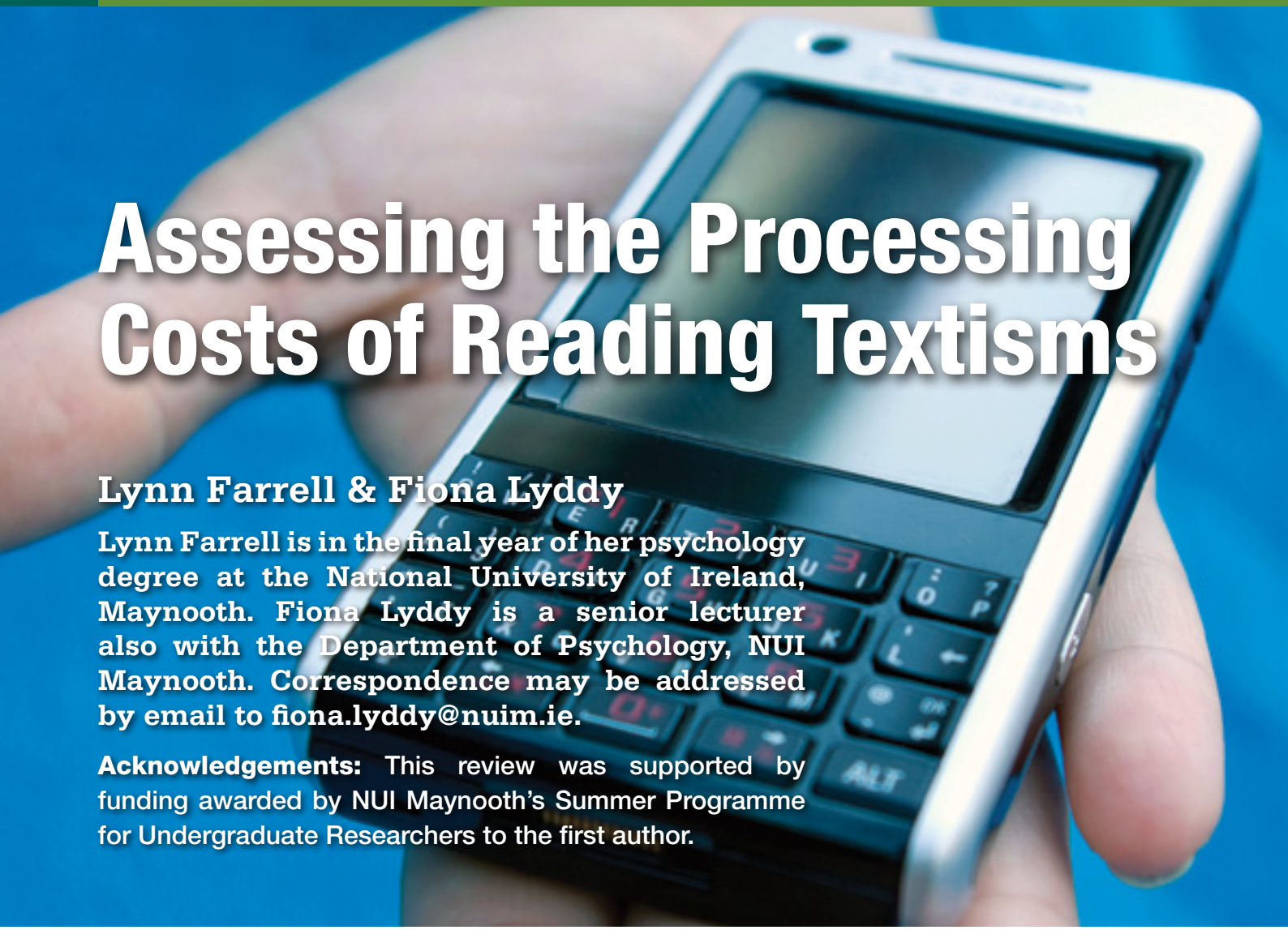

Assessing the Processing Costs of Reading Textisms

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My smmr hols wr CWOT. B4, we used 2 go 2 NY 2C my bro, his GF & thr 3:-@ kds FTF. ILNY, its gr8. Bt my Ps wr so {:-/ BC o 9/11 tht thay dcdd 2 stay in SCO & spnd 2 wks up N... *(Thurlow, 2006, p. 686).*

The above extract purportedly comes from the school essay of a 13 year old Scottish girl. The entire essay takes the form of a textism-dense text message, and would seem to support the popular portrayal of text language as practically unintelligible (Thurlow, 2006; Thurlow & Poff, in press). In conventional English the extract reads as follows:

> *My summer holidays were a complete waste of time. Before, we used to go to New York to see my brother, his girlfriend and their three screaming kids face to face. I love New York, it's a great place. But my parents were so worried because of the terrorism attack on September 11 that they decided we would stay in Scotland and spend two weeks up north... (Thurlow, 2006, p. 686).*

This extract is likely to be a hoax, and the full essay was never identified (Crystal, 2008a). Nevertheless, it was cited numerous times in the media (Thurlow, 2006), reinforcing media portrayals of text language and fears regarding the impact of texting on literacy (Crystal, 2008a). Such notions of text language, however, as we will discuss, seem to be largely without basis (see Plester, Wood, & Bell, 2008; Plester, Wood, & Joshi, 2009; Thurlow & Brown, 2003; Thurlow & Poff, in press).

Texting developed in the 1990s as a form of communication whereby individuals send short, text-based messages through the short message service (SMS) of their mobile phones. The use of texting has experienced rapid growth. Its popularity has become such that in 2004 the verb text was included in the Oxford English Dictionary (Bieswanger, 2008). A report by Lenhart, Ling, Campbell and Purcell (2010) highlighted the rapid increase in text messaging in the United States, where the number of teenagers using text messaging has risen to 72%, a large increase from 51% noted in 2006. In their survey of 800 teenagers aged 12 to 17 years, Lenhart et al. (2010) found that, on average, texters sent and received 50 texts a day. Irish mobile phone users were reported to have sent over 3 billion texts in the first quarter of 2011 (ComReg, 2011). In the United Kingdom, texting was cited by 52% of young people as the most important form of communication used to stay in touch with friends (Mobile Life Report, 2008), outranking instant messaging (17%), email (12%), calls via mobile (9%) or landline (10%), and letters (0%).

One of the most discussed features of texting is its language styles. Texting is often short and to the point and uses textisms; that is, abbreviations and contracted forms designed to reduce the length of text messages (e.g., see Crystal, 2008a). Texts are often popularly represented as full of emoticons (e.g., :-P) and almost unintelligible word manipulations, which can include replacing syllables or parts of words with letters or digits (letter/number homophones such as gr8) or reducing words to abbreviations (e.g., contractions such as tnx to represent thanks). Concerns have arisen over the use of such textisms; young people are often identified as the main users of such language and technology (Thurlow & Brown, 2003) and the media representation of such text language is for the most part negative (Thurlow, 2006). Not only is texting being charged with the corruption of English, it is also being blamed for falling standards in reading and writing (see Thurlow, 2006). The incident of the child who allegedly submitted an essay for school written entirely in the style of a text, which is referenced at the beginning of this review, has been used repeatedly to warn that text language will begin to transfer more regularly into schoolwork, compromising children's ability to use proper grammar, punctuation and spelling (see Crystal, 2008a).

In truth, empirical studies have shown that these concerns are largely unfounded. The majority of language in texts is of a standard form (Crystal, 2008a, 2008b; Farina & Lyddy, 2011; Thurlow & Brown, 2003; Thurlow & Poff, in press). The nonstandard items in such messages are rarely particularly new or unintelligible (Thurlow & Poff, in press). Many nonconventional spellings are frequently found outside of texting and some were established even before the advent of texting (Shortis, 2007). As far as emoticons are concerned, many texters avoid using them, and those that are used tend to be fairly simple, such as smiling or frowning faces (Shortis, 2007). Even the much cited use of letter/number homophones are found relatively infrequently in empirical analyses (Ling & Baron, 2007; Thurlow & Brown, 2003). Texters are aware that their texts must be comprehensible (Thurlow & Poff, in press) or it would defeat the purpose of communication. It has been suggested that textisms reflect the technological limitations of SMS, such as its 160 character limit per message (Crystal, 2008b). However, as texters do not often use the maximum space available to them, functional economy, speed and ease of typing may be another explanation (Thurlow & Poff, in press). Furthermore, adoption of nonstandard texting conventions invokes identity performance, with particular conventions enjoying prolific use within friendship groups (e.g., Shortis, 2007).

Some researchers have attempted to moderate the often reported claims regarding the negative impact of texting on literacy. Crystal (2008a) points out that instances of textisms finding their way into schoolwork are, in fact, a rare occurrence. Indeed, text language seems to provide an opportunity for linguistic creativity and diversity, through which texters are able to communicate their identities (Shortis, 2007). Studies have even associated the use of text abbreviations in preteen children with higher scores on reading and vocabulary tests (Plester *et al.*, 2008, 2009). It seems, therefore, that the use of textisms may promote, rather than compromise, literacy awareness (see also Crystal, 2008a).

Experimental Studies

In contrast to these positive views of textisms, however, there are experimental data which reinforce negative views regarding texting and literacy. Using eye tracking and event related potentials (ERPs), for example, these studies suggest that, in comparison to conventional language, there are cognitive processing costs involved with the reading of text messages. In order to assess whether there is such a difference in processing, the ecological validity of the studies must be carefully considered.

In some cases, studies employ artificial textisms created for the experiment as opposed to real, naturalistic text messages collected from the local population. This may exaggerate the prevalence of, and misrepresent the nature of, the textisms which are actually used in real text messages, a limitation acknowledged by some researchers (Berger & Coch, 2010; Kemp, 2010). For example, Kemp (2010) had young adult participants read texts in either conventional English or text language containing textisms. These text messages were compiled by Kemp using textisms written by participants in an initial session. An assessment of the participants' phonological and morphological awareness was also conducted. Kemp (2010) predicted that, while faster to type, messages with textisms would take longer to read. The results supported this, showing that while messages using textisms were faster to type for both infrequent and frequent texters, it took almost twice as long to read them compared to conventional written sentences, with significantly more errors made. Good phonological awareness seemed to be associated with fewer reading errors in conventional texts, while good morphological awareness was linked with fewer errors in the messages with textisms (Kemp, 2010).

However, the ecological validity of this study must be examined. First of all, the study did not use actual text messages. Instead, participants were required to write out as many textisms as they could in five minutes; some of these were then used to create the messages used as experimental stimuli. Although these texts included common forms of textisms such as letter/number homophones (e.g., 2moro/tomorrow) and contractions (e.g., ppl/people), they were not naturalistic messages. Each message was constructed to include a textism beginning in 2 or 4 (2moro/tomorrow; 4giv/forgive), one ending in 8 (l8/late), common contractions (ppl/people), and phrases of three words reduced to initialisms (brt/be right there). Textisms involving a combination of devices such as aQr8 (accurate) were also included and proved difficult for participants to interpret; switching between decoding strategies for such textisms may be particularly challenging for infrequent texters (Kemp, 2010). However, such textisms are actually quite low in frequency in real messages (Thurlow & Brown, 2003). Kemp (2010) acknowledges this, noting that the messages using textisms were most likely longer than real texts (at 39 to 43 words), and they likely contained a higher number of textisms. This is illustrated by a typical text message used in the study: "Plz 4giv me if i dnt get bak in time 2 hlp u celebr8 ur bday" (Please forgive me if I don't get back in time to help celebrate your birthday). The text sentences were written to contain many textisms, with textisms constituting 70% of the message on average (Kemp, 2010). This is far from typical of real messages;

for example, Thurlow and Brown (2003) found that less than 20% of text message content consisted of such abbreviations for a British student sample.

Another area for concern within the design of this study (Kemp, 2010) is that it obliged all participants to use the multipress method of texting, despite the fact that the majority of participants (*n*=47; 77%) reported using predictive texting and 21 participants had never used the multipress method. The multipress method was used to encourage participants to use abbreviations and other such textisms, as predictive texting may have reduced such a practice. Participants were allowed to become familiar with typing using the multipress method before being instructed to type two messages that were dictated to them. This forced participants to use a method that was not representative of their normal texting methods and also encouraged them to use nonstandard language forms that they may not have typically used. This, combined with the use of artificial texts constructed in the manner described above, may have led to an exaggeration of the textisms used and negatively affected participants' reading time for the textisms, as Kemp (2010) notes.

Another study, by Perea *et al.* (2009), examined the eye movements of skilled Spanish texters while they read sentences containing textisms and conventionally written sentences. Eye tracking is potentially a useful method for examining cognitive differences in reading stimulus types. This method involves recording the way in which eye fixations are affected by the characteristics of words, both in terms of duration and target of fixation (Perea *et al.*, 2009), with words of lower frequency resulting in longer fixations (Inhoff & Rayner 1986). The experiment involved recording participants' eye movements while sentences were read; participants also answered comprehension questions after 20% of the sentences to ensure that the sentence meaning was really understood. Each of the sentences written with textisms contained either mostly orthographic or mostly phonological abbreviations. The orthographic abbreviations involved Spanish sentences such as: "irmos l cnciert n m mto" (we'll go to the concert on my bike), the standard form of which would be: "iremos al concierto en mi moto". The phonological condition consisted of sentences like: "akab l kldo d 1 vz" (finish the soup at once), the standard form of which would be: "acaba el caldo de una vez". These sample sentences also illustrate another difficulty with experimental studies of textism reading: the context of text messaging is rarely considered. Text messages are sent for particular purposes, such as to make arrangements and share information, and the writing of textisms occurs with this context in mind, which aids understanding. Textisms are used for communication; the writer will want to be understood (see Crystal, 2008a).

Perea *et al.* (2009) found that the sentences with textisms took longer to read than the conventional sentences. The type of abbreviation also had an impact, with those containing phonological abbreviations resulting in a larger reading cost than those with orthographic abbreviations. Reading times were also longer, with more fixations, for the textisms relative to the conventional words (Perea *et al.*, 2009). Again reading costs were greater for the phonological abbreviations which may reflect a particular cost associated with such phonological words (Perea *et al.*, 2009). Perea *et al.* (2009) claim that this clearly shows that, despite skilled texters' familiarity with text abbreviations, reading sentences containing textisms involves a reading cost, making them harder to read than conventional sentences.

However, again, ecological validity must be considered. The textism sentences used within this study were constructed by the researchers themselves, with no input from the participants. The two abbreviation types were constructed using high frequency entries in a Spanish SMS dictionary (Perea *et al.*, 2009). The sentences used were short (*M*=6.2) and informal, but the artificial nature of the content may well have inflated the reading costs; a text message such as "finish the soup at once" seems unrealistic. Furthermore, due to the use of the SMS dictionary, Perea *et al.* (2009) acknowledge that some of the phonological sentences may have contained orthographic abbreviations and vice versa, making the two types of sentences difficult to compare. In real text messages these types are unlikely to be separated out completely in any case. The conclusion that phonological textisms produce greater processing costs might therefore be questioned.

Neuroscientific Studies

Neuroscientific studies of textism reading are adding a new dimension to our knowledge of possible processing differences between reading of textisms and conventional language. A number of studies have recorded ERPs while participants read. ERPs are a measure of the electrical activity that the brain produces while the participant is engaged in a particular task, such as reading. The electrical activity that occurs in response to particular stimuli (or events) is seen as waves and the onset, amplitude and offset of these waves can be recorded and measured in milliseconds, as the participant processes the information. A number of specific waveforms are of interest. The N400 waveform was first described by Kutas and Hillyard (1980), who noted a late negative brain wave that followed closely on the presentation of a semantically anomalous word in a sentence (for example, "he spread the warm bread with *socks*"; Kutas & Hillyard, 1980). After the semantically anomalous word was presented, a negative component was observed beginning 250 msecs from the onset of the stimulus and peaking at about 400 msecs. This late negative wave, the N400, is thought to reflect retrieval processes involving a lexical item and it is also associated with differences in processing of native and nonnative languages (Berger & Coch, 2010; Weber & Lavric, 2008). A number of recent studies have examined language containing textisms using ERPs and compared the findings to the electrical activity seen when conventional sentences are read.

Berger and Coch (2010) examined semantic processing of sentences containing textisms in comparison to conventional English sentences using a semantic incongruity task of the type used by Kutas and Hillyard (1980). Their sentences were created using an online translator and sentences in the textism condition contained items containing symbols (c@ = "cat"), digits (l8r = "later"), and case changes (thinkN = "thinking"). The sentence-final word however, which could be either congruous or incongruous with the semantic context, did not contain any mixed cases, symbols, or digits. Participants were presented with the sentences on a computer screen and were instructed

to respond as quickly as possible, pressing one button if the final word presented made sense and another if it did not. All participants used text or instant messaging multiple times each day and they identified themselves as fluent in text speak.

It was hypothesised that texted English would elicit an N400 effect which could then be compared with such an effect elicited by conventional English language, and also compared to second language studies. It was even suggested that texted English may perhaps be seen as a separate language and that those who are very familiar with textisms may perhaps be considered bilingual:

> *if at the neurological and electrophysiological levels texted English stimuli are semantically processed similarly to second language stimuli in other bilingual populations, these findings could be used to support claims that technologically savvy young adults are truly bilingual communicators (Berger & Coch, 2010, p. 138).*

This emphasises differences between textisms and conventional writing and perhaps plays into the media's representation of the otherness of text language. It was found that participants exhibited an N400 effect in both the standard and texted English conditions (Berger & Coch, 2010). As predicted, the peak latency was delayed for the text condition's semantically incongruent version and the N400 effect had a longer duration. This seemed to support the notion of texted English as a separate language and suggested significant differences in comparison with conventional language as the results were similar to those found when comparing the N400 effect when processing native and non-native languages (Berger & Coch, 2010). Participants also seemed to be more accurate and quicker in their judgements involving the standard English sentences. Taking all of this into account, Berger and Coch (2010) concluded that processing semantic information for sentences including textisms involved more neurocognitive resources and required longer processing time compared to conventional writing.

However, again ecological validity must be considered. The text sentences used did not come from actual text messages. They were constructed by the researchers, translated from conventional English using an online translator. Included within the text sentences used by Berger and Coch were words such as "c@" (cat) and "thinkN" (thinking). Such textisms are of extremely low frequency in real texts (Thurlow & Poff, in press), if they occur at all. The use of "c@" to represent "cat" in a real text message seems unlikely. Berger and Coch (2010) acknowledge that the semantic content of the text sentences was lacking in ecological validity, which may have made the texted sentences more difficult for participants, which may in turn have influenced the N400 effect (Berger & Coch, 2010).

Another study which used ERPs recorded them while participants engaged in a lexical decision task and focused on SMS shortcuts such as clippings (e.g., gr8,/great) and all-letter shortcuts (e.g., lol/laugh out loud) (Ganushchak, Krott, & Meyer, 2010a). This study investigated readers' processing of such shortcuts, comparing them with pseudo-shortcuts, which were closely matched but meaningless strings (Ganushchak *et al.*, 2010a). The nature of the N400 waveform during this task was noted, and a larger N400 effect was expected for the pseudo-shortcuts. For a direct comparison, both the shortcuts and the pseudo-shortcuts were classified as non-words. Participants were instructed to press a particular key on the response pad when the presented letter string was an English word which one might find in a dictionary. If the item was not an English word, they were to press a different key. If a shortcut is processed differently, for example if it activates the mental representation of the full word it abbreviated, then it would be predicted that the non-word response would be interfered with, causing a delayed response (Ganushchak *et al.*, 2010a). The results of the study seemed to bear out this prediction. The categorisation of textism shortcuts as non-words was slower in comparison to the categorisation of pseudo-shortcuts as non-words. Processing of a phonological and orthographic nature seemed to produce similar effects for both shortcuts and pseudo-shortcuts during early word recognition; however, shortcuts seem to then go on to activate lexical representations that have been stored. The N400 waveform was also more negative when associated with pseudo-shortcuts, as Ganushchak *et al.* (2010a) had hypothesised.

This study also examined the effect of embedded digits (e.g., gr8) on processing effort. The embedded digits, however, did not seem to affect the processing of the shortcuts (Ganushchak et al., 2010a). This presents a slightly less negative view of the processing of textisms than the aforementioned studies, as it seemed to demonstrate lexical processing of textism shortcuts. According to Ganushchak *et al.* (2010a), when there are few shortcuts in a sentence then difficulty arises only for early word recognition; after this the item is easily incorporated into the context of the sentence as though it were a normal word. As empirical studies show that such shortcuts or abbreviations are infrequent in real text messages (Ling & Baron, 2007; Thurlow & Poff, in press), their effect on processing would presumably not be so great, giving difficulty only in early word recognition, if at all.

However, some of the shortcuts used by Ganushchak *et al.* (2010a) were rather unusual and may not be all that common in real text messages, for example "1daful" (wonderful), "werubn" (where have you been). The study even used the shortcut "ezy", a textism similar to "ez", noted by Kemp (2010) as challenging to interpret. Familiarity with texting may also need to be considered. Ganushchak, Krott and Meyer (2010b) noted that the suppression of embedded digits in shortcuts may be easier for those familiar with such shortcuts as they could use stored lexical representations that those unfamiliar with such textisms do not have access to. This experiment by Ganushchak *et al.*

(2010b), however, also did not use real texts but rather used created shortcuts.

Conclusion

Although available experimental studies seem to reveal processing costs associated with textisms, their conclusions must be interpreted in light of the issues of ecological validity highlighted here. The main problem with current studies is the use of artificial textisms, which are constructed by the researchers rather than collected from the population. The textisms used are created through various means including the use of online translators and SMS dictionaries. In other cases, participants are instructed to compose texts from dictated messages. As a result, the textisms risk being exaggerated forms, comparable to those textisms used in media representations of text language, but unlikely to be used in real messages. Items such as "c@" for "cat" (Berger & Coch, 2010), "aQr8" for "accurate" and "ez" for "easy" (Kemp, 2010), and "werubn" for "where have you been" (Ganushchak et al., 2010a) illustrate the difficulty. Such items were often found to cause participants difficulty. Furthermore, as noted in Berger and Coch's (2010) study, the texts used in experimental studies may not be typical of the topics usually discussed through such communication. Thurlow and Brown (2003) found that approximately two thirds of the text messages they analysed were oriented towards organising social outings, and maintaining friendships and relationships. Messages of this kind would likely contain more familiar textisms, and both the context of the message and the recipient would be taken into account by the sender in composing the message. Finally, the proportion of textisms to words is also an important issue. Kemp (2010) acknowledged that the sentences involved in her study may have contained a greater proportion of textisms than would be found under natural conditions. This would have quite an effect on participants' reading of the texts, as Thurlow and Brown (2003) found that less than 20% of the content of the messages they collected were text abbreviations.

In considering these issues with experimental stimuli, it becomes clear that the best way forward is to collect, locally, actual text messages for use in the experiments, rather than attempting to construct them. Future studies would then provide a more accurate account of effects of text messages on literacy and processing costs.

References

Berger, N. I., & Coch, D. (2010). Do u txt? Event-related potentials to semantic anomalies in standard and texted English. *Brain & Language, 113,* 135–148.

Bieswanger, M. (2008). *2 abbrevi8 or not 2 abbrevi8: A contrastive analysis of different shortening strategies in English and German text messages*. Retrieved August 3, 2011, from http://studentorgs.utexas.edu/salsa/proceedings/2006/Bieswanger.pdf.

ComReg (2011). *ComReg quarterly report Q1 2011*. Retrieved August 3, 2011, from http://www.comreg.ie/publications/comreg_quarterly_report_q1_2011.583.103867.p.html.

Crystal, D. (2008a). *Txting: The gr8 db8*. Oxford: Oxford University Press.

Crystal, D. (2008b). Texting. *ELT Journal, 62*(1), 77–83.

Farina, F., & Lyddy, F. (2011). The language of text messaging: "Linguistic ruin" or resource? *The Irish Psychologist, 37*(6), 145–149.

Ganushchak, L. Y., Krott, A., & Meyer, A. S. (2010a). Electroencephalographic responses to SMS shortcuts. *Brain Research, 1348,* 120–127.

Ganushchak, L. Y., Krott, A., & Meyer, A. S. (2010b). Is it a letter? Is it a number? Processing of numbers within SMS shortcuts. *Psychonomic Bulletin & Review, 17*(1), 101–105.

Inhoff, A. W., & Rayner, K. (1986). Parafoveal word processing during eye fixations in reading: Effects of word frequency. *Perception & Psychophysics, 40,* 431–439.

Kemp, N. (2010). Texting versus txtng: Reading and writing text messages, and links with other linguistic skills. *Writing Systems Research, 2*(1), 53–71.

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potential reflect semantic incongruity. *Science, 207*, 203–205.

Lenhart, A., Ling, R., Campbell, S., & Purcell, K. (2010). *Teens and mobile phones*. Retrieved August 3, 2011, from http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones.aspx.

Ling, R., & Baron, N.S. (2007). Text messaging and IM: Linguistic comparison of American college data. *Journal of Language and Social Psychology, 26,* 291–298.

Mobile Life Report (2008). *Mobile life report 2008: The connected world*. Retrieved August 3, 2011, from http://www.londonmobilelearning.net/aigaion2/publications/show/1492.

Perea, M., Acha, J., & Carreiras, M. (2009). Eye movements when reading text messaging. *The Quarterly Journal of Experimental Psychology, 62*, 1560–1567.

Plester, B., Wood, C., & Bell, V. (2008). Txt msg n school literacy: Does texting and knowledge of text abbreviations adversely affect children's literacy attainment? *Literacy, 42*, 137–144.

Plester, B., Wood, C., & Joshi, P. (2009). Exploring the relationship between children's knowledge of text message abbreviations and school literacy outcomes. *British Journal of Developmental Psychology, 27*, 145–161.

Shortis, T. (2007). Gr8 Txtpectations: The creativity of text spelling. English Drama Media Journal, 8, 21–26.

Thurlow, C. (2006). From statistical panic to moral panic: The metadiscursive construction and popular exaggeration of new media language in the print media. *Journal of Computer Mediated Communication, 11*(3), 667–701.

Thurlow, C., & Brown, A. (2003). Generation Txt? The sociolinguistics of young people's text-messaging. *Discourse Analysis Online, 1,* 1–27.

Thurlow, C., & Poff, M. (in press). Text messaging. In S. C. Herring, D. Stein & T. Virtanen (Eds.), *Handbook of the pragmatics of CMC*. Berlin and New York: Mouton de Gruyter.

Weber, K., & Lavric, A. (2008). Syntactic anomaly elicits a lexico-semantic (N400) ERP effect in the second language but not the first. *Psychophysiology, 45*, 920–925.