannot be neatly defined as neither nonwords nor pseudowords, seeing as most studies define nonwords as implausible letter strings and pseudowords as plausible nonwords (orthographically and/or in terms of pronunciation) (Harley, 2014; Houpt, Townsend & Donkin, 2014; Holcomb & Neville, 1990). In-context typos from which the reader can still extract meaning might sometimes fall in either the nonword or pseudoword category from a purely visual standpoint, but that would fail to recognize their semantic worth. Christianson, Johnson & Rayner (2015) use the term "nonwords with TLs" in opposition to the "base words" from which two letters have been transposed (e.g., JUGDE for JUDGE), and points out that they may generate a priming effect similar to the original word. Similarly, less plausible nonwords are rejected faster than more plausible nonwords (Coltheart, Davelaar, Jonasson & Besner, 1977). The typographic version of this concept would be "nonwords with typos". Nonwords with typos are sometimes, but not always, understood by the recipient. For example, habitual users of direct messaging software have developed strategies for correcting typos, which are used at the writer's discretion. These strategies are a metalinguistic side note that acknowledge the mistake and amend it, such as sending an asterisk with the correct spelling immediately after sending a typo or an erroneous auto-correction (Figure 1). But not all mistakes are deemed necessary to correct, and communication flows relatively smoothly regardless. And this is where we have to ask, where is the line where we say, "no, this will not be understood, I have to type the right word," rather than assuming that our conversational partner will be able to read through the typo and extract the intended meaning?

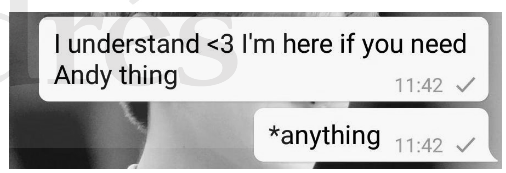

Figure 1. The asterisk is sometimes used to signal a correction in instant messaging or other forms of informal online communications.

The keyboard is the common denominator at play for typos. Studies show that being a skilled typist does not mean having explicit knowledge of the keyboard (Liu, Crump & Logan, 2010; Snyder, Ashitaka, Shimada, Ulrich & Logan, 2013). However, skilled typists can perform the task with a blank keyboard. This suggests the existence of some sort of mental keyboard, stored in their memories. We conducted an experiment to test whether knowledge, however implicit, of the keyboard, affects reading. Specifically, we focused on reading times for nonwords with typos within an instant messaging context.

This study looks at instant messaging because the aim is not just to account for reading times for mistakes but rather to look deeper into our actual use of technology. Typos, it seems, do not always prevent effective communication. In this case, we are studying meaning at the discourse level, not simply lexical access, which is why we must focus on sentences instead of isolated word targets. We performed an experiment where we studied reading times for sentences because we wanted to see how an orthographic violation—in this case, a misspelled word—affected overall meaning, and if fluent communication was possible regardless. The effect of context on word recognition or naming tasks is a well-researched topic, especially regarding the predictive inferences that readers or listeners can make when going through text (for a comprehensive review and summary of the literature on this topic, see Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort, 2005). In reading tasks in particular, the consensus is that facilitation—that is, the notion that context clues help with word recognition—exists when comparing context-predictable words with less predictable ones; the former are “read more quickly, skipped more often and responded to more quickly in naming and lexical decision tasks” (Van Berkum et al., 2005, p. 445). However, these studies do not present sufficient evidence to claim that integration is facilitated by context and not by post-lexical processing. Regardless, facilitation, be it context-based or due to post-lexical integration, is generally accepted to be found “in difficult circumstances, such as when the stimulus is degraded” (Harley, 2014, p. 188). Typographic mistakes could be considered to constitute a degraded stimulus, in which case it is of interest to study the sentence as a whole. Rather than focusing on a degraded word target, we focus on the sentence and the effect that the corruption of the word has on it. Previous studies have also shown that studying language processing at the sentence level might be better suited to understanding the effect of one specific focal stimulus, rather than, for example, word-by-word reading (Nair & Almor, 2010).

The consensus on reading, regardless of which model of sentence processing is preferred (interactive, modular, etc.), is that it is constituted by both bottom-up and top-down processes (see Whitney, 1998, for an in-depth review and comparison of models). Studying how we read typographic mistakes (or “degraded stimuli”) allows us to focus on the crossover between processes, to see how the mind deals with non-standard data. Furthermore, by focusing on the keyboard, we are attempting to study the relationship between reading as it happens in the mind and writing as it is defined by a specific set of tools.

This paper seeks to study the threshold of acceptability for typos and see whether knowledge of the keyboard affects the reading of certain mistakes. Our hypothesis is that the keyboard layout is somehow intrinsic to digital reading habits, and our recollection of it plays a role in how or whether we understand possible mistakes. Furthermore, we posit that there are more acceptable and less acceptable errors, which in our experiment we call “near” and “far” typos. Near typos are those in which the letter key that is wrongly pressed is directly to the left or right of the intended letter, while far typos swap for letters farther away. The underlying question is, when reading, do we make use of our mental keyboard?

EXPERIMENT

This experiment examines the processing of sentences with typographic mistakes, testing for differences in reading times with *near* typos and *far* typos. These conditions were contrasted with correct spelling of the same words, in order to test whether typographic mistakes delay reading times for sentences. If the underlying assumption is that the keyboard acts as a priming device, this would lead to the expectation that near typos would have shorter reading times than far typos. On the contrary, if no significant difference is found between reading times for these conditions, this assumption would be disproven.

Related to our research question regarding reading times for sentences with typographic mistakes, our hypotheses can be stated as follows:

H_1: Reading times for properly spelled sentences (RT_1) are shorter than for sentences containing typos (RT_2, RT_3)

H_2: Reading times for sentences with near typos (RT_2) are shorter than for sentences containing far typos (RT_3)

$$RT_1 < RT_2 < RT_3$$

METHOD

Participants

Eighteen undergraduate students, twelve male and seven female, between 18 and 24 years of age, from the University of San Andrés (UdeSA), Buenos Aires, Argentina, participated in a single session lasting approximately 10 minutes. All of them had normal or corrected-to-normal vision and were all native speakers of River Plate Spanish, the dialect spoken in Buenos Aires and neighboring areas. They were all daily users of smartphones or computers.

Materials

A set of eighteen written exchanges like the one in Table 1 was constructed. Each exchange consisted of two sentences in Spanish, presented in a one-on-one conversational format (i.e., the second part of the exchange was always in reply to the first one), simulating the style and tone of instant messaging. The participants were told that these "conversation snippets" were taken verbatim from real instant messages. Sentence (1) contained a sentence that required or expected a reply. This could be in the form of a statement (e.g. *No ceno en casa hoy*; "I'm not dining at home today") or a question (*¿Me podés llamar?;* "Can you give me a call?"). Sentence (2) was a direct reply and could be presented in one of three different conditions, as shown in Table 1: (a) orthographically correct: *No puedo ahora, estoy en clase* ("I can't right now, I'm in class"); (b) with a "near" typo: *No puedo ajora, estoy en clase;* or (c) with a "far" typo: *No puedo apora, estoy en clase*.

Table 1. Examples of all three conditions in the experiment.

No typo	No ceno en casa. OK, avisale también a mamá. ("OK, let mom know too.")
Near typo	No ceno en casa. OK, avisale tambkén a mamá.
Far typo	No ceno en casa. OK, avisale tambsén a mamá

There was no repeated syntactic structure throughout the different passages, but there was a tendency for sentences in the first-person singular. Common orthographic mistakes were avoided (such as *s* for *c*), even when the keyboard layout meant the substitution could be considered a near typo (such as *b* for *v*). Substitutions that would modify words into other words (such as *mora* for *mota*) were also avoided, as well as any typo that would tip the error into a semantic or a syntactic violation. Phonotactical rules were taken into consideration when deciding on the items, but we chose to have the corpus include both pronounceable and unpronounceable typos. The words submitted to the different conditions were all chosen from the first five hundred words in a dictionary of high frequency words in the Spanish language (Davies, 2006) to eliminate the chance of word frequency having an effect on reading times. Word category was considered irrelevant, but to ensure this had no effect, we selected a mix of content words (three adverbs, four nouns, three adjectives and eight verbs). Function words were avoided, as they are usually ignored by the reader (Healy, 1976) and are almost rarely longer than three letters. The chosen words were also all four letters long or more, and both the initial and final letter remained intact, as previous ERP studies have shown a significant difference in error-processing when the last letter is involved (Hagoort, 2003), and transposed-letter studies similarly show that there is a marked difference in lexical decision making related to letter position (Perea & Lupker, 2003). See Table 2 for a full list of experimental items.

Table 2. List of 18 written exchanges.

Sentence 1	No typo	Near typo	Far typo
¿Me podés llamar?	No puedo ahora, estoy en clase	No puedo ajora, estoy en clase	No puedo apora, estoy en clase
Estoy yendo para allá, tengo hambre.	Ah, pensé que venías después de comer.	Ah, pensé que venías desoués de comer.	Ah, pensé que venías destués de comer.
¿Cómo está el clima?	Yo tengo mucho frío.	Yo tengo muxho frío.	Yo tengo murho frío.
No ceno en casa hoy.	OK, avisale también a mamá	OK, avisale tambkén a mamá	OK, avisale tambsén a mamá
¿Te probaste la remera?	Sí, me queda grande, la voy a ir a cambiar.	Sí, me queda gtande, la voy a ir a cambiar.	Sí, me queda guande, la voy a ir a cambiar.
¿Estás en camino?	Estoy llegando, me atrasé un poco.	Estoy llehando, me atrasé un poco.	Estoy llewando, me atrasé un poco.
Llego en 5 minutos.	Tengo poco tiempo, por favor apurate.	Tengo poco tiwmpo, por favor apurate.	Tengo poco tikmpo, por favor apurate.
¿Vos tenés mi suéter azul?	Justo ayer lo encontré mezclado con mis cosas.	Justo ayer lo envontré mezclado con mis cosas.	Justo ayer lo enlontré mezclado con mis cosas.
¿Quién sos?	Soy Ana, este es mi nuevo número.	Soy Ana, este es mi nurvo número.	Soy Ana, este es mi nulvo número.
Necesito que me devuelvas mi tupper.	Lo dejé en casa, después lo busco.	Lo dejé en cssa, después lo busco.	Lo dejé en cmsa, después lo busco.
¿Me llamaste?	Sí, para avisarte que te dejaron algo en recepción.	Sí, para avisarte que te dekaron algo en recepción.	Sí, para avisarte que te decaron algo en recepción.
¿Sabés si Elena cena con nosotros?	Cuando hable con ella le pregunto.	Cuando habke con ella le pregunto.	Cuando habwe con ella le pregunto.
Tomás ya se fue, ¿no?	Sí, pero creo que vuelve más tarde.	Sí, pero creo que vurlve más tarde.	Sí, pero creo que vumlve más tarde.
¿Sabés de alguien que ya haya rendido este examen?	No conozco a nadie, la verdad.	No cobozco a nadie, la verdad.	No corozco a nadie, la verdad.
Hoy me voy a las 7.	Ok, voy a tratar de llegar antes.	Ok, voy a teatar de llegar antes.	Ok, voy a tmatar de llegar antes.
¿Vamos al cine a la noche?	No puedo, trabajo hasta tarde hoy.	No puedo, teabajo hasta tarde hoy.	No puedo, tkabajo hasta tarde hoy.
Estoy en clase, no puedo hablar.	No hay problema, te llamo después.	No hay pronlema, te llamo después.	No hay proslema, te llamo después.
¿Conseguiste lo que buscabas?	Todo menos el libro de Borges.	Todo menos el linro de Borges.	Todo menos el lipro de Borges.

Each two-sentence passage was followed by a yes/no comprehension question in order to ensure that participants were processing meaning as they read. A set of eighteen filler items was constructed to reduce the predictability of the experimental items and mask the purpose of the experiment. These fillers replicated the structure of the experimental set but contained no typographic errors. They were also followed by a comprehension question.

Design

Each experimental exchange was presented to each participant in only one condition, but all three conditions occurred across participants. Each participant read eighteen experimental items (six per condition) and eighteen filler items. The order of trials was randomized for each participant and also across subjects, Latin square-style. The session included a short practice at the beginning, consisting of five filler passages, in order to familiarize the participant with the format of the experiment, which also included yes/no comprehension questions. During this time, the participants were allowed to ask questions about the procedure.

Procedure

Participants read the instructions on the screen and proceeded to the practice session in order to become familiar with the self-paced reading task. They were instructed to put the index finger of their dominant hand on the space bar—without pressing—as this would serve as both the "yes" and the "next" key. Each trial started with the sentence "*Presione la barra espaciadora*" ("press the spacebar"), and once the participant followed the instruction, they were presented with the first sentence of the exchange. Subjects were encouraged to read as quickly as possible while still extracting meaning. Once they had gone through both parts of the simulated messaging exchange, a question regarding the meaning of what they had just read popped up on the screen, requiring a "yes" (space bar) or "no" (shift key) answer. The experiment was run on a personal computer running a Windows operating system, using E-Prime software. This software recorded the time lapse from the presentation of Sentence (2) to the pressing of the space bar. The reading time of Sentence (2) was the dependent variable.

RESULTS

Table 2 shows the mean reading time of Sentence (2) for all three conditions. A one-way repeated measure analysis of variance (ANOVA) with factor Typo (none, near, far) was performed on the data. The main effect of typo was found to be significant across all three conditions at the $p<0.05$ level, such that $F(2, 34)=10{,}178$.

Table 2. Mean reading time for sentence 2 (in ms) and standard error for the three conditions.

Condition	Mean	Std. Error
No typo	1620.32	113.01
Near typo	1930.19	162.60
Far typo	2151.36	180.72

Three paired sample t-tests were used to make planned comparisons between conditions. A first paired samples t-test indicated that there was a significant difference between reading time of sentences without typos (M=1620.32, SD=479.48) and with near typos (M=1930.19, SD=689.87); $t(17)=-2.65$, $p=0.017$. A second paired samples t-test indicated that there was a significant difference between reading times of sentences with near typos (M=1930.19, SD=689.87) and with far typos (M=2151.36, SD=766.76); $t(17)=-2.3$, $p=0.030$. A third paired samples t-test indicated that there was a significant difference between reading times of sentences with far typos (M=2151.36, SD=766.76) and with no typos (M=1620.32, SD=479.48); $t(17)=3{,}84$, $p=0.001$. These results show that there is significant change in reading time across conditions, where sentences with far typos are read 221ms slower than ones with near typos, and sentences without typos are read at least 309ms faster than both. This means that $RT_1<RT_2<RT_3$ is, indeed, true.

Table 3. Mean reading time for sentence 2 (in ms) for all subjects, across conditions.

Subject	No typo	Near typo	Far typo
1	1396.00	1551.60	1794.50
2	1601.17	1471.83	2654.17
3	2509.50	3311.20	3169.17
4	1097.00	1435.50	1529.80
5	1693.00	2189.17	2043.83
6	1202.00	1593.17	1622.17
7	1913.33	1850.50	2308.40
8	1775.17	1463.17	2019.5
9	1460.00	2025.00	2043.33
10	884.00	1298.83	2106.67
11	1811.33	2338.83	2545.83
12	1204.60	2660.50	2335.00
13	2396.17	2000.17	1858.17
14	1243.40	1310.17	1238.33
15	1832.33	1619.50	1705.00
16	1276.50	1294.67	1195.17
17	2492.17	3690.33	4530.67
18	1378.17	1639.33	1961.83

DISCUSSION

The purpose of this research was to examine the effect of keyboard knowledge on sentence processing, especially in the case of typographic mistakes. Two findings are especially noteworthy as they relate to our hypotheses:

(1) properly spelled sentences are read quicker than sentences with typos; and

(2) typos can be split into at least two categories, with one having shorter reading times and therefore considered to be more acceptable, in terms of mental processing.

This acceptability is related to their positioning on the keyboard, with keys that are closest to the original intended letter ("near typos") found to be more acceptable. The first finding shows that reading is at least partly data-driven, such that variation in the quality of the stimulus affects the outcome. The second finding, on the other hand, showed that reading also has a top-down element such that differences in the degraded stimuli were parsed differently and therefore obtained different results. Together, these two findings suggest that reading contains a data-driven element along with top-down processing, and that when the stimulus is degraded in some way, the mind must perform some form of mental gymnastics to deal with it successfully. This can be seen in the contrast between the first and second and third conditions combined, but especially in between the near and far typo conditions: keyboard knowledge does, in fact, affect the mind's ability to process the information presented; external stimuli affect the internal process. And in this case, the internal knowledge required to process the degraded stimulus seems to be directly related to a sort of "mental keyboard".

The theory of facilitation, which suggests that context helps word recognition, has been argued by some to be a result of associative priming from preceding words in a sentence (West & Stanovich, 1982), or to be a non-automatic part of post-access processing (Forster, 1981). Even if West and Stanovich are correct, associative priming would not be enough to explain why there is a difference between conditions two and three; facilitation should have had the same effect on both—that is, no significant difference in reading times—, unless there was indeed something at the letter or word-level affecting the reading of the entire sentence. If it were merely a data-driven effort, then the reading times should have remained constant, as the predictive inference encouraged by the sentence context should have yielded comparatively similar results. As this was not the case, we must assume that there is a link between *how* the stimulus is degraded and the difference in reading times.

While the experiment was conducted in controlled conditions, one could argue that there might be an issue related to the speed-accuracy trade-off in timed exercises (Pachella, 1974), whereby participants make more mistakes in an effort to be as quick as possible, because they were informed beforehand that they were being timed. However, this was offset by the shift in attention to the comprehension questions, as it was never made clear which step of the experiment was on the clock and participants focused on getting the yes/no questions correctly. After finishing the experiment, most participants made comments that suggested that they had focused primarily on these comprehension questions and believed the experiment to be centered around them.

On a minor note related to the typos manufactured for the experiment, it is interesting to mention that no significant difference was found for items which presented acceptable and non-acceptable spellings throughout different conditions. That is, orthographic acceptability did not override or alter the effect of distance between keys in any significant way.

For further research, this study would have to be conducted in languages and countries that do not use the QWERTY keyboard, such as the French AZERTY, as a way to strengthen our hypothesis. This paper also discussed the idea of print manipulation, and our experiment recreated the structure of online text messaging; it would be of interest to study whether there is a difference in exposure to handwritten and typed text. Previous studies have shown that, when comparing handwriting to typing during written language acquisition in children, handwriting is superior to typing in helping with letter recognition (Longcamp, Zerbato-Poudou & Velay, 2005; Kiefer, Schuler, Mayer, Trumpp, Hille & Sachse, 2015). Handwriting also has a more positive effect on letter memory (Longcamp, Boucard, Gilhodes & Velay, 2007), which supports the hypothesis that the change in use of fine motor skills has collateral effects not related to the skill itself (Sulzenbrück, Hegele, Rinkenauer & Heuer, 2011). However, none of these studies answer the question of whether this experiment would obtain similar results if performed on handwritten texts. Finally, our participants were all young adults who reported using smartphones and computers daily. A follow-up experiment with older participants or participants with less access[2] to screen displays and technologies could provide a point for comparison.

[2] In this paper, we did not make an analytical distinction between access and use. This distinction is relevant when discussing effective and advantageous use of technology, but in this case, we are working under the assumption that

The purpose of this study was not simply to see how quick the mind can process and understand mistakes, but rather to try and understand how meaning is extracted for effective communication; i.e., how we get on with it, despite our thumbs failing us, and why we might not choose to correct our mistakes, led by the instinct that the correction is unnecessary. Clear and proper orthography, it seems, is not indispensable for efficient communication. The mind is capable of making up for mistakes and might do so by making use of a diverse tools related to reading, such as the keyboard.

access implies a baseline use of the more basic characteristics of current screen display technologies—to put it simply, we assume that having regular access to a smartphone or a computer means writing with a keyboard.

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