HOW DOES READING TEXTING ABBREVIATIONS AFFECT PROCESSING?

HOW DOES READING INTERNET AND TEXTING ABBREVIATIONS AFFECT PROCESSING?

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Abstract

The use of shortcuts and abbreviations in everyday communications, both online and through texts, has become increasingly popular over the past decade. Shortcuts like 'lol' for 'laugh out loud' aim to provide emotional nuance and context that would otherwise be lost in standard written communication. However, studies have shown that there is a processing cost associated with using these shortcuts (Perea, Acha, & Carreiras, 2009; Ganushchak, Krott, Frisson, & Meyer, 2013). Other studies have found that texting shortcuts are lexically independent units: they are represented and stored in the brain independently of their full, standard form (Ganushchak, Krott, & Meyer, 2010; 2012; Tat & Azuma, 2015). The current study examines the effect of newer, more diverse shortcuts on processing and Working Memory (WM) capacity through two experiments. It was hypothesised that reading shortcuts would lead to an increased processing cost and poorer recall. Furthermore, it was hypothesised that this processing cost and poorer recall would depend on the type of shortcut. Phrasal shortcuts (e.g. 'brb' for 'be right back') would be more difficult to read and would lead to poorer recall compared to contractions and clippings (e.g. 'txt' for 'text'). In Experiment 1, the processing cost of reading shortcuts was explored through a self-paced reading task, with results supporting our hypotheses. In Experiment 2, participants read sentences which contained memory words to be remembered for recall at the end of a trial, with the number of correct items recalled used as a gauge of working memory capacity and processing efficiency (Service & Maury, 2014; Daneman & Carpenter, 1980). Results were mixed, with no clear effect of the presence of a shortcut or shortcut type modulating recall. Implications of these results are discussed with regard to reading and the direction of language evolution.

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List of Abbreviations

CC – Contractions and Clippings

PS – Phrasal Shortcuts

CCE – Contractions and Clippings (Expanded)

CCNE – Contractions and Clippings (Non-Expanded)

PSE – Phrasal Shortcuts (Expanded)

PSNE – Phrasal Shortcuts (Non-Expanded)

RTs – Reading Times

1 Chapter 1: Introduction

Rapid developments of communication technology over the last decades have been accompanied by linguistic adaptation and innovation: new words and phrases have entered common vocabulary, coined by the existing and novel processes of word formation, and have paved the way to even newer forms of communication. Abbreviations, acronyms, and initialisms have existed for centuries in languages across the globe, varying by context but on the whole functioning with one aim: to package a large amount of information into a shorter linguistic form, often in places where space is tight. This mechanism was observed in the 19th century in telegrams, where each message was charged by word, and those words could not exceed a certain number of characters. Thus, shortening words and omitting words not essential for understanding (articles, auxiliary verbs, etc.) became intuitive in order to reduce costs. This type of writing style was labelled as telegraphic language or cablese (Alred, Brusaw, & Oliu, 2009). When the use of mobile phones became more common and texting (via the Short Message System, or SMS) was introduced as a quick means of communication, the convenience of texting meant that these clippings and shortenings easily became prolific. In one early study discussed by Crystal (2008), it was reported that the number of texts sent over a single year jumped by almost 95 percent. Similar to the telegram, initial costs per text message were high and the restrictive keyboard made the use of plain language cumbersome. The abundant use of texting to communicate on a daily basis through a platform that was costly and unintuitive (i.e. required a learning curve before the user could master the keyboard) led to a shortening of words and the use of abbreviations. As the popularity of texting increased, so did the use of abbreviations and texting shortcuts. At the same time, this new language form – dubbed textese or textspeak – became common enough that it began being incorporated into everyday spoken communication.

Some view textspeak as a form of 'teenager talk', as the youth took to the communicative platform faster and used it to their advantage (Tagliamonte, 2016a, b). Those who found it useful praised texting for the ease and speed of communication it provided, in some cases finding it preferable to face-to-face communication (Crystal, 2008). Others, however, disparaged the use of texting and textspeak, dubbing the latter the ruin of language and a bane of literacy. As a global phenomenon across languages, however, it could not be easily contained. Interestingly, analyses of texts and Instant Message (IM) communications show that actual use of textspeak is far more conservative than has been claimed in the early days (Baron, 2005). To date, in the year 2017, just over two decades after the SMS was first introduced to mobile phones by Nokia, textspeak has evolved quite considerably (Gayomali, 2012). With the simultaneous evolution of the Internet, the widespread use of smartphones, and the easy availability of Wi-Fi networks or phone-based Data plans, it is far easier to communicate on Internet platforms or online social media than via text alone. This has led to a blurring of the lines between dialects used online and in texting. Although differences exist between the two – most notably because of the nature of the information being communicated and the input method – these differences diminish with people increasingly choosing to post cross-platform. For example, Twitter was created as a social media platform allowing short, 140-character updates of daily life to be shared with the world. Now, it is widely used as an application (or app) on the smartphone, allowing these updates to be posted in real-time. In a sense, this is more convenient than accessing Twitter as a website online; as the 140-character limit is reminiscent of restrictions that used to be imposed on texting, tweeting is therefore akin to ’texting’ snippets of your life to the world. Consequently, although website-specific textspeak might still exist, the difference between how something is expressed online versus how it is said via texting on a phone becomes negligible. In fact, there are very little barriers to written communication: character limits rarely exist, and most phones contain full keyboards. The presence of ’GIF keyboards’ and emojis/emoticons results in a multimodal conversation, making it easier to incorporate creative text forms such as textese. The present study investigates the cognitive consequences of communicating in textese.

In this thesis, the terms *textese* and *textspeak* will be used interchangeably to refer to stylistic choices made in communications both online and through texting. These shortened forms of communication will also be referred to as shortcuts rather than abbreviations. Although abbreviations and shortcuts are in essence the same, this thesis will refer to shortened words in common language as *abbreviations* (both alphabetisms and acronyms, e.g. BBC, NASA etc.), and shortened words in the context of Internet communication and texting as *shortcuts*. The use of textspeak in daily conversations—written, but increasingly spoken as well—has been firmly established by now; in fact, many children growing up in the last two decades do not know a world without texting abbreviations, so widespread have they become (Crystal, 2008; Tagliamonte & Denis, 2008; Sierra, Taute, & Hyman, 2013). The linguistic phenomenon of textspeak is not limited to English, although English has been one of the more prominent languages used online, and has therefore lent many shortcuts to other languages. Textspeak has been observed all over the world as an independent evolution of language based on need and shaped by the individual morphological features and restrictions of each language (Thurlow & Brown, 2003). It is, indeed, a by-product of changing technology and an example of language adaptation to social needs and technological advancements. The rationale for the use and linguistic form of textspeak is well known. However, some questions still remain unanswered: why exactly has textese become so prevalent, and what could it reflect about how we use language, and how language might develop in another decade or so?

To begin answering these questions, we conducted two experiments in order to gauge how textspeak is processed. In Experiment 1, Canadian undergraduate students performed a self-paced reading task out loud where they were presented with sentences that did and did not contain shortcuts. We hypothesised that sentences with shortcuts would be more difficult to read and would therefore have a longer reading time compared to sentences without shortcuts. We also hypothesised that there would be a difference in reading times based on the type of shortcut, with Phrasal Shortcuts (PS) being more difficult to read than Contractions and Clippings (CC). The difference between the two types of shortcuts is covered in more detail later on.

Based on the results of the first experiment, as well as the technical improvements and suggestions, Experiment 2 was constructed in order to gauge how textese is processed in the working memory modality. Therefore, for Experiment 2, participants performed a complex span task to test how shortcuts impacted their processing and memory capacity. We hypothesised that shortcuts would impose a greater load on working memory capacity, thereby resulting in poorer recall compared to controls (non-shortcuts). Again, we expected to see this difference at the shortcut level as well, with an effect of the type of shortcut on recall.

1.1 Thesis Overview

In Chapter 2, an overview of the current literature on textese is presented. The cultural impact of textspeak is examined, as well as how it is defined in current literature. Further literature discussing how textspeak is processed is discussed. Chapter 3 describes the two experiments conducted for this investigation in detail, and includes a brief discussion for each of the experiments. We conclude with a general discussion where we interpret the results from the experiments in relation to each other and the existing literature and analyse the shortcomings of the experiments we conducted. Finally, we discuss some ideas for future research on processing internet shortcuts.

2 Chapter 2: Current Research on Internet and Texting Shortcuts

This chapter outlines the current research that exists on how Internet and texting shortcuts are used, perceived, and processed. In addition, supplementary literature is reviewed that helps suggest how textspeak behaves cognitively and how we can further study it.

2.1 What is textspeak?

Thurlow and Brown (2003) attempted to answer the question of *why* people used texting, as well as how much experimentation in the use of language was observed within messages analysed. The analysis of a corpus of texts showed several results:

1. When analysed, texts sent showed a number of different patterns, including the use of shortenings, initialisms, contractions, repetitions, as well as numerous misspellings and typos;

2. Texts were found to have different functions and therefore the language differed based on the purpose of the message and the person it was being sent to;

3. The main motivation for brevity was not the lack of space but rather the need to communicate quickly and with more ease;

4. A lot of influence of English on texting was found, even in texts in other

languages.

These results were corroborated by af Segerstad (2005), who analysed Swedish text messages for linguistic markers to help determine how and in what format standard Swedish was being adapted in texting. A corpus of Swedish text messages was created via three methods: (1) a questionnaire, whereby the participants themselves selected a sample of their own texts, (2) diaries kept by participants about their texts, and (3) a corpus of text messages collected from participants. The linguistic features of note found in the corpus of text messages fell mainly into four distinct categories, ranging from punctuation (omission of all punctuation, non-standard usage, and lack of space between words), spelling (phonetic respellings, use of abbreviations that were both standard and non-standard, switching between capitals and lowercase etc.), grammar (dropping pronouns, articles etc.) or orthographical substitutions or additions (through the use of emoticons, asterisks, or symbols instead of sounds/words). This adds to the observations made by Thurlow and Brown (2003), and suggests that people choose to communicate via text in a variety of different ways.

Tagliamonte and Denis (2008) studied a corpus of teenage conversations, both spoken and online (written), in order to analyse (1) the kind of textspeak they were using and (2) how the use of language during texting compared to the use of slang in speech. The authors found that several of the observed linguistic features (e.g. intensifiers, the form '*be like*' for reported speech, etc.) were used predominantly in speech rather than online communication. This suggests that, at least 10 years ago, the online medium (in this case IM) was considered more formal than speech. However, IM showed greater variation than speech when it came to the use of these linguistic features, which could also suggest that textspeak is considered a 'hybrid register', somewhere between formal writing and informal speech. This gives us an interesting context for textspeak, demonstrating its versatility and ability to adapt to a situation while also dismissing the idea that this form of communication is used only by those who do not care to differentiate between formal, standard language and informal slang.

The distinct features seen in texting language used across different communicative registers were further examined by studying how young people interact (Tagliamonte, 2016a). The versatility and adaptability of textspeak was firmly established, and the study found that people were able to juggle different registers across multiple platforms during the same time period (e.g. through the course of a day). Again, it was found that the way people 'spoke' or the style they used to communicate depended largely on the person they were conversing with. Several features, however, remained constant across all examples of textspeak, including the use of intensifiers ('so'), the markers for laughter ('haha', 'lol' as an abbreviation for 'laugh out loud'), and the future direction marker ('going to'). The study examined language based on the Toronto Internet Corpus (TIC), which was collected before 2010 and was thus limited to textspeak in a pre-smartphone era. However, the results remain relevant and provide us with greater insight into how people switch between different styles of communication and the factors that shape those styles. Although the study was conducted before the introduction of smartphones, it can be concluded that this type of changing registers is even more relevant now that every form of communication is possible on the same device (i.e. a smartphone or tablet). It remains to be established, however, whether the use of smartphones has made changing registers easier, or whether it is simply more difficult for young people today to keep the informal register separate from formal communications. It could possibly also reflect the fact that a lot of information is now obtained through social media alone, and fewer people opt to read professionally written, more formal pieces.

It is no surprise that, given the increased popularity of smartphones and the ongoing changes in online communication trends, textspeak is constantly evolving. Given its prolific use online and through interfaces that now increasingly accommodate the use of emoticons and GIFs (Graphics Interchange Format; loops of several frames usually derived from television shows or movies) to convey the user's emotions, it is only natural that people have begun incorporating these in their communications. Tolins and Samermit (2016) found that GIFs introduce affective aspects of communication in a medium where users cannot personally convey emotion by 'borrowing' actions that are already available. Tolins and Samerit (2016) studied the way people use GIFs in communication by examining their usage in a group-text conversation. There were two ways GIFs were used: either as a 'bare form' stand-alone response, or as part of a '*be + like*' formation, which allowed GIFs to contribute to the conversation by becoming an element of the syntactic construction of the communication/text. The use of GIFs in conversations and within the framework of syntax itself points to the resourcefulness of speech online. Users adapt to the online features offered to them and compensate for the lack of cues that would otherwise be available to them in conversations face-to-face. Although GIFs used to be singularly seen as an 'online' communication tool, more and more texting apps – although still requiring Wi-Fi or data plans to provide connection – have begun introducing 'GIF keyboards', to make this form of communication not only possible, but encouraged.

2.2 Cultural impact of textspeak

The scrutiny around the various features and effects of textspeak rose along with its prevalence in everyday use. As documented by Crystal (2008), there was widespread criticism against the use of such a dialect, particularly amongst educators. As a result of the way standard language was adapted by textspeak, many people considered textspeak a perversion of what they considered to be the 'purer', correct version of language. Thus, the influence of textspeak on literacy has been studied quite extensively.

A good overview of the field of texting research and whether literacy is hurt by the use of textspeak by young adults is provided in the study by Rosen, Chang, Erwin, Carrier, and Cheever (2010). The authors also examined the effects of textspeak on formal and informal writing based on samples of language produced by young adult texters. Writing was evaluated based on a rubric with six levels, scored from 1 to 6. Each level had a set of criteria evaluating the writing on the basis of syntax, vocabulary, content, and grammar, with a score of 1 demonstrating 'Incompetent' writing and a score of 6 'Superior'. These results were then analysed across genders, education levels, and frequency of textspeak use. In general, it was found that females used more textspeak than males. Increased textspeak use had a negative impact on formal writing. However, this effect interacted with level of education – those who had not attended university or taken only a few university classes showed a greater negative impact on their formal writing than those with a university degree. Thus, postsecondary education seemed to offset negative effects of the use of textspeak. Concurrently, it was found that increased textspeak use had a positive impact on informal writing, that is, the more textspeak participants used, the better scores they got in the informal writing assignment. In general, people without a university degree tended to use substantially more textspeak in their writing than those with a university degree. This demonstrates interesting implications for how we perceive textspeak, as well as the notions of it influencing young adult 'literacy'. Furthermore, the results of this study suggest that textspeak only has a negative effect when it conflicts with the style of writing. Otherwise, it is possible that there is no inherent quality to textspeak that could make it harmful to language learning or use.

Several other studies support this result. Drouin and Driver (2014) examined the style of textspeak, the frequency of texting, and the overall relation of this mode of communication to literacy. The results of their study show that the influence of texting on literacy could be due to the *nature* of textspeak used by people rather than the amount of textspeak used. That is to say, texters who made stylistic choices that were creative by nature (observed mostly with young texters) showed a more positive effect on their literacy as opposed to texters who just omitted letters and parts of words for convenience reasons (as was observed with adult texters). Again, this seems to contradict the previously held view that textspeak on its own is detrimental to language, and demonstrates that it is the way textspeak is used that influences other aspects of writing and language use. It is almost intuitive to conclude that in the absence of self-monitoring, carelessness when writing for everyday personal online communication would affect formal writing more. Similarly, if conscious effort was made to manipulate or creatively exploit the rules of language, linguistic competence would remain intact. In this sense, we can begin to gauge how textspeak could be used to positively influence writing and literacy levels.

Sierra, Taute, and Hyman (2013) examined the use of textspeak in advertisements. They studied whether the presence of textspeak made a difference on how consumers perceived advertisements. They expected consumers to view advertisements with textspeak more favourably than advertisements without based on two theories. The first proposed that the novelty of textspeak would draw more attention, and the second that the familiarity of textspeak, based on its increased use, would introduce more trust in the brand. The researchers conducted several studies which tested different factors, including trust in the brand, familiarity, the likelihood to buy etc. with different groups of participants who were presented with advertisements that did or did not use textspeak to market their product. Results showed that, in general, the advertisements with textspeak led to more positive results than advertisements without textspeak, confirming the original hypothesis that textspeak would draw more attention, as well as would feel reassuringly familiar to consumers.

It is apparent that textspeak is now not only a concern for teachers and educators, who had previously decried its possible negative influence on literacy, but also for a wider audience who can use it strategically for their own purposes. Considering something like this a fad would therefore be erroneous at this point; instead, textspeak should be studied as an example of a natural shift in language and analysed further to see how it affects our perception of language in general, and how we could use it to aid language learning and teaching.

2.3 Processing of morphologically complex words

The linguistic nature of textspeak is both complex and interesting. On one hand, shortcuts can be considered to be morphologically complex units – including phrases or sentences – that may potentially function as independent lexical units. On the other hand, shortcuts may in some cases function almost idiomatically, acting as asides or comments within a conversation in order to supplement the main exchange with emotional information. Their irregular orthography and consequently their unusual phonological interpretation leads to the question of how we might process them cognitively.

Orthographic and phonological processing of morphologically complex words is one of the central questions in psycholinguistics. Several studies have shown that orthographic processing occurs temporally earlier than phonological processing (Ferrand & Grainger, 1993; Grainger, Kiyonaga, & Holcomb, 2006). One experiment testing words and pseudowords with varying typicality used electric brain activation patterns, or Event Related Potentials (ERPs) (Hauk, Patterson, Woollams, Watling, Pulvermüller, & Rogers, 2006). The authors were interested in lexicality and orthographical typicality interaction effects, specifically within 200 milliseconds (ms) post-stimulus presentation. They found that the less typical stimuli elicited a stronger activation in the brain waves 100 ms post-stimulus presentation. Pseudowords showed a greater negative deflection than words around 200 ms post-stimulus presentation, demonstrating an effect of lexicality (Hauk et al., 2006). This provides evidence for the effect of orthography on written language processing, with less typical orthography resulting in stronger brain responses than more typical orthography. There was a significant interaction effect between lexicality and typicality around 160 ms post-stimulus for words, with typical words showing greater negativities. Pseudowords did not show this interaction. Based on these results, it appears that irregular words are more difficult to process, and that orthographic familiarity affects the retrieval of the word's mental lexicon entry. Therefore, it would be harder to read and understand less common words than those that are more frequent. Previous literature demonstrates this to be true. Rayner and Duffy (1986) conducted an eye-tracking experiment where fixation times during reading – the amount of time a participant spent fixating on a single word – was used as a measure of processing difficulty. Words which were more frequent showed smaller fixation times compared to more infrequent words.

In another study, Holcomb and Grainger (2006) registered ERPs to assess the brain's response when testing orthographic word processing. Participants were presented with words preceded by very short-duration primes (words intended to affect the processing of the target) whose availability for processing was limited by both forward and backward pattern masks (brief stimuli presented before and after the prime in order to limit perception). The target was a word that was either a full or partial replication of the prime, or completely unrelated. ERPs were measured during the presentation of the target stimuli. Multiple relevant peaks were found. The first, a P150 response implying a positive deflection at 150 ms post-stimulus presentation, hinted at sublexical orthographic processing occurring early after stimulus onset; unrelated prime conditions showed a more positive going deflection compared to conditions where the primes were partially- or fully-repeated. An N250 response (negative deflection at 250 ms post-stimulus presentation) suggested the existence of the sublexical-lexical interface, again showing a larger (more negative) deflection for trials with unrelated primes than partially- or fully-repeated primes. The last peak that hinted at lexical form processing was a positive-going peak at 325 ms (P325), which was most positive for full repetitions of the prime in the target, hinting at the greatest ease in processing when the priming stimuli matched the target. Other peaks relating to semantics and syntax were also found. These results provide convergent evidence for the early processing of orthography, and suggest that the brain has to work harder and process information longer when the orthography does not match expectations. Therefore, orthography that is difficult to read or irregular by nature, such as novel forms in texting, can be expected to lead to a greater processing load as opposed to something that is more familiar or predictable.

The effect of attention on spoken morphologically complex (inflected vs. derived, i.e. multimorphemic) words as opposed to monomorphemic words, investigated using MEG and EEG, provides a greater understanding of the different stages of processing (Leminen, Lehtonen, Leminen, Nevalainen, Mäkelä, & Kujala, 2013). The researchers used MEG/EEG to investigate the effect of morpheme type when attention was controlled. Participants were instructed to either attend or not to attend, and the stimuli presented to them consisted of different kinds of morpheme structures. Results suggested that attention did not influence the processing of inflected vs. derived words before 150 ms post-critical point. However, after 150 ms had passed, attention modulated the results. This, therefore, suggests that up to a certain time point (in this case, 150 ms), language processing is automatic, and becomes more combinatorial and complex later on. Furthermore, 150 ms is the time previously established as the point where sublexical orthographical processing begins (Holcomb & Grainger, 2006). Taking these results together, we can conclude that the earliest deeper level of processing begins with orthography, before the other aspects of the stimulus are processed.

Orthography is not the only factor which affects the breakdown of a word and how it is processed. This is particularly true for multimorphemic words, where differences in how people break it down into morphemic parts during perception can influence how they lexically process the whole word (Libben, Jarema, Derwing, Riccardi, & Perlak, 2016). Libben et al. (2016) tested whether the breakdown of derived multimorphemic words (e.g. formality = form + al + ity versus formal + ity) had an effect on processing (that is, the participants' ability to recognize and produce it). They found that the type of added suffixes and their properties (length, word and affix frequency, etc.) had an effect on how easily and quickly people recognized the word. This further adds to the understanding of what exactly makes up a complex morphological unit, and suggests that there are multiple factors in addition to orthography, such as how a word is perceived and broken down, which influence how a word is processed. The same factors can be expected to affect processing of neologisms created in texting and online communication.

2.3.1 Processing abbreviations and acronyms

Shortcuts and abbreviations, in general, form a subsection of the research on the processing of complex morphological units. Findings about how these word types are processed provide interesting insights which help point towards possible hypotheses about how textspeak could be perceived and processed, based on its incorporation of abbreviations and shortcuts similar to those discussed above.

A study by Slattery, Pollatsek,and Rayner (2006) investigated the processing of acronyms that were preceded by either the indefinite article *an* or *a* immediately before an abbreviation that began either (1) with a consonant letter (pronounced with a vowel sound; for example, *F* pronounced /ef/), or (2) with a vowel letter (pronounced with a non-vowel sound; for example, *U* pronounced with a semivowel /yu/). The study aimed to investigate the competing effects of phonology and orthography. Results showed that participants were more confused in selecting a or an before the consonant letter (vowel-sound) condition. There was less confusion for the vowel letter (consonant-sound) condition. That is, it was easier for participants to choose the correct indefinite article for a vowel which phonologically began with a semivowel ('a/an UXX'), but it was more difficult to select the correct indefinite article for a consonant which phonologically began with a vowel sound ('a/an FXX'). The hierarchy for the choice of indefinite article seems to favour an initial phonological match, and then an orthographic match. Considering previous research, this is an interesting result. From previous studies (Ferrand & Grainger, 1993; Grainger, Kiyonaga, & Holcomb, 2006; Holcomb & Grainger, 2006; Hauk et al., 2006; Leminen et al., 2013), we know that orthographic processing precedes phonological processing in perception. However, from this result we can see that in production consideration is given to the later, phonological aspect of the stimuli before orthography is considered. This has different implications for the reception of textspeak, and its production. The ease of phonetic pronunciation could very well determine which elements of textspeak enter conversational vocabulary. However, textspeak features mainly in written conversation and intuitively invite focus on the orthography. Considering reception, however, priority is given to orthographical processing over phonological processing. It is possible, therefore, that when writing textspeak, this conflict between phonological production and orthographical reception leads to a greater depletion of resources. Why, then, do we prefer using textspeak in our written conversations? Would it make a difference if textspeak and related shortcuts behaved like independent lexical units, or not?

Although we do not know how processing shortcuts compared to their full forms differs, there is evidence to show that shortcuts might behave like independent lexical units. In 2009, Brysbaert, Sperboeck, and Vanderelst conducted a masked priming experiment where words were primed with either (1) related words, (2) unrelated words, or with (3) related acronyms and (4) unrelated acronyms. Related acronyms were presented in the same case (either all upper case, ’AAA’, or all lower case, ’aaa’) or in mixed case (upper and lower case, ’AaA’). The postulation was this: if the acronym primes behave like lexical words, then both should give rise to the same priming effect for target words as word primes. Results supported this hypothesis, thus providing evidence for the lexical processing of acronyms. Based on this study, we can further extrapolate that textspeak, particularly shortcuts that function as abbreviations or acronyms of shorter phrases, like *LOL* ('laugh out loud'), could very well function as independent lexical units in the brain.

2.4 Textspeak processing

So far, we have reviewed evidence for the popularity of textspeak in daily communication, the suggested advantages (and disadvantages) of this form of writing, as well as the possible implications of how we might actually process and perceive this form of writing. Given that textspeak shortcuts are highly similar to acronyms and abbreviations that have already become standardised language use, it is reasonable to assume that the conclusions drawn about shortened forms in standard language can be applied to equivalent short forms in textspeak. In recent years, experimental interest in textspeak has sharply increased beyond its role in affecting literacy and observations of how it functions. This research has begun to provide us with new information on how texting shortcuts function cognitively.

2.4.1 Textspeak processing cost

There has been a lot of interest in how we actually read textspeak. The processing cost of reading Internet and texting shortcuts has been studied extensively. Considering how ubiquitous this language form has now become, it is only natural that questions arise about how we perceive it, and how it affects our standard language use.

Textspeak has been a concern for educators. However, so far, there has not been any solid evidence that textspeak negatively effects cognition in children (van Dijk, van Witterloostuijn, Vasić, Avrutin, & Blom, 2016). This is a particularly relevant line of questioning now that the internet and smartphone have become something of a staple for many young people. van Dijk et al. (2016) investigated whether the use of text messages had an effect on (1) grammar performance and (2) executive function of children aged 8 to 13. Textspeak proficiency was tested by retrieving participants' text messages or asking them to participate in a monitored group chat, as well as through questionnaires. Participants then performed a number of grammar tests and executive function tests to see whether texting had an effect on either. No significant effect of textspeak was found on grammatical performance or cognition. However, there was a positive correlation between the use of omissions in texts and grammar, implying that either participants who use textspeak are better at surmising when they can or cannot use omission in their texting, or that using omission in their texting allows them to be more conscious of their grammar. There was a non-significant but positive trend between the use of textspeak and executive function, which suggests that, at the very least, textspeak does not harm the cognitive development of children. However, a number of effects of reading textspeak compared to a standard variant of language have been reported.

One study found that the use of textspeak, when evaluated using ERPs, patterned similarly to the use of another language (Berger & Coch, 2010). The N400 is an ERP elicited in response to semantic incongruity (Kutas & Van Petten, 1994). Berger and Coch (2010) hypothesised that participants would show a more delayed and longer N400 for incongruent stimuli in textspeak than standard English; this was derived from the way bilingual speakers pattern in their second language versus their first. Participants were presented with sentences one word at a time; the sentences were in either Standard English or translated fully into textspeak, and the final word varied in semantic congruity. At the end of each sentence, participants had to make a response evaluating the semantic congruity of the final word. Results showed that, as predicted, violations in sentences presented in textspeak showed delayed N400s that lasted longer than N400s for violations in sentences presented in standard English. Therefore, the only cognitive influence textspeak demonstrates seems to be due to its abbreviated nature and in how textspeak elements are stored in the mental lexicon.

One of the first studies to actively investigate the processing cost of reading shortcuts was by Perea, Acha, and Carreiras (2009). The eye movements of participants were tracked as they read Spanish sentences made up of texting shortcuts. The shortcuts presented within the sentences were of two kinds: orthographic (vowels/consonants removed, e.g. rd for 'read') or phonetic (words respelled by how they sounded, e.g. u for 'you'). Results showed that there was a processing cost for reading shortcuts compared to full words, and this cost was higher for phonetic shortcuts as opposed to orthographic ones. In a similar study investigating English shortcuts rather than Spanish ones, McCausland, Kingston, and Lyddy (2015) replicated the result and demonstrated that standard English sentences were read faster than sentences containing phonetic, orthographic, or both types of shortcuts. However, this study did not find any difference in reading times between the various types of shortcuts.

In 2013, Ganushchak, Krott, Frisson, and Meyer extended the Perea, Acha, and Carreiras (2009) study. Participants read sentences containing either shortcuts or their expanded forms, presented in an either semantically plausible or implausible context. Each sentence only contained one shortcut and the participants' eye movements were tracked as they read the sentences. Each sentence was presented with the shortcut and without the shortcut, and each of these sentences were presented twice, once in a semantically plausible condition and once in an implausible condition. During first-pass fixations, the results replicated those of Perea et al. (2009); participants had longer fixations for the shortcuts in the sentences, and therefore took longer to process the shortcuts. Through the second run of the same sentence, however, gaze duration was affected only by the semantic plausibility and not by the presence or absence of a shortcut. Therefore, though there was an established processing cost when the sentence was first read, it seemed to have been off-set by a practice effect.

Further studies were conducted to measure the processing cost of textspeak in a variety of different settings. Head, Helton, Russell and Neumann (2012) evaluated the effect of textspeak on cognitive load whilst conducting another task, in this case (simulated) driving. This was represented experimentally by having participants respond to vibrations from a belt on their torso through a serial response mouse. The vibrations could occur either on their right or left. The researchers hypothesised that if participants had to read a passage as well as make a decision on the vibration task, that is, read while they were 'driving', they would be slower and less accurate on the decision task. Furthermore, if the passage contained textspeak, the results would be even poorer—although this would be modulated by how willing a participant was in general to use textspeak. Those who were more willing, as established by questionnaires, would not perform quite as poorly as those who were less willing. It was also hypothesised that reading textspeak would result in lower reading comprehension scores. This was tested with questions presented some time after the participants had read the paragraphs. The results corroborated the first hypotheses: participants were indeed slower and less accurate on reading trials, and textspeak did result in even poorer results. There was also an effect of willingness/comfort, with better/more willing textspeak users doing better. There was, however, no effect on reading comprehension scores of textspeak. This might be due to the presentation rates (which were slower than usual). This not only demonstrates the danger of reading text messages whilst driving, but also demonstrates the cognitive cost of reading textspeak relative to standard English.

Similarly, another study tested the effect of regular words versus textspeak forms on attention using a sustained-attention-to-response task (SART) (Head, Russell, Dorahy, Neumann, & Helton, 2012). The textspeak stimuli used in this experiment were limited to subset words (shortcuts created from standard English through letter deletions). The SART demands participants to make responses on a serial response mouse to each neutral stimuli but refrain from responding to the target stimuli which were, in this case, the word ’text’ or subset word ’txt’. This allowed the researchers to test which strategy participants employed during the task, as well as examine how participants performed in relation to their textspeak proficiency, about which they were quizzed later. The researchers’ original hypothesis, that participants who were more proficient in textspeak would read the subset words faster and therefore respond with greater commission errors (i.e. responding to the target stimuli when they were supposed to withhold a response), was supported by the results. This implies that familiarity with textspeak leads to faster reading speeds and responses to that form of language, and unfamiliarity may lead to slower processing. Therefore, although there is a processing cost associated with the use of textspeak, it can be controlled with increased textspeak familiarity.

Head et al. (2013) measured the physiological processing cost of reading shortcuts through the use of a Functional Near-Infrared Spectroscopy (fNIRS) to assess the levels of cerebral oxygenation in the prefrontal cortex, fluctuations in which would give an indication of processing cost. Participants were presented with sentences containing either standard English words or shortcuts, followed by a word probe that would or would not make semantic sense in the context of the sentence. This was presented alongside a letter vigilance task, where participants had to monitor an array of letters for a target letter, and the target word could appear before a letter (no load condition) or after it (memory load condition). It was found that sentences containing shortcuts elicited a greater processing cost in the right hemisphere (RH) of the brain than the left hemisphere (LH). This suggests that the cognitive load of reading textspeak was compensated for by the RH working harder in order to maintain performance.

Therefore, there is a general consensus that reading textspeak incurs a greater processing cost compared to reading standard language. The literature reviewed here shows converging results on this across several different types of experiments. This processing cost seems to be modulated by the familiarity of the reader with the given shortcut, with greater familiarity leading to a reduction in the processing cost.

2.4.2 Textspeak lexicality

Given the established processing cost of textspeak, the question then turned to the nature of textspeak, and how it compared to its non-abbreviated, full counterpart. What aspect of its retrieval during language processing incurs the cost, and how are the meanings of the shortcut and its full form stored cognitively?

Ganushchak, Krott, and Meyer (2010) further investigated the processing of shortcuts using ERPs. Participants were presented with shortcuts and pseudoshortcuts, which were matched to existing shortcuts but did not have lexical representations. They had to complete a lexical decision task to decide whether a stimulus was an existing word in the language or not. Pseudoshortcuts were rejected as non-words comparatively faster than shortcuts. The ERPs showed a significant difference between pseudoshortcuts and shortcuts, ranging from 270 milliseconds (ms) to 500 ms post-stimulus onset, with pseudoshortcuts showing a more negative peak than shortcuts. In previous research, this time bracket has been associated with lexical access, suggesting that shortcuts activate a lexical representation in the brain; the easier it is to access that representation, the shallower the peak (Van Petten and Luka, 2006). This result was supported by Ganushchak, Krott, and Meyer (2012), who used a primed lexical decision task to determine how shortcuts were accessed. Participants were briefly shown words that acted as primes to a target word, which was a texting shortcut. These primes could be related to the shortcuts, related to a component of the shortcut, or unrelated to the shortcuts. Overall, a facilitatory effect was seen in response to related and component-related primes and participants responded faster in these conditions, suggesting again that there is an independent lexical representation for the texting shortcuts.

Further support for textspeak lexicality was found in a number of other studies examining particular aspects of textspeak. One study looked at the role of numbers in shortcuts (Ganushchak, Krott, & Meyer, 2010). The goal of the study was to elucidate whether numbers in shortcuts such as *gr8* ('great') or *b4* ('before') were perceived as numbers. A priming paradigm was used where shortcuts or pseudoshortcuts were presented alongside or 250 ms before a target comprising of a varying number of dots. The participant then had to make an odd-even judgement of the number of dots at the end of the trial. Participants were faster in making decisions for match trials in which the number in the shortcut matched the number of dots than for mismatch trials. This suggests that the number concept is activated briefly, even if it is suppressed later. The perception of the shortcut as an individual unit that conveys meaning, as opposed to a string of letters and numbers, additionally supports the notion of the lexicality of shortcuts.

Another study used textspeak from New Zealand to test for lexicality, as well as examine the effect of familiarity and experience on the priming potential of textspeak (Head, Neumann, Russell, Helton, & Shears, 2013). The results showed that identity primes were related to faster and most accurate responses compared to *subset* primes (that is shortcuts derived from regular words through the deletion of a single letter, e.g. 'txt' from 'text') and nonword primes. However, subset primes were related to faster and more accurate responses compared to nonwords. This provides us with further evidence regarding the lexicality of textspeak forms, and the fact that they are processed as words independent of the related full form stored in the mental lexicon. Finally, a study testing the role of textspeak in episodic memory retrieval provided additional evidence in support of the lexical independence of textspeak (Tat & Azuma, 2015). Participants were presented with sentences containing shortcuts in conversational contexts or without context, and then performed a recognition memory task with sentences that contained the same or different abbreviations. Greater recognition rates were found for shortcuts that had been presented in conversational contexts, as well as for shortcuts that showed greatest orthographic similarity with their expanded forms (e.g. deletions like *tmrw* for 'tomorrow'). This again hints at lexical representation of shortcuts in episodic memory.

Therefore, although shortcuts incur a processing cost when they are read, this is not due to the way they are retrieved. Shortcuts are stored as lexically-independent units in the mental lexicon, therefore signifying that they do not need to be broken down into their components in order to be understood.

2.4.3 Summary of research

In the last two decades, a number of studies on the processing of internet and texting shortcuts, in particular dealing with the processing cost incurred whilst reading these shortcuts have emerged. The results had been verified through a number of different experimental methods and design, using a range of experimental tools (including eye-tracking and EEG). With the fast evolution of technology related to the internet and social texting, shortcuts keep changing and are quickly adaptated to everyday language. This creates a need to continually update textspeak studies with new lists of stimuli. Further attempts to understand how these shortcuts are perceived and processed in the brain would, ultimately, contribute towards a greater understanding of language processing and language change in general.

The greater range of tools and experimental setups used to explore this question, the better insight we shall gain into how textspeak functions.

Furthermore, the research outlined above delves in how we process and read textspeak, but less work has been done to explore how textspeak influences other cognitive processes. In the study presented in this thesis, the effect of textspeak on working memory is studied by manipulating the cognitive load using a complex span task. The final part of this literature review deals with relevant research on working memory.

2.5 Working Memory

Working memory is defined as the component of memory which supports ongoing tasks (Baddeley & Hitch, 1974). In 1974, Baddeley and Hitch introduced a model for working memory that presented memory as being split into long-term memory (LTM) and working memory (WM). The LTM contains accumulated knowledge in the semantic and memories for events in episodic memory. WM is comprised of a number of subsystems, including short-term stores and active processing mechanisms. It is described as a system of feedback loops consisting of the Central Executive, and two modality-specific systems: the Visuo-spatial Scratchpad (VSSP) and the Articulatory Loop (AL). Theoretical developments to the model have subsequently been presented in number of publications (e.g. Baddeley, 1983; 2000a; 2000b; 2012). Memory span for verbal material has been found to be affected by a multitude of factors, including word length in number of syllables, possibly temporal duration, and speed of articulation (Baddeley, Thomson, & Buchanan, 1975). These effects led Baddeley to propose that the phonological loop memory system, as the articulatory loop came to be called, has a temporal limit of about 2 seconds. This type of time limit is assumed in Pierre Barrouillet's and Valérie Camos' model of a family of working memory tasks first introduced by Daneman and Carpenter (1980). Based on a series of experiments, Barrouillet and Camos (2001) hypothesise that items in working memory diminish as a result of temporal decay. That is, the longer the interval across which items or tasks need to be maintained, the weaker their representations. They present this theory later as part of the time-based resource-sharing model (Barrouillet, Bernardin, & Camos, 2004). The time-based resource-sharing model relies on attention-switching in order to fulfil cognitive tasks. Barrouillet et al. (2004) hypothesise that the longer the time between attention switches, the greater the chance that the task or information decays within memory and is therefore lost. Therefore, within a complex span task based on the time-based resource-sharing model, cognitive load would be a measure of the ratio of the number of possible retrievals of the item to the time given (Barrouillet et al., 2004). Although the main hypothesis postulates that a task carried out over a short time period would demonstrate better recall as there is greater chance of refreshing, it is nevertheless possible for there to be a high cognitive load over a short time period if the number of retrievals is varied appropriately.

In 1980, Daneman and Carpenter suggested that the reading proficiency of an individual could be related to their working memory efficiency. This hypothesis was tested through the development and usage of the so called *reading span task*.

Subjects read sentences in groups of increasing number of items and were asked to memorise the last words for each sentence. At the end of each group of sentences all the last words had to be recalled. The maximum number of words recalled, the participant's reading span, was recorded. This was tested in both listening and reading, and results showed a decrease in probability of recall for each word as memory load, i.e. the number of sentences read and words to be recalled, increased. Using this kind of paradigm, therefore, we can test for effects of processing load of sentences using the number of words recalled as a measure of the amount of WM resources available for the word recall task over and above the load stemming from sentence processing.

Turner and Engle (1989) analysed the relation of the task to general WM, asking whether the reading span task only correlated reading to remembering words or other materials as well. Results suggested that WM was independent of the kind of material that was being memorised by the participants (e.g. digits or words). The results also suggested that people might be good or poor readers *because* their individual WM capacity is large or small, rather than the level of their reading skills limiting their available WM resources. So called *complex span tasks*, like the reading span that combine a processing task (reading, solving equations, making spatial decisions etc.) and memorising single items (words, letter names, numbers, spatial positions), have ever since become the favoured instrument for studying how working memory resources are distributed across two tasks.

Oberauer, Farrell, Jarrold and Lewandowsky (2016) reviewed the available empirical evidence for the three main theories on how WM processing takes place and discuss the limitations of each based on existing data. WM capacity has been hypothesised to be limited in three ways:

1. Decay model: whereby the representation held in the WM naturally weakens with time (Baddeley et al., 1975; Towse & Hitch, 1995; Barrouillet et al., 2001; 2004).

2. Resource model: in which the representation is only held in the WM as long as there are resources to attend to it (Just & Carpenter, 1992; Case, Kurland, & Goldberg, 1982).

3. Interference model: in which competing cognitive representations 'interfere' with one another, which makes it difficult to hold all of them in WM (Nairne, 1990; Oberauer, Lewandowsky, Farrell, Jarrold, & Greaves, 2012; Oberauer & Lewandowsky, 2014).

Oberauer et al. (2016) conclude that, based on the data, WM makes use of a combination of the Resource and Interference models. This seems to be the most viable account, and suggests that WM processing is dependent on the type of words (or stimuli) introduced to it, as well as the pre-existing resource available to be devoted to it. Given what we know of working memory and its involvement in language, it follows that we should be able to use reading and listening span tasks as a measures to compare language processing load for different types of language material. The review above suggests that the reading span task and its variants can be used to test processing cost and the taxing nature of various stimuli. This task has been used to explore many aspects of language processing, and previously has been used to study, for instance, morphological processing. In 2002, Service and Tujulin studied the effect of morphological complexity and type of morphology (inflectional versus derivational) on WM (testing the phonological loop and the more general aspects of WM), and also how WM resources might differ between neurotypical and dyslexic children. In this experiment, children were presented with a simple word list task (to evaluate the phonological loop component of the WM) and with a complex reading span task (to measure the consequences of morphological complexity on WM). Results showed that, in general, it was easier for the participants to recall base words than inflected/derived words, and that it was harder to recall inflected as opposed to derived (which may tell us something about how they are stored in the mental lexicon). These results were mostly replicated by Service and Maury (2014). These studies also demonstrate that the reading span task and its variants can be used to test differences between how word forms are stored in and retrieved from the mental lexicon.. The review above of previous literature demonstrates the validity of reading span as a tool to study cognitive processing and the effect of different aspects of language on cognition. Studying WM processing in relation to textspeak will allow us to learn more about textspeak and its cognitive representations, as well as how the brain handles new forms of language.

2.6 Overview

There is now a firmly established background of research on textspeak, its effects on literacy and its varied uses, as well as, indeed, its evolution. This interest in textspeak suggests to us how important it is to continue linguistic and psycholinguistic research on this changing form of communication. From previous studies, we know that reading textspeak incurs a processing cost, which is modulated by both familiarity and type of shortcut. A wide variety of tools has already been used to test the processing cost of textspeak. In the current study, our aim was to use newer textspeak stimuli in a sentential context to test the cognitive load textspeak might impose on WM as participants conducts a complex span task, thus hypothesising that shortcut processing load will consume WM resources. The composition of textspeak forms is often morphologically complex and, based on previous research on morphologically complex words and its conclusions we formulate hypotheses of the results of WM experiments involving textspeak. Although there have been a number of studies using textspeak stimuli, very few attempted to differentiate between the types of textspeak, or use a novel experimental setup in order to examine the issue from another angle. Our current study uses that as a rationale to explore the influence of texting shortcuts on processing and memory storage. In the current study, participants were required to read sentences including text shortcuts in a reading span experiment with regular words as memoranda. It was hypothesised that sentences with textspeak shortcuts would result in poorer recall of embedded memory words in comparison to sentences with no textspeak (that is, sentences in standard English). It was also hypothesised that recall would be modulated by the type of shortcut (Phrasal Shortcuts or Contractions and Clippings) in the sentence, as well as participant familiarity with each specific shortcut.

3 Chapter 3: Experiments

3.1 Experiment 1

In this study, the processing cost of newer shortcuts was measured through a self-paced reading task. It was also observed how written shortcuts translate into the spoken medium as participants read each sentence out loud. This study adds to previous research by targeting newer stimuli to measure processing cost. A distinction is made between two types of shortcuts. Phrasal Shortcuts (PS) are acronyms where short phrases or sentences are initialised (e.g. LOL – laughing out loud). Clippings and Contractions (CC) are words shortened by cutting off part of the word or removing a combination of consonants and vowels (e.g. convo – conversation, or srs – serious). Unlike previous studies, phonetic respellings (e.g. b4 – before) were not used as they were not deemed to be used frequently enough in the recent past. This experiment also tested the phonological aspect of reading shortcuts, which is something that has previously been untested in research on texting abbreviations and shortcuts.

3.1.1 Hypotheses

Our main hypothesis postulated that the reading times (RTs) would be shortest for control (filler) sentences and longer for sentences containing phrasal shortcuts (PS) or clippings and contractions (CC). Amongst the two types of shortcuts, we also predicted that PS would have longer RTs than CC, and that the abbreviated, non-expanded forms of both would be read slower than the non-abbreviated, expanded forms. Regarding the phonological aspect of reading these shortcuts, we expected participants to find shortcuts to be difficult to pronounce and enunciate, and that this would influence the time it takes them to read the sentence. Our main hypothesis predicted that reading times (RTs) would be shorter for control (filler) sentences and longer for sentences containing phrasal shortcuts (PS) or clippings and contractions (CC). This was due to the expectation that shortcuts would impose a greater cognitive load during reading than standard English, resulting in longer RTs for sentences with shortcuts than without. Amongst the two types of shortcuts, we also predicted that PS would have longer RTs than CC, and that the abbreviated, non-expanded forms of both would be read slower than the non-abbreviated, expanded forms. This was due to the similarity of each kind of shortcut with standard English: CC show greater orthographic similarity to standard English, which should make them easier to read than PS, which are more orthographically irregular. Regarding the phonological aspect of reading these shortcuts, we expected participants to find shortcuts to be difficult to pronounce and enunciate, and predicted this would influence the time it took them to read the sentence.

3.1.2 Method

3.1.2.1 Participants

A total of 15 Canadian undergraduate university students (8 female and 7 male) were recruited through the Linguistics Research Participation System. Participants were all native or native-like speakers of English (mean age of 21.5 years). All participants provided informed consent for the experiment, and were compensated for their time with one course credit per hour. The experiment was cleared by the McMaster Research Ethics Board. A many as 12 out of 15 participants had had exposure to one or more languages other than English with varying levels of fluency (described on questionnaire as 'some Italian', for example). Of these, only 5 claimed to text in a language other than English. A summary of the top social media use by number of hours per week is presented in **Figure 1**.

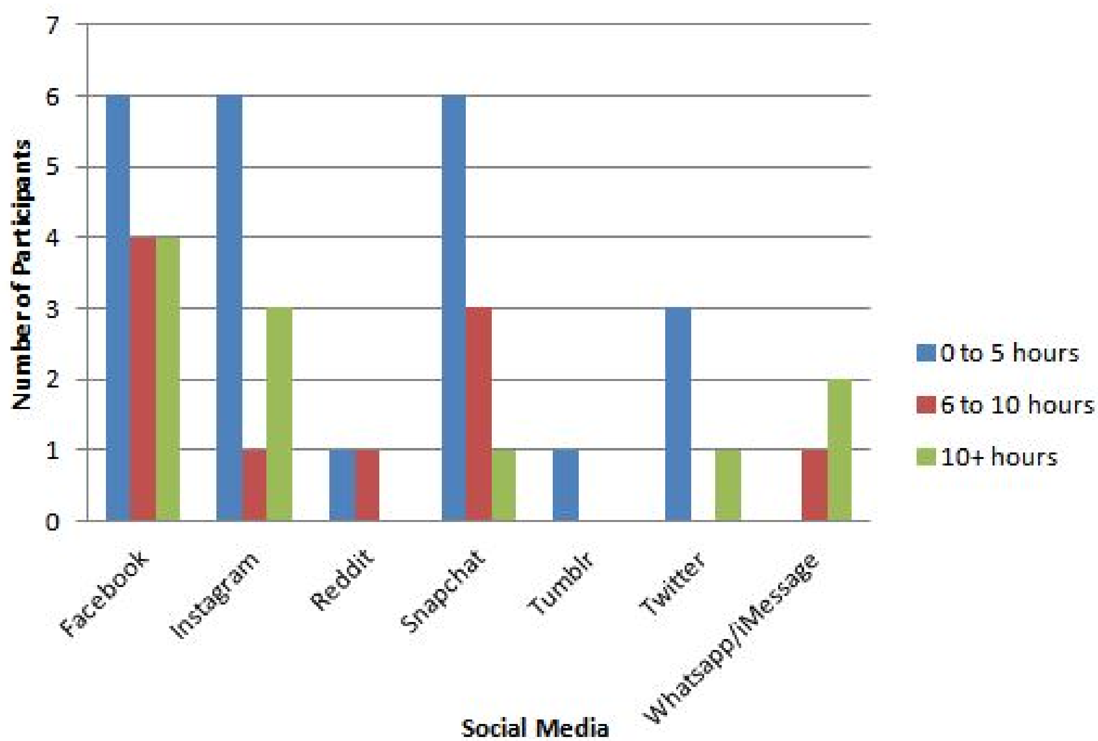

Figure 1: The frequency of Social Media use per week in hours.

3.1.2.2 Stimuli

Sentences used as stimuli either contained a shortcut or did not contain a shortcut (filler sentences). Of the sentences that contained the shortcut, half contained a PS in its expanded (PSE) and half in its non-expanded (PSNE) form. In half of the sentences with a CC it was in its expanded (CCE) and in the other half in its non-expanded (CCNE) form. In total, there were five different kinds of sentences: 27 x PSNE, 27 x PSE, 27 x CCNE, 27 x CCE, 42 x filler, for a total of 150 sentences that were presented to the participants one sentence at a time. These were divided into three equal blocks, with 50 sentences each (9 + 9 + 9 + 9 + 14, respectively).

Sentences were constructed to be seven words in length, plus the shortcut. On average, each sentence was 8.2 words long. The lengths of the sentences varied most for the expanded forms of PS, with the PSNE averaging 8.0 words per sentence, whereas PSE averaged 10.1. CCNE and CCE were consistent in having approximately 8 words per sentence. Character-wise, however, all sentences averaged 32.6 characters with no spaces (SD=5.01). Shortcut placement in each sentence was either in the beginning or at the end of the sentence for PS, and roughly in the middle of the sentence for CC (with a few at the beginning or end). Sentences were constructed without punctuation (except for apostrophes where appropriate) and were in lower case. The order of the sentences was shuffled within each block for each participant (see APPENDIX A for a full list of stimuli used in the experiment).

3.1.2.3 Design and Procedure

When participants arrived, they were informed about the nature of the experiment and given a consent form to sign. They were then seated approximately 100 cm in front of a 21” iMac monitor positioned at eye level. Participants were told that they had to read the sentences presented to them on screen out loud, and that they would be recorded as they did so. All recordings were made on a Samsung Galaxy Tab 4, using a Voice Recording application. Sentences were presented using Superlab 4.0. For each trial, participants were presented with a fixation cross in the centre of the screen, followed 500 ms later with the sentence they had to read out loud. Sentences were presented in the centre of the screen in Calibri size 18. Participants were instructed to press the spacebar key to proceed with the experiment and to go to the next sentence after they had finished reading the current sentence. The experimental blocks were preceded by a short practice block. Each trial consisted of a sentence being read out by a participant, and each participant was therefore presented with 150 trials.

After the experiment had been completed, participants were given a short survey with demographic questions, as well as questions about participants’ social media habits and the tools they used most frequently. When the questionnaire had been completed, participants were asked some additional questions based on the questionnaire. This discussion was also audio-recorded. The questions comprised of the participants’ thoughts on reading internet shortcuts out loud and their personal outlook on how they used shortcuts and how they thought these should and could be used.

3.1.3 Results

3.1.3.1 Reading Times

A total of 2250 trials across all fifteen participants were recorded, excluding the practice trials. Two sentences from the CCNE and CCE groups were removed because of typos. One trial was also removed as the participant skipped the sentence. A 2 x 2 (Shortcut type x Condition type) factorial ANOVA was conducted using the RTs for the PSNE, PSE, CCNE, and CCE groups. Filler was omitted from analyses as it was deemed the NE vs. E comparisons would be sufficient. Therefore, a total of 1369 trials were analysed. The main effect for the type of shortcut was significant ($F(1) = 15.067$, $p = 0.000194 <<< 0.05$). Participants performed significantly faster on trials with CC (mean RT = 3103.58 ms) than on trials with PS (mean RT = 3467.35 ms). There was also a significant main effect of the Condition type, that is, whether the shortcuts were presented Expanded or Non-Expanded ($F(1) = 6.919$, $p = 0.00998 << 0.05$). This showed that participants performed significantly faster on Expanded trials (mean RT = 3214.31 ms) than on Non-Expanded trials (mean RT = 3362.14 ms). There was no significant effect of the Shortcut type x Condition type interaction.

In **Figure 2**, we can see the differences in RTs across the different groups. On average, the RTs for the CC conditions (Expanded and Non-Expanded) showed faster reading times than both PS conditions. The reading times for the expanded forms of the PS and CC shortcuts are shorter than the reading times for the Non-Expanded. In addition, the average reading time for CC (Expanded) is comparable to the average time for the filler (control) sentences.

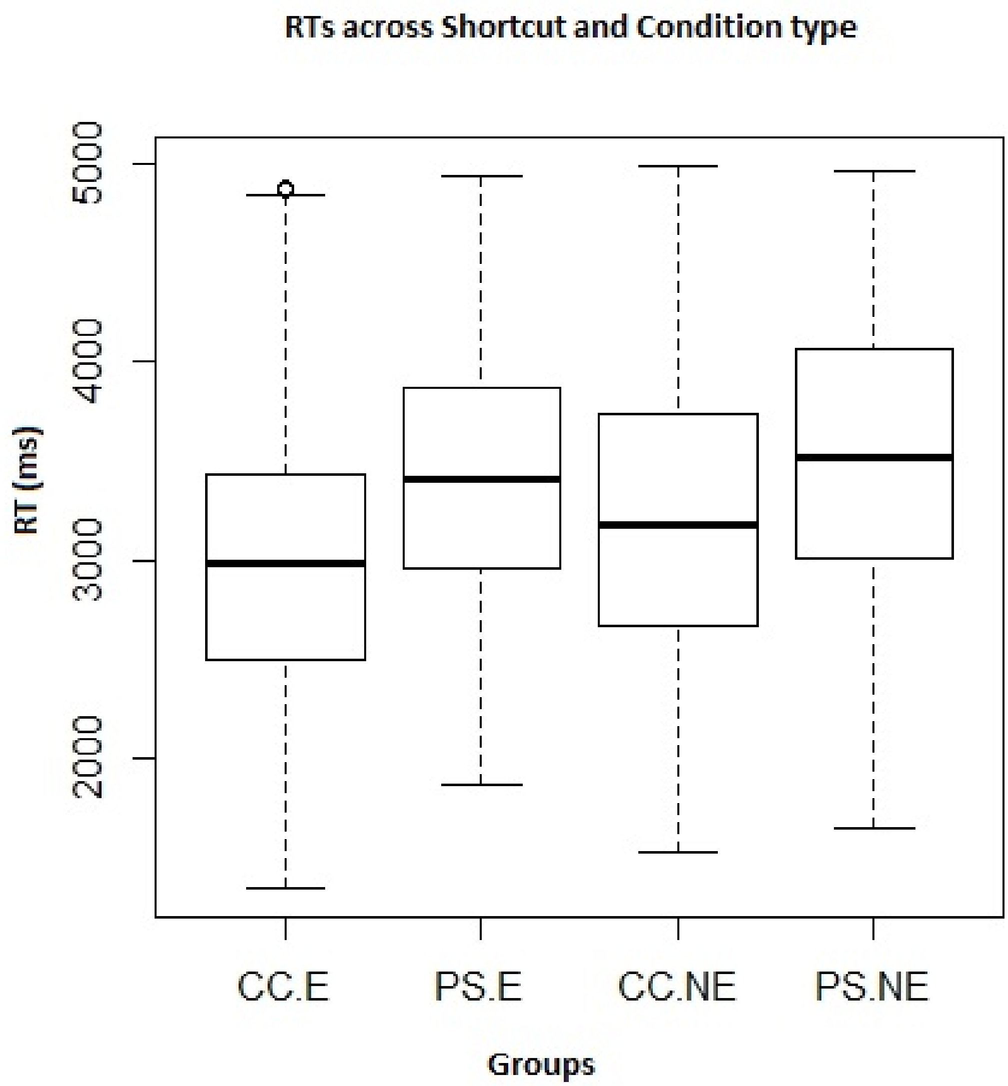

Figure 2: The reading times across type of shortcut and condition in milliseconds (ms).

3.1.3.2 Phonological shortcut processing

Participants had been instructed to read each sentence out loud. They had begun with a practice block and had been instructed to address any questions they might have to the experimenter before the start of the first block. After reading the first few sentences, each participant posed the same question to the experimenter: 'How do you want me to read this?' Although this was the rationale of the experiment, this question suggests that the change in modality within which the shortcuts were to be processed (from visual recognition to oration) led to the participants clarifying what was required of them.

Perceived familiarity with the shortcut presented made a difference in how the participants read it. PSs which were perceived to be more familiar were read either as words (asap, /eɪsæp/), initialism (imo, /aj əm o/ for 'in my opinion'), or as the full, expanded version of what they stood for (jsyk, 'just so you know'). CCs perceived as more familiar were either read as spelt (convo, /kawnvo/ for 'conversation') or as the full,expanded version the CC stood for. In the cases when the participants were unfamiliar with the shortcut, they would either read it as an initialism (mostly for PS), try to make up what it could stand for based on context, or skip it entirely.

3.1.4 Discussion

This experiment was conducted to measure the processing cost of reading morphologically complex textspeak words. Participants were presented with sentences that did or did not contain shortcuts. It was hypothesised that sentences without shortcuts would be easier to read and show shorter reading times than sentences that did contain shortcuts. Within the type of shortcuts, it was also hypothesised that CC would be easier to read than PS.

3.1.4.1 Reading Times

There were significant main effects of Shortcut type (PS vs. CC) and Condition type (NE vs. E), such that reading times were shorter for CC and E than PS and NE. Previous studies have shown reading times to be indicative of processing cost, with shorter RTs pointing to a smaller processing cost compared to longer RTs (Rayner & Duffy, 1986). We can therefore infer that the filler sentences were read the fastest because those sentences were easier to read as they contained no shortcuts. The difference between PS and CC might exist because of the nature of the shortcuts: CC were easier to read aloud because those shortcuts are shortened forms of words and thus more recognizeable than initialisms and acronyms.

We also saw a difference in the mean RTs between the Expanded (PSE, CCE) and Non-Expanded (PSNE, CCNE) groups of shortcuts, with the expanded forms being faster (and easier) to read than the non-expanded forms. Again, this suggests that the expanded forms, which are closest to standard English, are easier to read than the non-expanded forms, which are relatively unfamiliar. It is also possible that the difference between PS and CC processing times is due to a decision phase, where participants took extra time in order to decide how to produce the spoken output, selecting between the expanded form and the other various alternatives (discussed below).

There was no effect of the Shortcut type x Condition type interaction factor. This suggests that the RTs for Non-Expanded vs. Expanded are not dependent on the type of shortcut, and the difference in RTs for the different shortcut types does not depend on whether they were presented in the Non-Expanded group or the Expanded group. One possible reason for this difference could be that processing times are affected solely by the nature of the shortcut, and not by whether it is in its Non-Expanded or Expanded form. Similarly, the reason we see an effect for Condition type (NE vs. E) could be because the Expanded sentences were easier to retrieve meaning from than the Non-Expanded sentences.

3.1.4.2 Phonological shortcut processing

The participants all asked the researcher how the sentences should be read, a fact that seems to hint at their uncertainty. This is interesting as it implies that a change in medium—from reading/writing these shortcuts to having to read them out loud—makes a difference in how the participant has to deal with the shortcuts and makes it harder. This is not a novel observation; previous research has shown that there is a difference between orthographic and phonological processing.

An EEG experiment that modulated a negative going N250 component, which has been shown to occur in response to sublexical processing when visual word recognition is taking place, showed that effects due to orthographical priming occurred earlier compared to phonological effects (Grainger, Kiyonaga, & Holcomb, 2006). Furthermore, orthographical priming elicited a different pattern of ERPs compared to phonological priming. An ERP study on orthographic word processing showed the presence of an early peak reflecting sublexical orthographic processing, followed by peaks reflecting the processing of other aspects of word processing (Grainger & Holcomb, 2006). The fact that orthographic processing may precede phonological processing suggests that it would take longer to process and read words out loud than it would to read them visually. This could be another factor that contributed to the hesitance to read the shortcuts out loud. With the participants realising that they were used to processing shortcuts strictly orthographically, they might have been less willing to say them out loud as it was not something they were used to doing.

Furthermore, orthography that is more typical for a language has been reported to be processed differently from orthography that is less typical (Hauk et al., 2006). Studies have also shown the influence of other factors, such as word frequency and length on processing (Asadollahi & Pulvermüller, 2000). Altogether, these factors could have contributed to the difficulty participants found in reading shortcuts in the current study.

3.2 Experiment 2

Based on the results of Experiment 1, we constructed another experiment with better controlled stimuli and a new experimental design to evaluate how shortcuts are cognitively processed. As some of the effects on reading times in Experiment 1 could have resulted from an extra decision stage added to shortcut processing in a read-aloud task, we aimed to target cognitive cost in a different way. In Experiment 2 we, therefore, implemented a task to gauge the impact of reading shortcuts on Working Memory. A complex reading span task was used (Daneman & Carpenter, 1980) which combined a reading task with memorisation of words. In this task, participants are presented with a number of sentences and asked to remember a specified word for recall at the end of the trial. Participants are then scored on total correct recall, and we expect this recall to be modulated based on the cognitive load of the sentence within which the memory words are embedded.

3.2.1 Hypotheses

We hypothesised that the shortcuts would be more difficult to process compared to equivalent control sentences in standard Canadian English. If the Non-Expanded shortcuts result in a processing cost compared to expanded forms, participants should show poorer recall of memory words presented in connection with sentences with shortcuts compared to sentences without shortcuts. We also hypothesised that phrasal shortcuts would result in poorer recall than contractions and clippings. Similar to our predictions for Experiment 1, this is because we expect phrasal shortcuts to be more difficult to process due to their irregular orthography. Contractions and clippings, which are more similar to standard English, should therefore be easier to process in comparison. We further varied the location at which memory words were presented: either interrupting sentence processing just before the shortcut or its expansion, or after the sentence was over.

The former position could be more sensitive to shortcut processing if this had a localised processing cost. In this case, we would predict an interaction between Shortcut condition and Memory word position such that fewer memory words would be remembered in connection with sentences with shortcuts than those with expansions, and this difference would be larger when the memory words were presented inside the sentences than after the sentences. Otherwise we expect no such interaction effect.

3.2.2 Method

3.2.2.1 Participants

A total of 53 Canadian undergraduate university students (45 female, 7 male, 1 other) were recruited through the Linguistics Research Participation System. All participants self-identified as native or native-like speakers of Canadian English, with a mean age of 20.7 years. Three participants identified a first language other than Canadian English (Ukrainian, Punjabi, and Cantonese). Out of 53 participants, 29 had had exposure to one or more languages other than English with varying levels of fluency (described on the questionnaire as 'some Italian', for example). Of these, 15 claimed to ever text in a language other than English, and only 5 used texting shortcuts in that language. All participants provided informed consent for the experiment and were compensated for their time with one course credit per hour. The experiment was cleared by the McMaster Research Ethics Board.

3.2.2.2 Stimuli

Sentences: Sentences either contained a shortcut (Non-Expanded condition) or contained an expanded form of the same shortcut (Expanded condition) (e.g. 'Their convo lasted for hours.' [Non-Expanded] and 'Their conversation lasted for hours.' [Expanded]). For sentences where the expanded form of the shortcut did not syntactically fit within the sentence, a semantically-equivalent sentence was used (e.g. 'He got drunk af tonight.' [Non-Expanded] and 'He got very drunk tonight.' [Expanded]). There was a total of 100 sentences in both conditions, divided equally into two blocks. The words to be memorized appeared in all caps and red font, and were positioned either at the end of the sentence, or inside the sentence immediately before the shortcut.

Similar to the stimuli for Experiment 1, the sentences in Experiment 2 contained two types of shortcuts: phrasal shortcuts (PS) and contractions and clippings (CC). PS shortcuts were condensed forms of short phrases (e.g. 'lol' for *laugh out loud*), whereas CC shortcuts were shortened forms of single words (e.g. 'convo' for *conversation*).

Sentences were 6.95 words long on average. The lengths of the sentences varied depending on the condition and the type of shortcut. Sentences in the Non-Expanded condition with PS were 6.28 words on average, and sentences in the Non-Expanded condition with CC were 6.72 words on average. Sentences in the Expanded condition with PS controls were 8.08 words on average, and sentences with CC controls were 6.72 words on average. The length for the Expanded PS sentences was longer as phrasal shortcuts, when expanded, added to the length of the sentence in the Non-Expanded condition. The difference in length was not likely to increase the likelihood of false load effects for shortcuts, as we hypothesised that PS sentences would show greater processing cost in the Non-Expanded than in the Expanded condition. If PS stimuli in the Non-Expanded condition demonstrated a greater processing cost than the stimuli in the Expanded PS condition, it would be so despite the increased average length of the Expanded sentence, lending credence to our hypothesis that shortcuts are more difficult to process.

Shortcut placement varied for each sentence. Shortcuts were presented either at the beginning of the sentence (either as the first or second word in the sentence), in the middle, or at the end (second-last or last word in the sentence). For PS, 3 shortcuts were positioned at the beginning of sentences, 14 in the middle, and 33 at the end. For CC, shortcuts were positioned 7 in the beginning, 23 in the middle, and 19 at the end. We used only syntactically simple sentences, and all sentences began with a capital letter and ended with a full stop (see APPENDIX B for a full list of the sentences used in the experiment).

Memory Words: The memory words were retrieved from the MRC Psycholinguistic Database available on line at (http://websites.psychology.uwa.edu.au/school/MRCDatabase/uwa_mrc.htm). All memory words were four-letter long, monosyllabic concrete nouns controlled for familiarity, number of phonemes, concreteness and imageability. They comprised of only 3 or 4 phonemes. The concreteness ratings for the nouns chosen were restricted to the range of 350 to 650. Imageability ratings were restricted to be between 500 and 700, and Familiarity ratings were between 500 and 650. All three of these features were rated on a scale of 100 to 700 (see APPENDIX C for a full list of memory words used in the experiment).

3.2.2.3 Design and Procedure

The experimental setup was a 2 (Non-Expanded vs. Expanded) x 2 (CC vs. PS) x 2 (memory word inside sentence vs. after sentence) design where the Shortcut condition was a between-subjects variable and the two other variables were within subjects. Participants were given an Information and Consent sheet to sign upon arrival. After they had signed the consent sheet and had been allowed to ask any questions they had, they were given a Demographic Questionnaire to fill out. This questionnaire contained questions about their age, education, gender, languages spoken, texting habits, social media use, any head injuries they may have suffered, and medications they took. After the survey was completed, participants were seated 1 meter from a 21” iMac monitor positioned at their eye level. The experimenter briefed the participant on the experiment and the task they had to perform. The experimenter then pointed out the keyboard keys they would be using to answer the comprehension questions. They were told to recall the words out loud to the experimenter. Participant responses were audio-recorded using Audacity.

Sentences were presented using Superlab 5.0. Participants started with a short practice block before beginning the experimental blocks to allow them to familiarize themselves with the experiment setup. At the beginning of each trial, participants saw a fixation cross in the centre of the screen for 500 ms, followed by a sentence presented to them one word at a time via Rapid Serial Visual Presentation (RSVP). Participants saw each word on screen for 400 ms. Sentences were presented in Lucida Grande size 30 in Sentence case format. Memory words were presented in Lucida Grande size 36, red, bolded, and in all caps, and were on screen for 1000 ms. Each sentence was followed by a yes/no comprehension question about the content of the sentence. After the last word had been presented, followed by a period, participants saw a question on screen, prompting a yes/no answer. Questions were presented in full at the end of each sentence in Lucida Grande size 36. Answering the question with a keypress to indicate either 'y' or 'n' led to the next sentence, beginning with a fixation cross again. Each trial was five sentences long; after the comprehension question for the fifth sentence, participants were prompted on screen to orally recall the five memory words in the order they had been presented. They were instructed to say 'BLANK' when they could not recall a word.

The order of the sentence presentation varied according to the version each participant had been assigned. The between-subjects Expanded and Non-Expanded conditions had four versions each: A, with trials presented in order 1 to 20; B, with trials presented 20 to 1; C, with trials presented in order 1 to 20, but the sentences within each trial inverted in order; and D, with trials presented 20 to 1 with sentence order inverted. Each participant was assigned to either Non-Expanded-A (NE-A), NE-B, NE-C, or NE-D, or Expanded-A (E-A), E-B, E-C, or E-D versions. Therefore, a participant assigned to the Expanded condition only saw sentences without shortcuts, whereas a participant assigned to the Non-Expanded condition only saw sentences with shortcuts. Memory word positions were counterbalanced across participants in such a way that each sentence was presented with the memory word both at the end of the sentence and within it.

After participants had completed the experiment, they were asked to complete a shortcut familiarity survey. The survey listed the shortcuts they had seen in the sentences and asked participants to provide a full form for each shortcut, as well as rate each shortcut on a scale of 1 to 7 on familiarity, with 1 being 'I have never seen this before' and 7 being 'very familiar'. When they were finished, participants were told they would be granted 1 credit for this experiment and told they could ask any questions they might have.

Experiment Scoring

Recall: Participants were scored as they recalled the words at the end of each trial. The maximum possible score of a trial was 5. Participants were scored on the total number of items recalled correctly, as well as on the total number of items recalled correctly and in the correct position. For example, a list of 'PARK, TANK, FOOT, NECK, BRAT' recalled correctly would have an Item and Order score of 5 each. If it was recalled as 'PARK, TANK, NECK, FOOT, BRAT', it would have an Item score of 5 but an Order score of 3. The same list recalled as 'PARK, BLANK, NECK, FOOT, BRAT' would have an Item score of 4 and an Order score of 4. The first five words recalled by each participant were scored; in cases where participants recalled an extra word, the last word was not scored. In cases where participants recalled fewer than five words, the missing words at the end of the list were scored as 'blank's. Participants who consistently recalled fewer than 5 words were prompted to recall 5 words and say 'blank' for those they could not remember.

Shortcut familiarity Familiarity scores for each participant were compiled from the surveys they had filled out. Scores were cross-referenced against the expanded form of each shortcut, and only scores which matched acceptable expanded forms were used. Other unacceptable forms and related scores were removed.

3.2.3 Results

3.2.3.1 Frequency of texting

Before beginning the experiment, participants answered demographic questions, questions about their linguistic background, as well as questions about their texting and social media use. Participants were Canadian University students who self-reported their use of abbreviations and shortcuts during texting on a 7-point scale (1 = I do not use them at all, 7 = I use them all the time). The average score was 4.15 (sd = 1.34). Alongside shortcut use, participants reported how familiar they were with shortcuts and their meanings (1 = I do not know them at all, 7 = I know what all of them mean and stand for). This produced an average score of 5.13 (sd=1.1). Over 50 percent of total participants reported sending 50 or more texts on a daily basis (**Figure 3**).

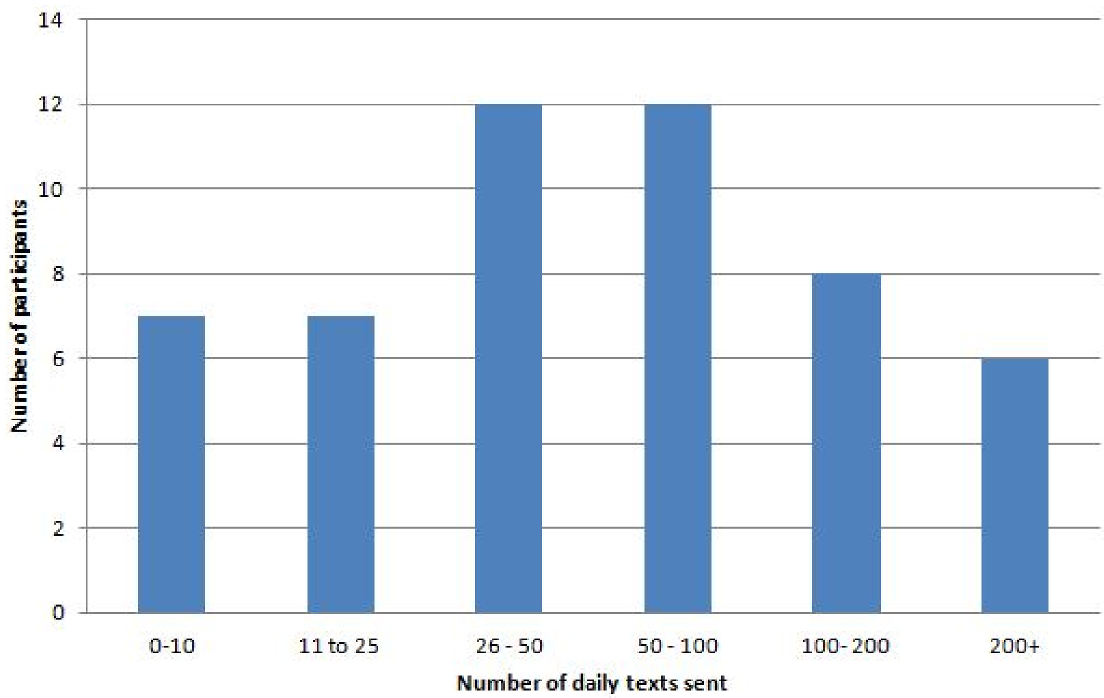

Figure 3: The number of texts reported as sent by participants every day.

3.2.3.2 Social media use

On the demographic survey, participants were additionally asked to list the three social media applications they used most frequently and choose how much time they spent using each of them every week. The choices were 0 to 5 hours, 6 to 10 hours, or 10+ hours per week. **Figure 4** summarises the number of hours spent per week over different social media.

The three most-used social media platforms across all participants and time brackets were Facebook, Instagram, and Snapchat. Snapchat was the most frequently used platform for 0 to 5 hours per week. Instagram was used more frequently for 6 to 10 hours per week. Finally, Facebook was used the most per week, with the greatest number of participants reporting using Facebook 10+ hours a week. It is worth noting that the three platforms allow for multimodal communication that includes images, memes, GIFs, video clips, etc. in addition to plain text. More text-based social media websites, like Twitter, Tumblr, and Reddit, were used far less frequently.

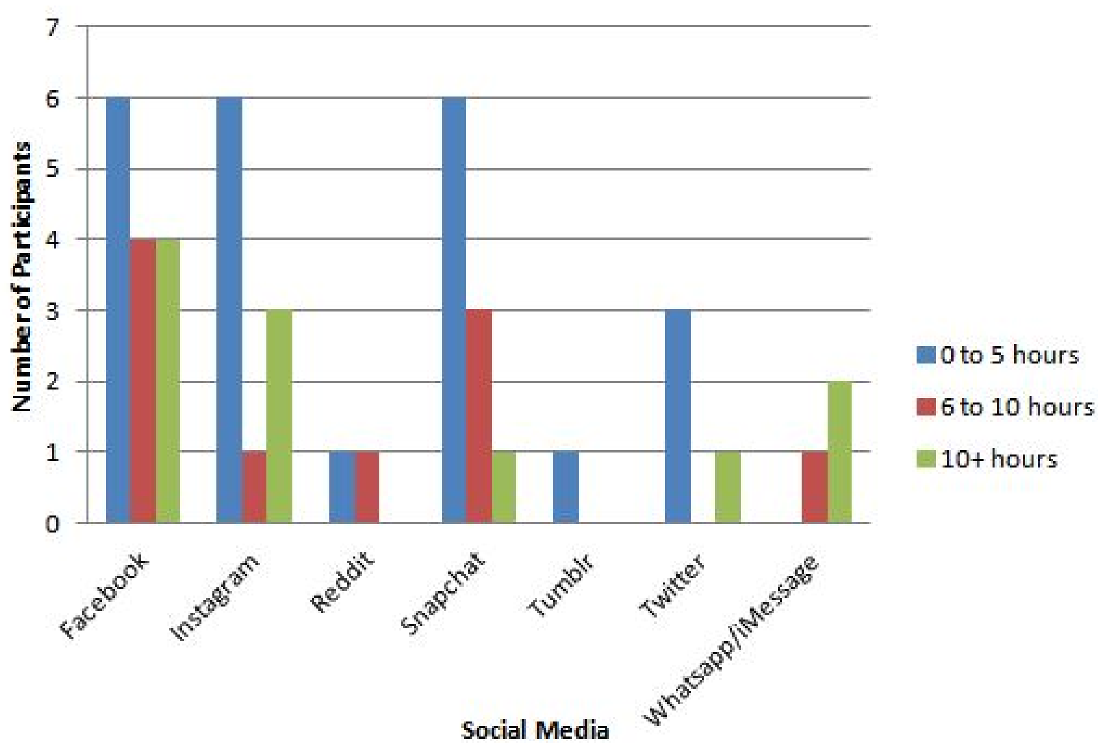

Figure 4: The number of hours spent by participants on social media per week.

3.2.3.3 Shortcut familiarity

At the end of the experiment, participants were asked to fill out the Familiarity

Survey. The survey consisted of a list of shortcuts and participants were asked to rate them on a scale of 1 to 7 for familiarity. Participants were also asked to provide the expanded form of each shortcut.

Table 1 lists each given shortcut with the average familiarity score across participants. Overall, the pattern of scores was similar for both PS and CC. Shortcuts like 'lol' and 'fb' showed higher average familiarity ratings with less variability (e.g. 6.98 (sd = 0.14) and 6.62 (sd = 0.79) respectively). Lesser known shortcuts like 'lbr' and 'p' showed lower average ratings (e.g. 1.39 (sd =1.18 and 1.73 (sd = 1.67)). PS showed a greater range of scores as compared to CC, which had a smaller range.

The shortcuts listed in the survey were the same ones as those utilised in the experimental stimuli. The meaning of these shortcuts was fixed and, to some extent, predictable in context. However, presented on the survey without context, some shortcuts could be interpreted in multiple ways. The shortcuts were treated as familiar in subsequent analyses whether or not they fit the stimulus context of the experimental sentences. Responses where the participant offered an unacceptable expansion were removed from further analyses. In these cases, the related familiarity score would have acted as a confound. Shortcuts where ratings were left blank were also removed, resulting in an overall of 4.4 percent of responses being removed.

3.2.3.4 Shortcut expansion

Out of the one hundred shortcuts presented on the survey, twenty-nine were offered expansions that differed to some degree from the ones used in context within the sentence stimuli. Two of those alternatives were due to either changing the expansion to fit the abbreviation (e.g. expanding 'hbu' as 'how 'bout you' instead of 'how about you') or giving an incorrect (but acceptable) expansion (e.g. expanding 'aka' as 'as known as' instead of 'also known as'). Fifteen shortcuts were given alternative expansions which, although not fitting the experimental context, were common uses of the shortcut (e.g. expanding 'atm' as 'automated teller machine' instead of 'at the moment') and therefore accepted for analysis in the sentence experiment. Five differed because of alternative word choice, although the meaning remained the same (e.g. expanding 'wrt' as 'with regards to' instead of 'with respect to'), and so these were accepted for analysis as well. Finally, eight shortcuts showed varying expansions due to choice of a different inflection (e.g. expanding 'lol' as 'laugh out loud' instead of 'laughing out loud'). Table 1 lists the shortcuts that participants were asked to evaluate and their intended expansions, as well as the average Likert scores and standard deviations. Out of the one hundred shortcuts presented on the survey, twenty-nine were offered expansions that differed to some degree from the ones used in context within the sentence stimuli. Two of those alternatives were due to either changing the expansion to fit the abbreviation (e.g. expanding 'hbu' as 'how 'bout you' instead of 'how about you') or giving an incorrect (but acceptable)

expansion (e.g. expanding 'aka' as 'as known as' instead of 'also known as'). Fifteen shortcuts were given alternative expansions which, although not fitting the experimental context, were common uses of the shortcut (e.g. expanding 'atm' as 'automated teller machine' instead of 'at the moment') and therefore accepted for analysis in the sentence experiment. Five differed because of alternative word choice, although the meaning remained the same (e.g. expanding 'wrt' as 'with regards to' instead of 'with respect to'), and so these were accepted for analysis as well. Finally, eight shortcuts showed varying expansions due to choice of a different inflection (e.g. expanding 'lol' as 'laugh out loud' instead of 'laughing out loud'). Table 1 lists the shortcuts that participants were asked to evaluate and their intended expansions, as well as the average Likert scores and standard deviations.

Table 1. List of shortcuts used in stimuli by Shortcut Type, showing mean Likert score and standard deviation across participants. They are ordered here as participants would have seen them in the NE/E-A version of the experiment.

PS				CC			
Shortcut	Expansion	Mean	SD	Shortcut	Expansion	Mean	SD
nbd	no big deal	6.02	1.65	p	pretty	1.73	1.67
jsyk	just so you know	3.52	2.16	pic	picture	6.53	1.25
hbu	how about you	6.53	1.14	fb	facebook	6.58	0.82
lmao	laugh my a** off	6.60	1.01	spose	suppose	3.33	2.07
eta	estimated time of arrival	4.55	2.52	fave	favourite	6.57	0.89
tbh	to be honest	6.86	0.45	abt	about	4.17	2.37
brb	be right back	6.75	0.91	attn	attention	4.83	2.27
atm	at the moment	6.50	0.96	srs	serious	4.19	2.29
hmu	hit me up	4.00	2.55	min	minute	6.34	1.40
byob	bring your own beer/booze	5.58	1.84	whatevs	whatever	6.15	1.60
bff	best friend forever	6.79	0.66	lil	little	5.45	1.92
diy	do it yourself	6.28	1.28	yr	your	5.13	2.07
lbr	let's be real	1.39	1.18	pg	page	5.66	2.06
aka	also known as	6.35	1.30	knw	know	2.47	1.75
stg	swear to God	1.93	1.89	convo	conversation	6.51	0.82
rofl	roll on the floor laughing	5.60	1.82	wat	what	5.58	1.81
yolo	you only live once	6.28	1.51	tho	though	5.57	1.81
omw	on my way	6.15	1.39	bc	because	6.62	0.79
wrt	with respect to	1.60	1.44	ep	episode	2.71	2.28
imo	in my opinion	3.50	2.60	rly	really	5.92	1.36
asap	as soon as possible	6.94	0.24	tmrw	tomorrow	6.50	1.11
gtg	got to go	6.34	1.37	smth	something	3.20	2.42
idk	i don't know	6.71	0.96	sry	sorry	6.14	1.41
btw	by the way	6.91	0.35	gf	girlfriend	6.24	1.38

PS				CC			
Shortcut	Expansion	Mean	SD	Shortcut	Expansion	Mean	SD
ily	i love you	6.66	0.78	hr	hour	5.25	2.19
faqs	frequently asked questions	4.80	2.54	v	very	3.74	2.49
ttyl	talk to you later	6.37	1.55	ppl	people	6.62	0.88
rn	right now	6.58	0.72	ridics	ridiculous	4.15	2.15
gtfo	get the f***out	5.72	1.74	evn	even	3.30	1.88
lmk	let me know	3.82	2.55	def	definitely	6.10	1.58
jk	just kidding	6.72	0.69	tru	true	6.04	1.51
idc	i don’t care	6.36	1.21	tht	that	3.84	2.40
lol	laugh out loud	6.98	0.14	evry	every	4.33	2.03
fml	f*** my life	6.40	1.29	pls	please	6.49	1.31
hs	high school	3.92	2.42	anon	anonymous	4.70	2.30
tba	to be announced	5.20	2.11	congrats	congratulations	6.56	1.36
fyi	for your information	6.57	1.14	probs	probably	6.45	0.93
irl	in real life	4.94	2.42	appt	appointment	5.56	1.93
np	no problem	6.72	0.60	bday	birthday	6.52	1.29
dw	don’t worry	5.60	2.09	msg	message	6.40	1.13
iirc	if i recall correctly	1.29	1.21	txt	text	6.28	1.33
idgi	i don’t get it	2.90	2.32	diff	different	6.02	1.32
af	as f***	6.21	1.30	obvs	obviously	6.47	0.97
tfw	the feel when	2.52	2.21	bio	biology	5.73	1.76
pov	point of view	4.24	2.64	totes	totally	5.34	1.96
smh	shake my head	6.04	1.37	jst	just	3.43	2.42
ty	thank you	6.54	1.20	fab	fabulous	5.96	1.17
icymi	in case you missed it	1.72	1.66	esp	especially	5.47	1.96
omg	oh my God	6.98	0.14	cn	can	1.37	1.07
wth	what the hell	6.27	1.30	fam	family	6.07	1.82

3.2.3.5 Recall

The percentage Accuracy on the presented comprehension questions was calculated for every participant. Participants with an accuracy of less than 60 percent were eliminated from analyses; this resulted in the removal of data from three participants. A total of 4900 trials were used in analyses across 49 participants, excluding the practice trials. Furthermore, trials where the participants did not accurately answer the comprehension question were also eliminated. In total, 3956 trials were used for analysis. A binomial generalised linear mixed-effects model was used to evaluate the effect of Condition type on Order and Item scores. Data was modelled across all trials after removing all trials on which comprehension question Accuracy scores were 0. Therefore, out of a total of 5200 trials, 3956 trials were analysed using the lme4 package (Bates, Maechler, Bolker, & Walker, 2015) in R (Version 3.3.2; R Core Team, 2016).

Accuracy: Participant Accuracy was analysed across Condition type using the Kruskal-Wallis rank sum test. Results demonstrated a significant difference of Accuracy across Condition, ($H(1) = 9.785$, $p < 0.05$), suggesting that participants were significantly worse at answering comprehension questions for sentences in the Non-Expanded condition as opposed to the Expanded condition.

Recall Scores: Mixed-effect models for Order and Item scores were set up separately, with the Order and Item scores as dependent variables. Fixed effects were added to the null model one at a time.

Order Recall The results for the Order Recall analyses are summarised in **Table 2**. There was a significant main effect of Serial position within presented trials, with $p <<< 0.05$ (see **Figure 5**). Percentage recall of the memory word presented as the first word of the trial was greater than the recall of the word presented as the second word. This decreasing pattern continued across the trial, and average recall was poorest for words presented last in the trial. This effect was seen across both types of shortcuts (PS and CC), with the Shortcut type x Serial position interaction reaching significance, $p = 0.028 < 0.05$. The effect was also significant across the two conditions (Non-Expanded and Expanded), with the Condition type x Shortcut type x Serial position interaction reaching significance, $p = 0.018 < 0.05$. In Figure 5, the overall average recall across all serial positions is slightly higher for the Non-Expanded condition than the Expanded condition.

The final result of note for Order recall was a four-way interaction between Condition type x Shortcut type x Familiarity x Memory word position, with $p = 0.0091 << 0.05$ (see **Figure 6**). This was plotted by splitting the data analysed earlier by Familiarity: the Low familiarity group contained the responses for all trials where participants had rated the shortcut presented to them with a score of 4 or less out of a total of 7, and the High familiarity group contained responses scored 5 or more (maximum 7). Percentage recall was plotted across memory word position, that is, whether participants saw the memory word to be remembered at the end of the sentence (outside) or within the sentence, right before the shortcut (inside). For the Low familiarity group, in general average recall across participants was better when the memory word was outside the sentence than when it was inside. The Expanded CC group showed the greatest

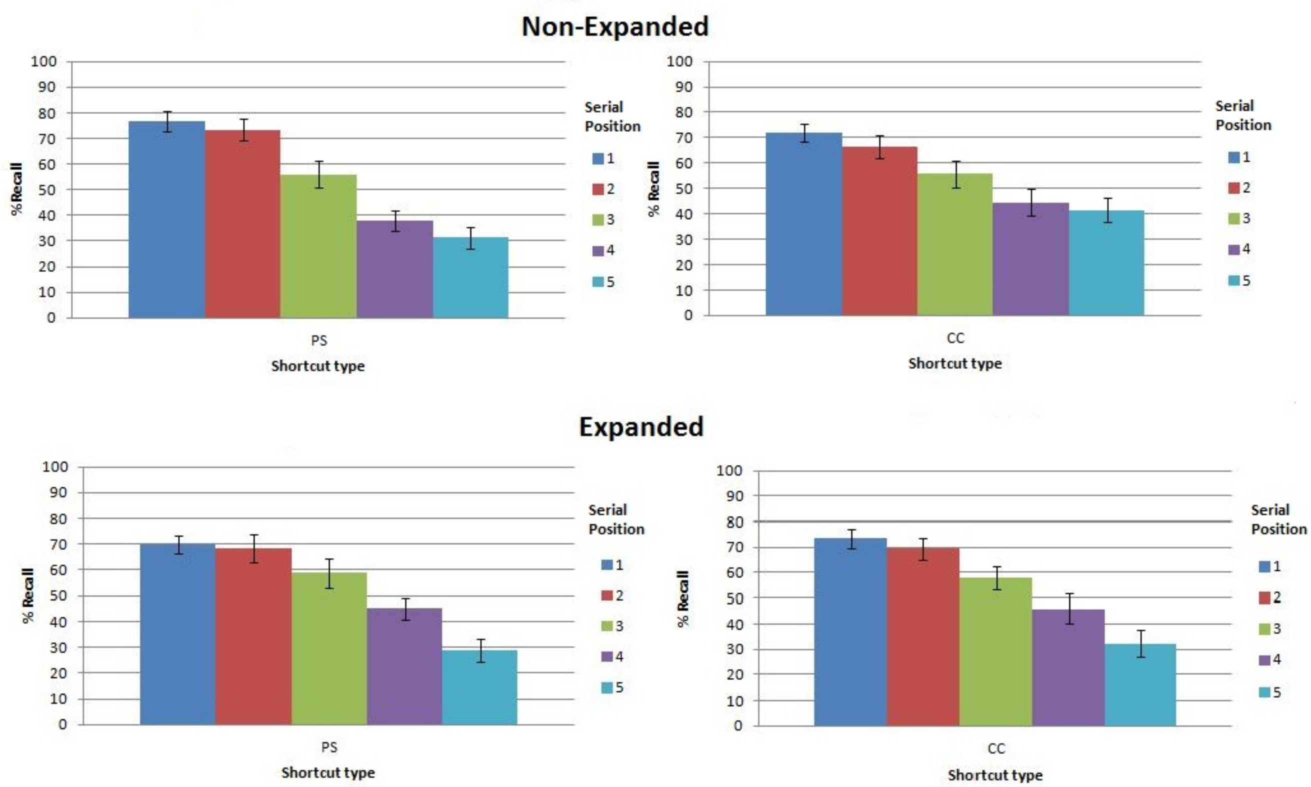

Figure 5: The top figure shows the recall across shortcut type for the Non-Expanded condition, and the bottom figure shows the recall across shortcut type for the Expanded condition. The x-axis shows shortcut type (phrasal shortcuts vs. clippings and contractions) and the y-axis shows the average percentage of words recalled across all trials and participants, based on serial position (see legend). Each bar shows a percentage Std. Error value.

difference in recall based on memory word position. Non-Expanded CC showed an opposite effect, with recall improving when the memory word was within the sentence than when it was outside. Recall was similar across conditions for PS. For the High familiarity group, the results were the opposite: average recall improved when the memory word was inside the sentence compared to when it was outside. Expanded PS showed the greatest increase in recall, whilst recall improvement for Non-Expanded PS and Expanded CC was comparatively smaller. Percentage recall for Non-Expanded CC different compared to the rest, with recall decreasing when the memory word was inside the sentence rather than when it was outside. There were no other significant results, although a few other interactions approached significance.

Item Recall Results based on Item recall scores were comparable to those based on the Order scores. There was a significant main effect of Serial position within presented trials, with $p < 0.05$, as well as a significant effect of the Shortcut type x Serial position interaction, with $= 0.0096 < 0.05$, and the Condition type x Shortcut type x Serial position interaction, with a $p = 0.0079 < 0.05$. There were no other significant results, although the Condition type x Shortcut type x Familiarity x Memory word position interaction approached significance, $p = 0.064$.The results for the Item Score analyses are summarised in **Table 3**.

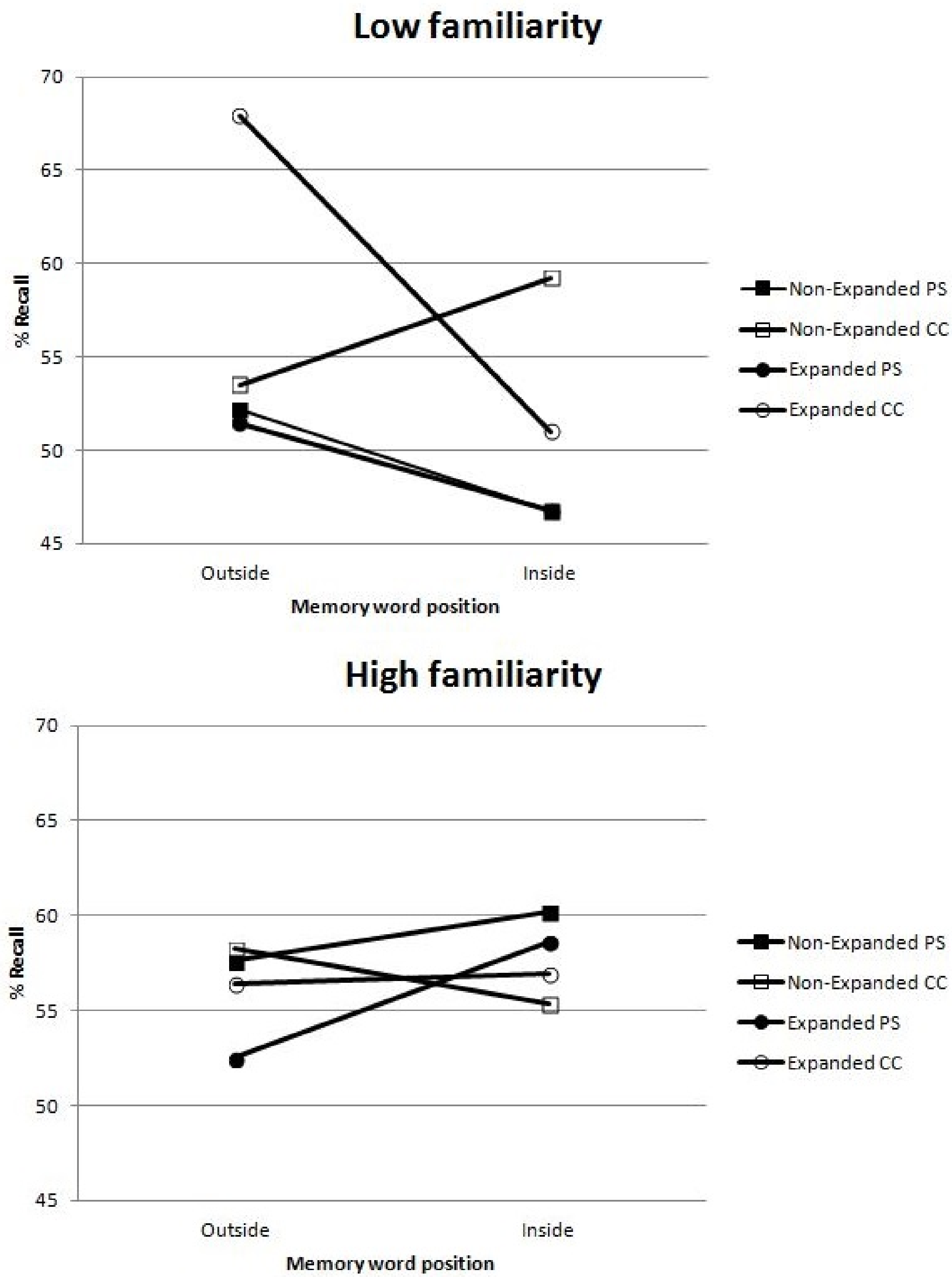

Figure 6: Figure shows percentage recall across memory word position by Familiarity (Low vs. High). The x-axis shows memory word position within the sentence. The y-axis shows percentage recall across all participants and trials, split by shortcut type and condition.

Table 2. Interaction effects for Order recall.

	Fixed effects		
Factors	Std. Error	z-value	p-value
Condition type	0.097	-0.080	0.94
Shortcut type	0.072	-0.020	0.98
Familiarity	0.041	0.70	0.48
Memory Word Position	0.080	0.35	0.72
Serial Position	0.027	-19.0	$2e^{-16}$ $***$
Condition type * Shortcut type	0.073	0.33	0.74
Condition type * Memory Word Position	0.073	0.030	0.97
Condition type * Familiarity	0.041	-0.61	0.54
Condition type * Serial Position	0.027	0.090	0.93
Shortcut type * Memory Word Position	0.17	-1.4	0.16
Shortcut type * Familiarity	0.077	0.89	0.37
Shortcut type * Serial Position	0.054	2.2	0.028*
Familiarity * Memory Word Position	0.076	0.040	0.97
Familiarity * Serial Position	0.027	0.14	0.89
Memory Word Position * Serial Position	0.054	1.2	0.22
Condition type * Shortcut type * MW Position	0.15	-1.1	0.28
Condition type * Shortcut type * Familiarity	0.078	-0.080	0.94
Condition type * Shortcut type * Serial Position	0.054	-2.4	0.018*
Shortcut type * Familiarity * MW Position	0.15	0.92	0.36
Shortcut type * MW Position * Serial Position	0.11	0.050	0.96
Familiarity * MW Position * Serial Position	0.055	-0.080	0.94
Condition type * Familiarity * MW Position	0.077	-0.54	0.59
Condition type * MW Position * Serial Position	0.054	-0.11	0.92
Condition type * Familiarity * Serial Position	0.028	-0.13	0.90
Shortcut type * Familiarity * Serial Position	0.055	0.66	0.51

	Fixed effects		
Factors	Std. Error	z-value	p-value
Condition * Shortcut * Familiarity * MW Pos.	0.16	2.6	0.0091**
Condition * Shortcut * MW Pos. * Serial Pos.	0.11	0.66	0.51
Shortcut * Familiarity * MW Pos. * Serial Pos.	0.11	-1.7	0.082
Condition * Shortcut * Familiarity * Serial Pos.	0.056	0.97	0.33
Condition * MW Pos. * Familiarity * Serial Pos.	0.056	-1.9	0.059
Condition * Shortcut * Familiarity * MW Pos. * Serial Pos.	0.11	0.55	0.58

Table 3. Interaction effects for Item recall.

	Fixed effects		
Factors	Std. Error	z-value	p-value
Condition type	0.081	0.49	0.62
Shortcut type	0.073	-0.60	0.55
Familiarity	0.039	0.18	0.86
Memory Word Position	0.084	-0.55	0.58
Serial Position	0.028	-18.4	$2e^{-16} ***$
Condition type * Shortcut type	0.074	0.30	0.76
Condition type * Memory Word Position	0.074	0.20	0.85
Condition type * Familiarity	0.042	0.23	0.82
Condition type * Serial Position	0.027	-0.62	0.53
Shortcut type * Memory Word Position	0.17	-1.6	0.104
Shortcut type * Familiarity	0.079	1.1	0.26
Shortcut type * Serial Position	0.054	2.6	0.0096**
Familiarity * Memory Word Position	0.077	-1.7	0.091
Familiarity * Serial Position	0.028	0.33	0.74
Memory Word Position * Serial Position	0.054	1.5	0.15
Condition type * Shortcut type * MW Position	0.15	-1.2	0.22
Condition type * Shortcut type * Familiarity	0.079	0.75	0.46
Condition type * Shortcut type * Serial Position	0.055	-2.7	0.0079**
Shortcut type * Familiarity * MW Position	0.16	0.19	0.85
Shortcut type * MW Position * Serial Position	0.11	0.080	0.94
Familiarity * MW Position * Serial Position	0.056	-0.37	0.71
Condition type * Familiarity * MW Position	0.078	-0.27	0.79
Condition type * MW Position * Serial Position	0.054	-0.060	0.95
Condition type * Familiarity * Serial Position	0.028	-0.27	0.79
Shortcut type * Familiarity * Serial Position	0.056	0.55	0.58

	Fixed effects		
Factors	Std. Error	z-value	p-value
Condition * Shortcut * Familiarity * MW Pos.	0.16	1.9	0.065
Condition * Shortcut * MW Pos.* Serial Pos.	0.11	1.02	0.31
Shortcut * Familiarity * MW Pos. * Serial Pos.	0.11	-1.7	0.087
Condition * Shortcut * Familiarity * Serial Pos.	0.057	1.4	0.17
Condition * MW Pos.* Familiarity * Serial Pos.	0.056	-1.7	0.099
Condition * Shortcut * Familiarity * MW Pos.* Serial Pos.	0.12	0.66	0.51

3.2.4 Discussion

3.2.4.1 Social media use

The self-reported Participant Social Media use per week was interesting. Facebook showed the greatest total number of responses for total use, with 44 participants reported using it to some capacity. Second was Instagram, with 37 total responses, and third Snapchat with 34. This distribution is particularly interesting considering how differently the three social media operate. Facebook is far more text-based compared to Instagram and Snapchat. Other social media which are text-heavy, such as Twitter, Tumblr, and Reddit, all showed relatively fewer responses to weekly use. The preferences seem to have shifted to social media which provide shorter and more instant updates involving the ability to capture the moment in a short picture or video as opposed to something longer and text-based. This could suggest a recent loss of motivation for the use of shortcuts. However, Snapchat does make use of a character limit, and that could very well encourage shortcuts.

3.2.4.2 Recall scores The working memory load results were analysed with respect to Order recall as well as Item recall. The main hypothesis predicted a main effect of or interaction involving Condition type on recall for both types of scores. The main effect was not significant; neither was the main effect of Shortcut type on recall. However, interactions involving these factors were significant. In general, analyses with Order recall showed a greater number of significant interactions as opposed to those with Item recall. This is as we expected; Item recall is a less-sensitive measure compared to Order recall. The former measures only the total number of items recalled, whereas the latter measures the total number of items recalled correctly in the correct positions. Taking this into consideration, we mainly discuss the results with to Order recall.

Both Order and Item scores showed a main effect of Serial Position, as well as several interactions involving Serial Position. The main effect suggests better recall by participants for memory words presented first within the trial. Recall grew poorer as serial position increased; this is as we would expect under the *primacy effect* (Murdock, 1962). Literature has long shown an effect of serial position on recall; that is, items presented first in general are better recalled than items in the middle of the list. This is suggested to be due to the fact that words presented first are easier to remember because there is more time for rehearsing them compared to words later on in the list. Alternatively, another explanation favoured by more recent memory theory (e.g. Oberauer et al., 2012) is that new items are encoded to the extent to which they differ from previous items in working memory. This theory, called *novelty encoding*, leads to increasingly less information being included for later items. This could, therefore, impact their recall.

There was a significant interaction between Shortcut type and Serial position on recall. This interaction was further modified by a three-way interaction between Shortcut type, Serial position and Condition type (see Figure 5). This seems to reflect the pattern that PS is associated with a steeper serial position curve than CC in the Non-Expanded condition of interest. Thus, recall associated with PS shortcuts is better in the earlier positions and poorer in the later positions compared to CC shortcuts, possibly reflecting faster increasing memory loads in this shortcut condition. This could be due to the fact that PS introduce greater interference during recall compared to CC. Since CC are clipped forms of single words, they are more comparable to standard English than PS, which are shortened forms of short phrases or sentences. This difference could have made it easier for participants to recall memory words in connection with sentences containing CC shortcuts instead of PS shortcuts when memory load became heavy (i.e. for the last two memory words).

A complex four-way interaction between Condition type, Shortcut type, Memory word position and Familiarity showed one situation where participants had better recall in the Non-Expanded condition than in the Expanded condition, contrary to our hypotheses. The interaction appeared to be mainly driven by better recall for memory words presented within sentences alongside unfamiliar, Non-Expanded CC (CCNE) compared to Expanded CC (CCE) shortcuts, whereas recall was superior for memory words presented after sentences with unfamiliar CCE compared to CCNE forms. This interaction was not apparent for the PS sentences and familiar CCs. This is interesting, as it suggests that participants in one specific situation found it easier to recall the memory words when they were presented with sentences that contained shortcuts instead of when they were presented with sentences without shortcuts. As this pattern was restricted to memory words presented within the sentence, it suggests a local effect where unfamiliar CC shortcuts seemed to interfere less with working memory for words than their expansions did. Shortcuts could, in this case, be making recall easier because the irregular orthography of the shortcut makes the memory word easier to separate from the sentence. However, this effect was also modulated by Familiarity, with the effect mostly restricted to unfamiliar shortcuts. Therefore, the lesser interference of NE sentences with memory words could be due to the fact that the participants would quickly recognise the orthographic shortcuts as unfamiliar and process them faster than sentences with standard English. When the memory words were presented outside (after) the sentences, unfamiliar CCNE shortcuts seemed to suppress memory. This could be because of unfamiliar CCNE shortcuts being processed after the sentence had ended, thereby interfering with the encoding of the memory word.

An effect of Familiarity was also seen with the Accuracy scores of participants answering the comprehension questions presented after each sentence. Although there was no main effect of Familiarity, Accuracy impacted participant recall when in conjunction with memory word position within the sentence, shortcut type, and condition type.

It is possible that the shortcuts present within the sentences did not interfere with the recall of the embedded memory word. Instead, the shortcuts could have been perceived as part of standard language. If this is true, it suggests that, despite the array of literature on the processing cost of shortcuts (Perea et al., 2009; Head et al., 2012; 2013; Ganushchak et al., 2013; McCausland et al., 2015), shortcuts might fit into our mental lexicon better than had been previously assumed.

Furthermore, it is possible that shortcuts do not interfere with working memory specifically, which could suggest that the processing cost previously observed is a result of some other mechanism involved in reading that does not interfere during a working memory task. This would then mean that the cognitive load as a result of reading shortcuts is due to the unfamiliarity of the shortcuts or difficulty in their retrieval, but some other feature not instigated during the complex span task. Alternatively, it is possible that participants dismissed the shortcut when reading the sentence, choosing to focus on the memory word instead. Provisions were taken to prevent this: a comprehension question was presented after each sentence, with 45 percent of questions hinging upon the meaning of the shortcut. Additionally, participant responses where they did not correctly answer the comprehension questions were removed .

3.2.5 Conclusion

Although a main effect of condition (Non-Expanded vs. Expanded) was not observed, a number of interactions with this factor were significant. Of note are the interactions between Condition type, Shortcut type, and Serial Position, as well as the four-way interaction between Condition type, Shortcut type, Familiarity, and Memory word position, both of which were significant.

Overall, PSNE show a steeper serial position effect for recall, which suggests that the memory load for PS increases faster than it does for CCs, thereby leading to greater interference for the recall of the last two words. However, it also suggests that for a smaller number of items, PSNE shortcuts do not interfere as much and could actually be helpful in recall due to their short length and encapsulation of a large amount of information within a short abbreviation.

We also better recall words in the NE condition than the E condition within a specific context. Unfamiliar CCNEs showed better recall compared to unfamiliar CCEs when the memory word was presented within the sentence. When unfamiliar CCNEs were presented outside the sentence, they appeared to interfere with memory word encoding, resulting in poorer recall. This has implications for how we process information, suggesting that unfamiliar CCNEs are ignored within sentential context when there is an interfering task (in this case, a memory word that needs to be remembered), but are processed for longer when they are alone within the sentence.

4 Chapter 4: General Discussion and Conclusion

4.1 General Discussion

The overall aim of this study was to explore how shortcuts affect our cognitive processing, whether or not there is a processing cost associated with reading shortcuts and, if so, what the reason behind it could be.

In the first experiment, a self-paced reading task was carried out with participants reading sentences out loud. The results of the first experiment demonstrated a clear processing cost of reading shortcuts, with participants reading standard English sentences significantly faster than sentences with shortcuts. The type of shortcut also had an effect, with PS being more difficult to read than CC. However, this effect could also reflect hesitation about how to pronounce the shortcut.

4.1.1 Spoken shortcuts

Based on the results of Experiment 1, we can see that there is an effect of shortcut pronounceability on processing cost and reading times. CC shortcuts, which are shortened or clipped forms of single words, were more intuitively derived and easier to read out loud as compared to PS, which were often consonant clusters resulting in initialisms rather than acronyms. CC were often pronounced as a single word, something which was difficult with PS (e.g. the difference between ’omw’, which would be pronounced as an initialism, vs. ’lol’, which could be pronounced as a single word). This aspect of pronounceability could signal the increased likelihood of certain shortcuts being incorporated into spoken conversation. In this case, the use of CC shortcuts in speech is much likelier than that of PS. In turn, this could mean that PS shortcuts will cease to be popular – both in written and spoken conversation – while CC shortcuts will prevail. Alternatively, this could also mean that these shortcuts would adapt to their modality of choice. Already we observe a lot more 'slang' in the way teenagers talk (Tagliamonte, 2016b). Given the ease of pronouncing CC, these shortcuts can be adopted into the lexicon for everyday vernacular. In turn, PS might remain confined to the written medium and, without the versatility of being used in multiple modalities, be limited to just the written medium.

4.1.2 Shortcut processing

Participants underwent a complex span task for the second experiment, and memory recall in this case was used as a gauge of cognitive processing. Overall, results suggest that shortcuts add to the working memory load under certain circumstances (for example, when presented after the sentence) but do not in other cases (for example, unfamiliar CCNE when the memory word was presented within the sentence).

In Experiment 1, the results provided corroborative evidence for the processing cost of reading Internet and texting shortcuts. Based on the first study, there is also an effect of shortcut type (PS versus CC) on the processing cost of reading shortcuts. However, the results of Experiment 2 seem to show that how we process shortcuts is not quite so simple. The nature of the shortcut affects the rate at which cognitive load increases, with a steeper serial position curve for PS than for CC. Additionally, interference with shortcut processing seems to have an effect as well; no interference leads to greater resources being devoted to processing the shortcut compared to the presence of an interfering mechanism, in which case the shortcut is processed fast (or skipped over entirely). This, too, seems to be based on shortcut type, with this effect being observed only for CCNE.

Taken alongside the results for Experiment 1, this has implications for how we read and use shortcuts. If the presence of an interfering task does indeed lead to the shortcut being processed faster, then the use of CCs in our daily conversations presents an advantage. The fact that shortcuts are used more than ever to communicate faster and with greater ease rather than to save space, supports this (Thurlow & Brown, 2003). Using CCs not only allows us to communicate efficiently and effectively, it also then allows us to devote more cognitive resources to other tasks. The fact that we do not see this for PS suggests that these shortcuts may be detrimental to use – or, at least, not quite as beneficial to our cognitive resources as CCs. Oviatt, Coulston, and Lunsford (2004) suggest that multimodal communication is favoured over unimodal communication when cognitive load increases. This theory works well with the results discussed above; the increased use of textspeak as well as GIFs, emoticons, and emojis in written text communications and online could allow for increased multitasking and cognitive load management.

4.1.3 A comparison between Experiments 1 and 2

The differences between the experimental paradigms employed in each of these experiments succeeded in demonstrating a different aspect of shortcut processing. The first experiment was a simple reading task that showed that we do not read shortcuts and standard English the same way. The second experiment, however, showed finer nuances of how shortcuts were processed. Although there was no main effect of Condition or Shortcut type, the interaction effects suggested that the context within which we use shortcuts in our conversations might be as important as the type of shortcut itself.

4.1.4 Morphological evolution

Shortcuts behave as abbreviations as well as more complex lexical units which embody both shortened words and phrases. These are used to save time or to add context to written communications. Internet and texting shortcuts are, perhaps, more complex than had been previously considered. Although previous studies have provided evidence for their lexical independence (Ganushchak et al., 2010; Ganushchak et al., 2012; Head et al., 2013; and Tat & Azuma, 2015), there is very little work on exploring *how* this lexical access is achieved. A recent study by Fruchter and Marantz (2015) provides evidence for complex morphological processing to occur via a *Full Decomposition model*, whereby the complex morphological unit is first broken down into its components before lexical retrieval and further processing (Taft, 1979; 2004). This could suggest a reason as to why CCNE shortcuts demonstrated better recall within a specific context without the same effect being replicated by the PS shortcuts, as the latter would have taken too long to process via full decomposition. CC shortcuts would be processed relatively faster via this route as they would need to be broken down to a single word stem. However, considering the popularity of textspeak in general and PS (which comprise of initialisms and acronyms) in particular, this type of explanation seems incompatible and insufficient. The recognition of the full word/shortcut form with subsequent decomposition would make the processing of irregular shortcuts far easier (*the Supralexical model*; Giraudo & Grainger, 2000). Further study into the nature of how these morphological units are processed is, therefore, necessary and would provide interesting implications into morphological processing of language in general, and the perception and storage of shortcuts in the lexicon in particular.

4.1.5 Improvements

Internet and texting shortcuts are prolific and so embedded in daily conversations of young English speakers that it is a valid assumption that this linguistic phenomenon will be around for a while. Our understanding of how these shortcuts are used and how they are cognitively processed is still limited. Whilst we gain valuable insight from the results of this experiment, there are certain aspects that, with some improvement, would give us more accurate results.

The experimental design for both experiments would have benefited from preparing the stimuli more stringently. Choosing stimuli by controlling for word frequency and length would also improve the accuracy of our results, even though these variables can be statistically controlled. Furthermore, since the stimuli consisted of sentences for both experiments, controlling for the type of syntactic structure and shortcut placement used would have been beneficial. Finally, better controlling the length of the sentences would have ensured that comparisons between groups were as accurate as they could be.

For the current study, shortcuts were chosen by the experimenter. Importing stimuli from a corpus, or creating a corpus by retrieving shortcuts from the Internet, would have had the added benefit of providing measures of shortcut frequency as well as reducing bias (which was introduced when the experimenter chose shortcuts based on their experience). Stricter criteria should also have been set up for sorting shortcuts as either PS or CC. Additionally, the phonological construction of the shortcuts could be constrained and accounted for. This would ensure comparability between shortcuts, and any differences would have been better accounted for.

Finally, at the experimental level, recruiting a larger number of participants per condition would have ensured greater statistical power and a more accurate result. As the case was, Experiment 1 contained only 15 participants, and Experiment 2 contained only 26 participants per condition in a between-subjects design, which was not sufficient. An increased number of participants and a greater number of trials would result in a more robust measure of the variable being measured.

4.2 Future Directions

Research on the cognitive processing of Internet and texting shortcuts is beginning to take off. Although there are several studies which have investigated the nature of texting and the contexts within which it arises, there is little work on the actual distribution of textisms in media and daily communication. Beginning here, gathering information about their distribution, frequency and familiarity would help build a stronger base for future research. Further investigation into the nature of shortcuts, as well as an examination of what affects their processing, would build on the number of current studies which exist on shortcut processing. Further examining the way the phonotactics of shortcuts affect their use would also be interesting.

Finally, a study examining pseudo-shortcuts which mimic existing ones to see whether some intrinsic property differs about them or if their processing is just related to a learning curve would be fascinating. It would help define what exact property of the shortcuts helps them be so prolific, and whether this property makes the shortcuts popular in spite of their processing cost.

4.3 Conclusion

Despite the fact that a subset of internet and texting shortcuts are pronounceable and even used in spoken conversation, in general they seem to be fixed as a written communication device. Although often perceived as the language of teenagers, the fact is that these shortcuts are employed by a variety of users.

It is possible that as internet and texting shortcuts become better assimilated into our vocabulary, they will grow to be a feature of language as we know it. The difference between standard English and informal English could very well widen, with shortcuts and other creative language choices taking precedence over prescriptive grammatical rules.

Exploring the nature of different kinds of shortcuts and testing them within new experimental paradigms gives us a better idea of how they work. Their unique features—being already a part of language and yet still apart—places them in the exquisite position of being able to tell us more about morphological processing and language processing as a whole. There is still much work to be done, and it will be interesting to see how these shortcuts evolve in another decade or two. Will they become an even deeper ingrained part of language than they already are? Or will they split off and become a new dialect of their own? These questions remain to be answered by future research. However, they do not change the fact that internet and texting shortcuts are a wonderful example of how creative and useful language continues to be.

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6 Appendices

6.1 APPENDIX A

Appendix A: List of stimuli sentences used in Experiment 1. Sentences were divided into a Non-Expanded group (Phrasal shortcuts and contractions and clippings) and an Expanded (filler) group.

PS

Shortcut	Expansion	Sentences
btw	by the way	btw what are you up to tonight then
dw	don't worry	dw about doing a thing when you're back
hbu	how about you	i'm nearly done my assignment for tomorrow hbu
idc	i don'tcare	idc about going to class tomorrow morning
idk	i don't know	idk the answer to that question i'm sorry
idec	i don't even care	idec if we have an evening class tomorrow
idek	i don't even know	idek when that boring bio quiz is due
imo	in my opinion	imo that movie is very highly overrated
jsyk	just so you know	jsyk our midterm for intropsych is this week
lbr	let's be real	you could never have passed the exam alone lbr
nbd	no big deal	i got an A in organic chemistry nbd
ily	i love you	thank you so much for making dinner ily
rip	rest in peace	i just finished watching star wars and rip
rn	right now	rn i'm busy writing my paper so no
smh	shaking my head	smh i can't believe he would say that
tbh	to be honest	tbh i think you should listen to her
wth	what the heck	i can't believe we have another midterm wth
omg	oh my God	omg did you hear about that talking parrot
ttyl	talk to you later	okay I really have to go now ttyl
brb	be right back	brb i think someone just rang the doorbell
lol	laughing out loud	that video is hilarious and so true lol

Shortcut	Expansion	PS Sentences
asap	as soon as possible	i will try to finish my work asap
faqs	frequently asked questions	her age should be on her website's faqs
fyi	for your information	fyi you might want to watch this movie
iirc	if i recall correctly	iirc she said she would be there too
jk	just kidding	that hat makes your head look huge jk
tfw	that feel when	tfw you have three midterms in three days
np	no problem	np it was a pleasure to help you
omw	on my way	give me a couple more minutes i'm omw
tl;dr	too long; didn't read	tl;dr i tried to juggle and i failed
wrt	with respect to	wrt the article you shared on facebook yesterday
icymi	in case you missed it	icymi the midterm was moved to next week
atm	at the moment	i'm not busy tomorrow but i'm swamped atm

CC		
Shortcut	Expansion	Sentences
convo	conversation	i had that convo with my mom too
bc	because	i wish the weekend was here bc i can't wait to go home
cn	can	i cn definitely see why he did that
def	definitely	it would def be better if you could wash them separately
gluck	good luck	oh man gluck on your midterm!
kno	know	i kno what you mean
ofc	of course	ofc i'll help you with your homework
p	pretty	it was p clear to me honestly
v	very	are you v sure that's what you want to do
pls	please	can you pls be serious for a moment
ridics	riduclous	that is so ridics that it can't possibly be true
ridicness	ridiculousness	what kind of ridicness is this
smth	something	i think he asked for a black pen or smth like that
tho	though	you're right about it tho
tru	true	it was tru though, what you said
whatevs	whatever	whatevs i'll just buy groceries later
totes	totally	i will totes go to your party
wat	what	wat are you talking about
yr	your	yr sweater is super cute!
probs	probably	it was probs true but i didn't care
ep	episode	that ep last night was so terrible
nvm	never mind	i was going to ask you about the exam but nvm
ppl	people	i can't believe all those ppl agree with that
tht	that	tht cake was really good
esp	especially	i agree esp since it's so cold out
srs	serious	are you being srs or is this a joke?

Non-Shortcut sentences (Filler)	
Sentences	Sentences
he was playing video games all day	she said she would be done today
i can be there by Monday evening	i have an assignment due tomorrow morning
she attended a violin concert last week	i heard you were buying a car
he does his laundry every other week	i will take care of it later
the movie we saw yesterday was great	the questions on the midterm were difficult
i bought new boots on sale yesterday	i don't like milk in my coffee
his favourite desserts is chocolate cream pie	my mother makes the best chocolate cake
she prefers ordering pizza to cooking dinner	he always writes his exams in pen
the boy likes playing in the mud	she can solve it faster than me
i have to get up early tomorrow morning	i can't function without my morning coffee
i need to have lunch by noon	she did not finish her assignment today
he tried to hide his disappointing grades	she was on her school's rowing team
i run every day for thirty minutes	he took an hour to get ready
she ate nothing but cookies for lunch	they were going out for dinner tonight
his oldest cat is seven years old	last year she read fifty books altogether
he sold twenty suits in a month	the filing cabinet was stuck all day
the wind blew snow off the roof	he always preferred having tea over coffee
he was happy even though he lost	she solved the crossword in two minutes
he liked watching movies about old wars	green beans are my least favourite vegetable
she said she preferred pasta over pizza	he dropped his phone on the floor
I prefer reading books to watching movies	they always sat in the same seats

6.2 APPENDIX B

This section lists the sentences and related comprehension questions used in Experiment 2.

PS Sentences (Non-Expanded and Expanded) plus related Comprehension Questions

Shortcut	Sentence (NE)	Sentence (E)	Questions
omg	The bird hit the window omg.	The bird hit the window wow.	Did the bird hit the window?
af	He got drunk af tonight.	He got very drunk tonight.	Was he drunk tonight?
dw	I am telling you dw about it.	I am telling you to not worry about it.	Should you worry about it?
btw	She was asking for you btw.	She was asking for you by the way.	Was she asking for you?
hbu	I am going to the party hbu.	I am going to the party but I am not sure if you are.	Are you going to the party?
idc	Do what you want idc.	Do what you want because I do not care.	Do you care about what they are doing?
idk	Idk the location of the test.	I do not know where the test is.	Do you know where the test is?
imo	The test was easy imo.	The test was easy in my opinion.	Did you think the test was easy?
jsyk	It is raining today jsyk.	It is raining today just so you know.	Is it raining today?
lbr	He is going to lose lbr.	He is clearly going to lose.	Is he going to lose?
nbd	I aced the exam nbd.	I aced the exam as it was no big deal	. Was the exam difficult?
ily	I tell you ily every morning.	I tell you I love you every morning.	Do you say I love you every morning?
bff	The girl sat with her bff.	The girl sat with her bestest friend.	Did the girl sit with her sister?
rn	He says he is busy rn.	He says he is busy right now.	Did he say he was busy?
smh	I am late for work smh.	I am late for work and it is annoying.	Are you on time for work?
tbh	I like how cold it is tbh.	I like how cold it is to be honest.	Do you like the cold?
wth	The cat ate the bird wth.	The cat shockingly ate the bird.	Did the cat eat the bird?
tba	The new movie is tba any day.	The new movie is to be announced any day.	Is the new movie announced already?
ttyl	I need to go work ttyl.	I need to go work so I will talk to you later.	Are you finished with your work?
brb	The man said he would brb.	The man said he would be right back.	Is the man going to be back?
lol	The play was really funny lol.	The play was funny and I enjoyed that.	Was the play funny?
asap	The man had to finish his task asap.	The man had to finish his task as soon as possible.	Was the man’s task complete?
faqs	The faqs online were incomplete.	The questions online were incomplete.	Were the questions complete?
fyi	There is no class today fyi.	There is no class today for your information.	Is there a class today?
iirc	She is new to town iirc.	She is new to town if I recall correctly.	Is she new to town?

PS Sentences (Non-Expanded and Expanded) plus related Comprehension Questions

Shortcut	Sentence (NE)	Sentence (E)	Questions
jk	I was jk about the pop quiz.	I was just kidding about the pop quiz.	Is there a pop quiz?
tfw	He talked about tfw you lost the game.	He talked about the feeling of losing the game.	Did he talk about losing the game?
np	It was np at all.	It was no problem at all.	Was it a problem?
omw	I texted my friend I was omw.	I texted my friend that I was on my way.	Did you text your friend?
wrt	The news wrt the traffic was wrong.	The news with respect to the traffic was wrong.	Was the news right?
icymi	I sent you the blog icymi.	I sent you the blog in case you missed it.	Was the blog sent?
atm	There is a dog outside my office atm.	There is a dog outside my office at the moment.	Is there a dog outside the office?
fml	I failed another course this term fml.	I disappointedly failed another course this term.	Did you pass all your courses?
irl	Her name irl and online was the same.	Her name in real life and online was the same.	Was her name different online?
rofl	The way he tripped had me rofl.	The way he tripped had me cackling.	Did you laugh when he tripped?
lmao	I think he was joking lmao.	I think he was joking amusingly.	Was he joking?
lmk	I am free so lmk if you want to meet.	I am free so let me know if you want to meet.	Are you free to meet your friend?
aka	That is the team leader aka their boss.	That is the team leader and their boss.	Is the team leader their boss?
diy	The woman started a new diy project.	The woman started a new craft project.	Did the woman start a new project?
hmu	I am in town this week hmu.	I am in town this week so text me.	Are you in town this week?
yolo	The boy yolos everything he does.	The boy is carefree about everything he does.	Is the boy careful about everything?
ty	I was tired so ty for the break.	I was tired so thank you for the break.	Did you need a break?
gtfo	I told the angry man to gtfo.	I told the angry man to leave right away.	Was the man angry?
pov	The story had two povs.	The story had two point of views.	Did the story have one point of view?
gtg	I have gtg right now.	I have got to go right now.	Do you have to leave?
hs	The girl was still in hs.	The girl was still in high school.	Was the girl in university?
stg	I stg I am done with this show.	I swear to God I am done with this show.	Are you done with this show?
byob	The party he attended was byob.	The party he attended asked them to bring beer.	Did the party have beer?
idgi	She told me the answer but idgi.	She told me the answer but I do not get it.	Did you understand the answer?
eta	He said his eta was in an hour.	He said he would be there in an hour.	Did he say he would be there in two hours?

CC Sentences (Non-Expanded and Expanded) plus related Comprehension Questions

Shortcut	Sentence (NE)	Sentence (E)	Questions
convo	Their convo lasted for hours.	Their conversation lasted for hours.	Was their conversation short?
totes	He was totes scared by the movie.	He was totally scared by the movie.	Was the movie scary?
bc	She was late bc of the traffic.	She was late because of the traffic.	Did the traffic make her late?
cn	The students cn choose the topic.	The students can choose the topic.	Were the students given topics?
def	She def knew when her test was due.	She definitely knew when her test was due.	Was she confused by her test due date?
knw	They knw where the mall is.	They know where the mall is.	Do you know where the mall is?
p	The cat was p friendly.	The cat was pretty friendly.	Was the cat friendly?
v	The girl was v happy.	The girl was very happy.	Was the girl sad?
pls	She asked the man to pls stop talking.	She asked the man to please stop talking.	Was then man quiet?
ridics	The hat looked ridics on him.	The hat looked ridiculous on him.	Did the hat look good on him?
smth	I need smth from the store.	I need something from the store.	Do you need anything from the store?
tho	The man tripped even tho he was careful.	The man tripped even though he was careful.	Did the man trip?
tru	The woman found out the story was tru.	The woman found out the story was true.	Was the story true?
whatevs	He thought the new movie was whatevs.	He thought the new movie was whatever.	Did he like the new movie?
wat	The boss asked her wat she was doing.	The boss asked her what she was doing.	Did the boss ask her how she was?
yr	She asked for yr number.	She asked for your number.	Did she ask for your address?
probs	It is probs going to snow next week.	It is probably going to snow next week.	Is it going to rain next week?
ppl	The ppl lined up for coffee.	The people lined up for coffee.	Did the people line up for coffee?
tht	The website says tht they are closed.	The website says that they are closed.	Did the website say they were open?
esp	It is esp warm today.	It is especially warm today.	Is it cold today?
srs	The man could not tell if she was srs.	The man could not tell if she was serious.	Was the man sure about her being serious?
obvs	The tattoo looked obvs fake.	The tattoo looked obviously fake.	Was the tattoo fake?
fave	The food there was her fave.	The food there was her favourite.	Did she like the food there?
abt	The meeting was abt his job.	The meeting was about his job.	Was the meeting about his grades?
appt	He made an appt to see the doctor.	He made an appointment to see the doctor.	Did he make an appointment with the salon?

CC Sentences (Non-Expanded and Expanded) plus related Comprehension Questions

Shortcut	Sentence (NE)	Sentence (E)	Questions
attn	No one paid him any attn as he left.	No one paid him any attention as he left.	Did anyone pay him attention as he left?
sry	He was sry he missed the concert.	He was sorry he missed the concert.	Was it a play that he missed?
congrats	He told his friend congrats.	He told his friend congratulations.	Did he tell his friend congratulations?
fam	She waved goodbye to her fam.	She waved goodbye to her family.	Did she wave goodbye to her friends?
diff	There was no diff in the weather.	There was no difference in the weather.	Did the weather change?
evn	He did not evn notice the snake.	He did not even notice the snake.	Did he notice the snake?
fab	She wanted to buy that fab dress.	She wanted to buy that fabulous dress.	Does she want to buy the suit?
hr	It took an hr for the pizza to arrive.	It took an hour for the pizza to arrive.	Did the pizza arrive quickly?
lil	The lil baby crawled to the toy.	The little baby crawled to the toy.	Did the baby crawl towards the toy?
msg	Her friend sent her a msg.	Her friend sent her a message.	Did her friend message her?
min	It took the man a min to get there.	It took the man a minute to get there.	Did it take the man long to get there?
rly	It was rly windy this morning.	It was really windy this morning.	Was it windy this morning?
pg	The last pg of the book was blank.	The last page of the book was blank.	Was the last page of the book blank?
pic	The pic he took was blurry.	The picture he took was blurry.	Was the picture clear?
spose	I spose the test was not hard.	I suppose the test was not hard.	Was the test hard?
bday	Tomorrow is her bday.	Tomorrow is her birthday.	Is tomorrow her birthday?
fb	The girl was always on fb.	The girl was always on facebook.	Was the girl always on twitter?
ep	He watched the last ep of the show.	He watched the last episode of the show.	Did he finish watching the show?
anon	The singer had a lot of anon messages.	The singer had a lot of anonymous messages.	Did the singer get a lot of messages?
gf	He came to the party with his gf.	He came to the party with his girlfriend.	Did he come to the party alone?
evry	The woman was right evry time.	The woman was right every time.	Was the woman wrong?
bio	The bio test was too long.	The biology test was too long.	Was the test short?
txt	The man sent his wife a txt.	The man sent his wife a text.	Did the man sent his sister a text?
jst	It snowed jst after six.	It snowed just after six.	Did it snow before six?
tmrw	She said she would meet him tmrw	She said she would meet him tomorrow.	Would she meet him today?

6.3 APPENDIX C

Appendix C: Memory words used in Experiment 2 with their Familiarity ratings, number of phonemes, concreteness and imageability ratings.

Memory Word	Familiarity	Phonemes	Concreteness	Imageability
AUNT	554	3	564	567
BALL	575	3	615	622
BAND	575	4	590	579
BATH	599	3	609	601
BEEF	604	3	637	625
BELL	543	3	620	610
BOOT	566	4	595	604
BRAT	507	4	501	536
CALF	511	4	592	565
CAPE	521	3	581	566
CELL	520	3	542	590
CHIN	545	3	592	608
COAL	513	3	584	581
COIN	564	4	581	603
COKE	585	4	580	623
CUBE	502	4	530	575
DATE	598	4	514	501
DECK	507	3	566	539
DESK	583	4	583	574
DIME	586	3	582	590
DIRT	571	4	564	547
DOLL	503	3	588	565
DUST	558	4	550	549
FACE	612	4	599	581
FLAG	545	4	606	607
FOOD	579	3	597	539

Memory Word	Familiarity	Phonemes	Concreteness	Imageability
FOOT	583	3	558	597
FORK	584	4	592	598
FROG	507	4	619	617
GANG	515	4	492	535
GATE	540	4	573	545
GIFT	566	4	533	553
GOAL	554	3	482	556
GOLD	550	4	576	594
GOLF	503	4	546	616
GOWN	515	4	586	578
HALL	592	3	565	559
HAND	601	4	604	598
HAWK	504	4	623	591
HELL	564	3	355	519
HERB	514	4	558	502
HILL	585	3	588	607
HOME	626	3	539	599
HOOD	510	3	547	558
HUNT	523	4	416	527
JAIL	539	3	590	608
JEEP	564	3	622	659
KING	522	4	559	585
KNEE	599	3	593	597
KNOB	534	3	586	554
LAKE	583	3	585	616
LAMP	578	4	615	575
LAWN	534	4	588	608
LEAF	556	3	593	608
LENS	519	4	573	556
LUNG	546	4	569	576
MALE	588	3	564	587
MEAL	603	3	602	573

Memory Word	Familiarity	Phonemes	Concreteness	Imageability
MEAT	589	3	587	618
MILE	568	3	460	511
MILK	588	4	670	638
MINK	524	4	589	604
MOON	585	4	581	585
NAIL	563	4	598	588
NECK	576	3	587	622
NEST	521	4	557	571
NOSE	584	3	628	605
PARK	571	4	579	573
PIPE	535	4	602	598
PLUG	575	4	558	583
POLE	510	3	577	579
PORK	538	4	585	522
RAMP	504	4	538	527
RICE	548	3	608	506
ROOT	554	3	558	565
SHOP	615	3	549	561
SIGN	543	4	520	534
SOAP	594	4	598	600
SOCK	578	3	581	553
SUIT	543	3	545	536
TAIL	533	3	613	551
TANK	511	4	581	563
TAPE	567	4	564	573
TENT	521	4	608	593
TEST	566	4	520	528
TOAD	516	4	568	591

Memory Word	Familiarity	Phonemes	Concreteness	Imageability
TOWN	589	3	556	553
TRAY	558	3	590	550
TRIP	559	4	448	520
WALL	596	3	589	576
WEED	542	3	600	596
WELL	550	3	467	522
WIFE	585	3	562	575
WINE	570	3	621	624
WING	510	4	595	584
WOMB	508	4	538	529
WOOD	574	3	606	577
WOOL	540	3	608	586
YARD	522	4	553	568