Wait Wdym?: Examining the (Mis)Perception of Emotional Valence in Text Messaging Across Generations

by

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In a series of two experiments, I determined the frequency with which individuals under 25 and over 50 use certain paralinguistic features to convey emotion, and the accuracy with which individuals in these same age groups interpret the emotion contained in text messages. Previous research suggests that younger individuals interpret text-final periods to be more negative in tone, while older individuals interpret it to be neutral. I found that although the older group used them more than the younger group overall, both groups produced text-final periods more frequently in negative contexts than in positive or neutral contexts. Several effects highlighted difficulties in interpreting tone in text messages. (a) Sad texts were more inaccurately interpreted than neutral texts. (b) Texts from older individuals were generally interpreted less accurately than those from younger individuals. (c) Although I expected that participants would have more difficulty interpreting tone when a text was sent by a person much younger or older than the participant, when interpreting tone in texts from younger individuals, it was the older participants (compared to younger) who were more accurate in assessing the text's tone. A similar trend followed for texts from older individuals: younger participants (compared to the older) were better at interpreting negative texts from older individuals. Overall, younger text senders appear better than older senders at ensuring their tone is conveyed accurately. However, younger text recipients may have a bias to interpret texts more negatively than intended, resulting in greater errors in interpretation of tone in positive messages regardless of the age of the sender.

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Preface

I would like to thank several people who were instrumental in the success of this project. First, I would like to thank Kole Norberg, who assisted with this project at every step from beginning to end, for all his support during my time at Pitt. I would also like to thank Nishant Purewal who assisted with data coding and set-up for Experiment 2, as well as Scott Fraundorf and all the members of the MAPLE Lab for their support and advice over the past several years. Finally, I want to thank my Bachelor of Philosophy committee members for their time and constructive feedback on this project.

1.0 Introduction

The current study aimed to understand how interlocuters interpret emotion in text messages written by someone from a different generation. Text messaging is a prevalent form of computer-mediated communication (CMC), which also includes email, video calls, and instant messaging (IM). Pew Research Center reported in April of 2021 that over 95% of adults between 18 and 49 own a smartphone, and 100% of adults in this age range own a cell phone of some kind. Meanwhile, eighty-three percent of adults between 50 and 64 have a smartphone and 97% have a cell phone (Demographics of mobile device ownership and adoption in the United States, 2021). With the ubiquity of the cell phone, texting has become increasingly synchronous, with both interlocutors responding in real time (Farina & Lyddy, 2011) and the features of text messages increasingly resembling informal speech, making text messaging more similar to IM than to email (Frissell, 2019; Houghton et al., 2018; McCulloch, 2020). Much like speech, paralinguistic cues are used during CMC to help users express themselves. However, CMC, especially text messaging from smartphones, is a relatively new form of communication, and as such there may be generational divides in how CMC-related paralinguistic cues are used and interpreted. Generations who had access to CMC during their childhood may have adapted language to fit the non-verbal constraints of CMC in ways that are less familiar to generations who adopted CMC as adults. Thus, miscommunication, particularly across generations, may occur as a result of differences in interpreting seemingly small cues. In the current study, I hoped to answer the following two questions: (1) Are there age-related differences in the frequency with which individuals use paralinguistic cues in texting? and (2) Are there age-related differences in how individuals process the valence of text messages written by users of a different generation?

Synchronous CMC, especially IM on applications such as Slack, Zoom, and Microsoft Teams, has become a staple of professional workplaces (York, 2021), potentially even more so due to the ongoing COVID-19 pandemic. The increased use of CMC in the workplace suggests that CMC is occurring across hierarchical levels within companies and across generations. A message from one's boss reading, "We need to talk about the idea you mentioned in today's meeting," could be intended positively, remarking on the employee's novel idea, or negatively, warning against an ill-advised venture. The employee's interpretation might not only impact their response to the message itself but could lead to them entering the meeting expecting praise instead of a reprimand, or vice versa. Further, younger individuals may be more comfortable with IM, but they also tend to infer meaning that older individuals did not intend from subtle cues in the message (McCulloch, 2020). Thus, an older boss may add paralinguistic features which create confusion in meaning for younger employees. In these situations, the individual with less power is left vulnerable to a potential misunderstanding of the other's intention and may face negative repercussions as a result.

The risks of cross-generation miscommunication through CMC are also present outside within familial relationship or friendships. Pop culture has already caught onto the fact that people of differing ages communicate differently over texts. Headlines such as "Why… do old people… text… like this…?" (Martineau, 2018) and "Is your texting punctuation sending the wrong message? Yes. Maybe! Think so…" (Mallenbaum, 2020) point to an increasing awareness about how people of different ages use CMC. Indeed, the pop culture references are backed by empirical findings. Across several studies, younger individuals were more likely to both convey emotional information in and interpret it from paralinguistic cues in text messaging (Gunraj et al., 2016; Houghton et al., 2018), which may be overlooked by older generations (Riordan et al., 2018). This

opens up the potential for age-related miscommunication in the workplace and in an individual's personal life. Further, CMC recipients tend to attribute fault to the sender and the mode of communication (Maneerutt, 2021). Thus, if miscommunication via CMC is greater across generations, it could open the potential for cross-generational conflict if a younger recipient blames an older sender (or vice versa) for poor communication.

One reason the likelihood of a miscommunication during CMC is greater than during the face-to-face communication is that during written CMC, there is a finite number of characters one can use to express emotions (Reynolds et al., 2017). Considering a standard QWERTY keyboard and excluding features such as emoji, there are 26 letters, 10 numbers, and 32 other symbols. This limits interlocutors to use only certain types of cues, allowing CMC fewer nonverbal cues than in face-to-face communication (Reynolds et al., 2017). However, despite CMC's apparent lack of richness in nonverbal cues, cues that carry emotional meaning have evolved over time, especially among generations which came of age after cell phones became ubiquitous (McCulloch, 2020). One of these is the treatment of the period at the end of a text message. Gunraj et al. (2016) constructed written conversations to present to college-aged participants, containing one-word affirmative answers to a single text message, which either did or did not have a period at the end. When these conversations were presented in the form of text messages, the participants rated the replies with periods to be more insincere than those without a period. Notably, when the conversations were presented in the form of handwritten notes, these results differed. In fact, both forms of the handwritten notes (with and without a period) were rated to be approximately as sincere as the texts without periods. This suggests something about the context of texting affected the way the college-aged participants interpreted the presence of a period. Gunraj et al. concluded

that individuals in this age group were using the period to substitute for nonverbal cues present in face-to-face communication, including prosody, gestures, filler words, and eye contact.

Conversations, even those via CMC, do not always consist of one exchange with a one-word answer. Understanding the role of text features in the context of a longer message is also important to further illustrate the emotional weight they can convey. Houghton et al. (2018) expanded on the findings of Gunraj et al. (2016) in two ways: increasing the length of the conversations and introducing different response conditions. The conversations these researchers constructed included two messages before the experimental messages, intended to make the conversation longer and appear more natural to the participants. The response conditions in this experiment were affirmative (e.g., *yes, yeah, sure*), negative (e.g., *no, nope*), and neutral (e.g., *maybe*). Importantly, all of these responses were single-word answers and varied only in whether there was a period at the end of the target text message. Supporting the findings of Gunraj et al., they found that, for the affirmative response condition, participants rated texts with periods to be less enthusiastic than those without. Similarly, in the negative and neutral conditions, responses with periods were perceived to be more negative than responses without sentence-final periods. Houghton et al. concluded that the period serves a rhetorical function in texting because it is optional: the presence of a period, to someone born shortly before or after 2000, indicates the author is using it to convey something about their message (typically that the tone is more serious). Thus, younger individuals in the present study who are aware of this rhetorical function are expected to be more likely to include text-final periods in negative text messages and to interpret their presence in text messages as more negative in tone.

However, CMC does not just occur among college students. Individuals of different generations are using CMC—specifically, text messaging—to communicate with each other.

Despite having access to the same text features, the usage and interpretation of these cues may differ based on one's age. Riordan et al. (2018) further extended the findings of Gunraj et al. (2016) by examining how individuals of different ages interpreted the sentence-final period. Participants in these experiments were divided into two age groups (born before 1985 and born after 1985, respectively) and shown text message exchanges in which the target texts were composed of multiple words rather than one word affirmative or negative responses. Similar to the studies above, text message exchanges were generated for the experiments and were presented to participants, who were told to rate the responses on a scale from negative to positive. When presented with a series of positive and neutral text exchanges, younger participants (born after 1985, known as "digital natives") rated those with sentence-final periods as more negative, a result that was not found for the older group (born before 1985, known as "digital immigrants"). Interestingly, when the researchers asked participants to produce responses to the initial parts of these conversations (in a serparate experiment), both age groups used periods in equal frequency. However, again, the digital natives rated their own responses as more negative than the digital immigrants rated their own texts. This supports the idea that, though individuals may use the same cues (i.e., the sentence-final period) the cues do not carry the same emotional meaning across generations.

The addition or omission of a period to control the tone of a text message takes advantage of elements of language only available in text. These elements can serve to supplement aspects of prosody that are not available to a writer. Other cues more closely mimic speech to increase the expressivity of text. Walther (1992) identified some of the paralinguistic cues still used in CMC today, including spatial arrays (e.g., :), :-(, :/), capitalization, exclamation points, and ellipses. Also relevant are vocal spellings (e.g., *weeeell*, *soooo*), which are typically constructed by adding

additional letters to words to mimic drawing out sounds or placing emphasis on certain syllables (Kalman & Gergle, 2014; Pirzadeh & Pfaff, 2014). In a corpus study of corporate emails, Kalman and Gergle (2014) found that vocal spellings and letter repetitions were used in emails when speakers were communicating sounds, laughter, changes in pitch, and hesitation. It may be that vocal spellings are used in texting by college-age individuals for similar reasons today. However, because such features were identified as early as 1992, today's older generations (born before 1985) were using these features, at least in emails, and thus may be able to use them to accurately detect emotional tone in text messages. In the current study, I tested differences in the usage of vocal spellings among younger versus older individuals, a topic that was not discussed by Kalman and Gergle, primarily due to their context of corporate emails. Considering paralinguistic features in CMC that predate denoting negativity through a text-final period allows me to test whether today's younger generations are unique in how they incorporate emotion into text messages or if the text-final period is just a newer evolution in the use of paralinguistic cues in CMC. It further allows me test if there are differences in how paralinguistic cues are manifested (e.g., letter repetitions and text-final periods) across generations. If different generations have each created their own paralinguistic features for communicating emotion in text-messaging, it may increase the odds of cross-generation miscommunication.

The use of a given paralinguistic cue may differ according to the specific emotional state of the sender. Pirzadeh and Pfaff (2014) examined the ways college students used IM to convey emotional states in discussions with friends. The researchers induced four emotion conditions in their participants (e.g., happiness, sadness, relaxation, and anger) and had them talk to friends via IM about different life events related to the given emotional experience. In examining the conversations, the researchers were primarily interested in emotion words, vocal spellings, lexical

surrogates (e.g., *uh huh, haha*), spatial arrays, manipulation of grammatical markers (e.g., strings of periods/commas, all capital letters), and minus features (i.e., abbreviations, lack of capitalization). Consistent with prior research (Hancock et al., 2007), participants used more punctuation when happy than in other conditions. Similarly, they also used more vocal spellings, manipulation of grammatical markers, lexical surrogates, and minus features in the happy condition. The authors suggested that being in a happy mood made participants more likely to use nonverbal emotional cues to better express themselves. Notably, the participants reported happiness as the easiest emotion to express over IM because they could use emoticons, punctuation, and other strategies to help their conversation partner understand. Additionally, individuals also said they were more likely to talk to their friends over IM when they were already happy or in a good mood, so they were more comfortable doing so in the study. I hoped to further these findings by determining how individuals use paralinguistic cues to convey emotional tone in texting when they were already experiencing the emotion in question (i.e., without emotion induction) and by determining if individuals from different generations rely on different cues to convey their emotional state.

Overall, it is clear there has been significant research into the ways users of CMC incorporate nonverbal cues into their conversations and into the ways emotion is expressed via CMC, especially via IM. However, while some studies (Gunraj et al., 2016; Houghton et al., 2018; Riordan et al., 2018) presented text messages to participants, these were constructed by researchers for the experiment. This method provides greater control over the stimuli, thus lending itself to causal conclusions, but may not reflect the nuances with which individuals of varying generations actually construct texts. Exclusion or inclusion of a period affects how interlocutors from different generations interpret the tone of a text (e.g., Riordan et al., 2018), but interlocutors may rely on

multiple paralinguistic features such that if one fails, another may succeed. If this is the case, then cross-generation miscommunication may not occur, especially if some of the paralinguistic features overlap with those identified before the origins of text messages (e.g., Walther, 1992). In the present study, participant-constructed text messages were used to determine the extent to which the use of paralinguistic cues differs across generation and how well recipients of text messages can understand each other's intended tone across generations.

1.1 The Present Study

The purpose of this study was to examine the ways individuals of different ages interpret and use CMC regarding their paralinguistic cues and nonverbal communication and regarding their communication and perception of emotion. This was examined in a series of two experiments, involving the collection of authentic texts from participants, the presentation of these to other participants, and a survey regarding the frequency with which participants use various paralinguistic cues and grammatical features. To increase the external validity of the study, in Experiment 1, texts were collected by asking participants to provide the content of texts they had previously sent which conveyed happy, sad, angry, and neutral emotions. These texts were used in Experiment 2 to determine if readers are able to correctly interpret the intended emotions. If paralinguistic cues are interpreted differently across generations, interpretation of text messages should be more accurate when the reader ("Recipient") is in the same generation as the writer ("Sender"). Conversely, Recipients from a different generation than the Sender may be less accurate in their interpretations.

For each experiment, participants were divided into 2 age groups, one younger (born after 1996; age 25 and under) and one older (born before 1971; age 50 and up). This division was similar to that described in Riordan et al. (2018), between digital immigrants (born before 1985) and digital natives (born after 1985). Digital immigrants were described as being alive when CMC became more accessible but were likely older before they first adopted it. The digital natives, conversely, have not lived without the internet and CMC and thus the two groups may approach the use of CMC differently. I hoped to maximize generational differences in communication styles by increasing the divide between the participant age groups. This ensured that the older group would have adopted text messaging as adults, as text messaging did not exist before 1992 (Kelly, 2012), and they might not be as familiar with the subtle distinctions in paralinguistic cues that developed within the domain of text messaging among younger populations. It had the further benefit of ensuring two participants from opposite groups were not similar in age (i.e., born in 1985 vs 1986).

The emotion of the submitted texts included happy, sad, and angry in order to encompass a range of emotions that people likely express frequently via CMC. Anger and sadness are both negative emotions, but differ in their arousal (Russell, 1980). Including both emotions allowed for a greater understanding of how negativity, in various forms, is conveyed via CMC. Happiness is reported as the easiest emotion to express via CMC (Pirzadeh and Pfaff, 2014), which may suggest that it is also the easiest emotion to detect for the reader. A fourth, neutral, condition, acted as a baseline both to prevent participants from assuming all texts were valenced positively or negatively and to test differences in the extent to which digital natives versus immigrants read emotion into texts.

The study tested the following hypotheses:

Hypothesis 1: There will be age-related differences in how senders use paralinguistic cues to convey emotion. The types of paralinguistic features used by younger senders will vary by emotion (e.g., greater text-final periods for negatively valenced texts), but paralinguistic features will remain more consistent across emotions conditions among older senders.

Hypothesis 2: Texts will be more accurately interpreted when the Sender and the Recipient are in the same age group. In particular, younger Recipients will perceive texts from older Senders more negatively than the Sender intended across emotion conditions.

Hypothesis 3: Texts intended to convey Happiness (positively valenced) will be more accurately interpreted than negatively valenced (Sad and Angry) and Neutral texts across age groups.

2.0 Experiment 1

Experiment 1 had two primary objectives. The first was to collect text messages used by participants to convey a variety of emotions (Happy, Angry, Sad, Neutral) to people they knew. Critically, these messages had been sent before participants began the study. Thus, the messages contained paralinguistic cues that the participant actually used during their everyday interactions as opposed to cues they may have generated for a lab manipulation. A selection of these messages was then used during Experiment 2. Second, all of the text messages were analyzed to detect differences in paralinguistic cues among the Senders based on age group and emotion.

2.1 Method

2.1.1 Participants

Participants (N = 46, 34 female, 1 other) fell into 2 groups: younger (born between 1996 and 2003, between 18 and 25 years old, N = 25, M_{age} = 18, SD = 0.43) and older (born before 1971, 50 and older, N = 21, M_{age} = 57, SD = 5.48). The younger participants were recruited from the Introduction to Psychology participant pool and were credited one hour towards fulfillment of a course requirement upon completion of the survey. The older participants were recruited from Amazon Mechanical Turk and were compensated $5 upon completion of the survey.

2.1.2 Materials and Procedure

Participants completed a Qualtrics survey on an electronic device and were advised to complete it using a computer. The first part of the survey prompted them to submit the content of a text message "as precisely as possible, including capitalization, spelling, and punctuation," into a text box, reflecting a time when they were either happy, sad, angry, or not experiencing a strong emotion. For the three emotion conditions, participants were first prompted to submit a text from when they were "strongly" feeling that emotion. For the second text, participants were prompted to submit a text from when they were "somewhat" experiencing that emotion. Two texts of each emotion were collected to gather a wider range of emotional expression from participants, as well as to allow for the possibility that certain participants may not text frequently when they are really angry or sad, but only when they are somewhat in a negative mood. They then reported their perception of the emotional tone (Sender Valence) present in the text message on a Likert-type, 12-point scale ranging from 1 (Extremely negative) to 12 (Extremely positive). Two happy, two sad, two angry, and two neutral text messages were collected from each participant, along with the age of the intended recipient. After the last text was submitted, the next page contained a short Text Features survey regarding the participants' texting habits and use of paralinguistic features, including periods, ellipses, capitalization, text abbreviations or acronyms, and vocal spellings. Each of these was reported on a 7-point Likert-type scale. Participants also answered questions about how long they have used the internet, for what they frequently use the internet, how long they have had a smartphone, and at what age they started texting frequently. Exact questions are listed in Appendix A. After completing the Text Features survey, participants provided demographic information, including age, gender, race, income, and education level. As

participants completed the same survey in Experiment 2, descriptive statistics were collapsed across Experiments and are provided with Experiment 2.

Summary data for participants in Experiment 1 is listed in Table 1.

Table 1 Descriptive Statistics for Experiment 1

Group	Education	Race	Income[1]	Age	Age of Recipient
Younger Senders	Some college = 100%	White = 84.00% Black or African American = 4.00% Asian = 12.00%	$87,500	18 (0.43)	24.84 (14.00)
Older Senders	High School Diploma = 4.76% Some college = 19.04% Associate degree = 14.29% Bachelor's degree = 42.85% Master's degree or Higher = 19.04%	White = 90.48% Black or African American = 4.76% Asian = 4.76%	$37,500	57 (5.48)	48.65 (15.97)

Note. Values in parentheses indicate standard deviation.

[1] Income was reported for the individual's household, which may have included spousal or parental incomes.

2.1.3 Data Analysis Plan

All data analysis was performed in the R Project for Statistical Programming (R Core Team, 2019). Mixed effects regressions were conducted using the package *lme4* (Bates et al., 2015), and simple effects were analyzed using the emmeans package (Lenth, 2019).

Texts submitted in Experiment 1 were coded for use of various features by two coders. Each feature was considered in a separate model. Three binary features were coded: presence of a text-final period, explicit reference to emotion, and presence of an emoticon. The nature of data collection (users transcribed text messages) made it difficult for users to include emojis; thus, only emoticon usage was coded. Initially, the number of emoticons within a text was counted; however, to preview, emoticon rates were low. Thus, this variable was collapsed to reflect the presence of an emoticon.

For binary outcomes, a logistic mixed effect model was computed with fixed effects of age group (young = 0.5 and old = -0.5) and emotion (treatment coded with neutral as the reference variable). Pairwise comparisons were used to test for difference between emotionally valenced conditions. Participants were included as a random intercept, but when fixed effects were included as random slopes, all models failed to converge. Thus, the data best supported models without random slopes (Matuschek et al., 2017). For the model testing differences in the explicit use of emotion words, no emotion words were produced among the Older Senders in the Neutral group. Thus, reliable differences between other emotions and Neutral could not be reliably computed. Instead, the Neutral condition was dropped, and contrast coding was used to compare Happy to Angry and Sad and then Angry and Sad to Neutral. However, additional pairwise comparisons were used to detect further differences from the Neutral condition among Younger Senders.

A benefit of collecting authentic texts from Senders was the opportunity to observe a large variety of features. However, only the features above were of theoretical interest as it was not immediately clear how other observed text features would vary based on emotion. Nonetheless, these additional features (misspellings, abbreviations, complete thoughts, and the capitalization of proper nouns) were coded and the models are reported in Appendix C, Appendix Tables 2-6**.** To preview, although some differences based on age and emotion occurred, there were not significant interactions for these variables. Thus, the assumption that these variables would not vary based on emotion was incorrect, but the variance did not add to an understand of how Senders of differing ages express emotion in text messaging.

2.2 Results

2.2.1 Coding Text Production Features

The presence of a text-final period was determined using a formula in Excel. For all other features, two raters initially scored 10% (36/367) of the texts submitted for the presence of emoticons (K = 1.00) and emotionally valenced language (K = .95). As inter-rater reliability was high (K > .90), the remaining texts were divided equally between the two raters.

2.2.2 Text-Final Period

Across age groups, the emotion expressed predicted differences in the odds of a text-final period being used. The odds of a text-final period occurring in Angry texts were 5.94 times (95%

CI:[1.63, 21.67]) greater than for Neutral texts, $z = 2.70$, $p = .007$.[2] Similarly, the odds of a text-final period in Sad texts were 9.43 times (95% CI:[2.53, 35.06]) greater than for Neutral, $z = 3.36$, $p < .001$. There were no reliable differences when comparing the Happy and Neutral conditions, $p = .51$. Thus, collapsing across Sender Age, negatively valenced texts were most likely to contain text-final periods. See Figure 1 for the means across conditions and Table 2 for full results from the model.

The age of the Sender moderated the differences in text-final period based on emotion expressed. The odds of Older Senders including a text-final period in a Neutral text were 60.52 times (95% CI:[3.97, 922.70]) greater than Younger Senders, $z = 2.95$, $p = .003$. Further, although for Neutrally valenced texts, the Older Senders used more text-final periods in the Angry condition than Younger Senders, the odds of an increase in text-final period usage from Neutral to Angry texts was marginally greater among Younger versus Older Senders, $z = -1.91$, $p = .06$. The age of the Sender did not further alter the odds of a text-final period for the Happy and Sad conditions, ps > .22.

Additional pairwise comparisons were conducted to better understand differences in text-final period usage between valenced (Happy, Sad, and Angry) conditions. First, the finding that Older Senders were more likely than Younger Senders to use text-final periods in Neutral texts persisted for Happy texts, $z = 2.16$, $p = .03$, and Sad texts, $z = 3.06$, $p = .002$, but was only marginally significant for Angry texts, $z = 1.71$, $p = .09$. Further, after corrections for multiple comparisons (Tukey Test), there were no further significant differences among Younger Senders

[2] The original model produced results in log odds. Log odds have been back-transformed with the text to facilitate interpretation but are left in their original form within the tables.

based on the emotional valence of the text, *p*s > .16. Similarly, the odds of an Older Sender including a text-final period in a Happy versus Angry text were not reliably different, $p = .45$. However, the odds of an Older Sender including a text-final period were 7.77 times (95% CI:[2.22, 27.23]) greater for Sad versus Happy texts, $z = 3.23$, $p = .007$.

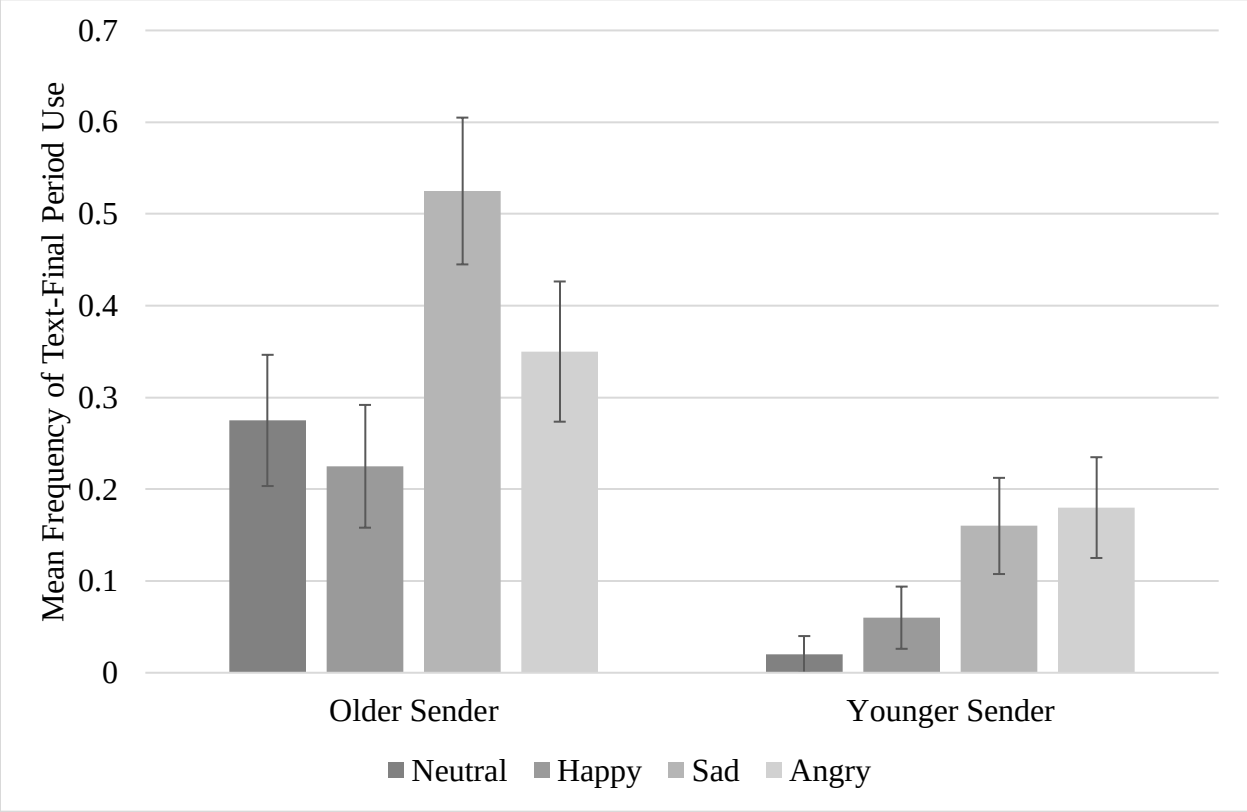


Figure 1 Senders' Use of Text Final Periods

Note. Error bars represent standard error of the mean.

Table 2 Fixed Logistic Effects of Emotion Condition and Age on Text-Final Period Production

	$\widehat{\beta}$	*SE*	*z*	*p*
Intercept	-3.64	0.749	-4.86	< .001 ***
Sender Age	4.10	1.393	2.95	.003 **
Happy (vs Neutral)	0.46	0.70	0.67	.51
Sad (vs Neutral)	2.24	0.67	3.36	< .001 ***
Angry (vs Neutral)	1.78	0.66	2.70	.007 **
Sender Age x Happy	-1.70	1.39	-1.22	.22
Sender Age x Sad	-1.16	1.32	-0.88	.38
Sender Age x Angry	-2.51	1.32	-1.91	.06

2.2.3 Explicit Reference to Emotion

Explicit reference to emotion included both explicit emotions (i.e., happy, sad) and other emotions (i.e., frustrated, tired), referred to in any form of the word (i.e., "stressing me out," "I'm so frustrated," "This is so exciting"). See Figure 2 for means and Table 3 for primary model results. The odds of a Sender directly referencing an emotion did not differ across age groups, $z = 0.47$, $p = .64$. However, participants were 1.92 times more likely (95% CI:[1.09, 2.38]) to reference emotion directly in the Happy versus Sad and Angry condition, $z = 2.63$, $p = .02$. Participants were also 0.26 times less likely (95% CI:[0.13, 0.56]) to reference an emotion directly when Angry compared to Sad, $z = -3.54$, $p < .001$. These differences were not further moderated by the age of the Sender, ps > .22. Differences between valenced conditions and neutral could not be detected for Older Senders as there were no instances of emotional language in the Neutral texts for these

participants. However, for Younger Senders, Happy and Sad texts both had greater odds of containing emotionally valenced words than Neutral texts, $z = 3.57$, $p = .002$, and $z = 3.42$, $p = .004$, respectively. There were no reliable differences among Younger Senders for Angry versus Neutral texts, $z = 0.35$, $p = .99$.

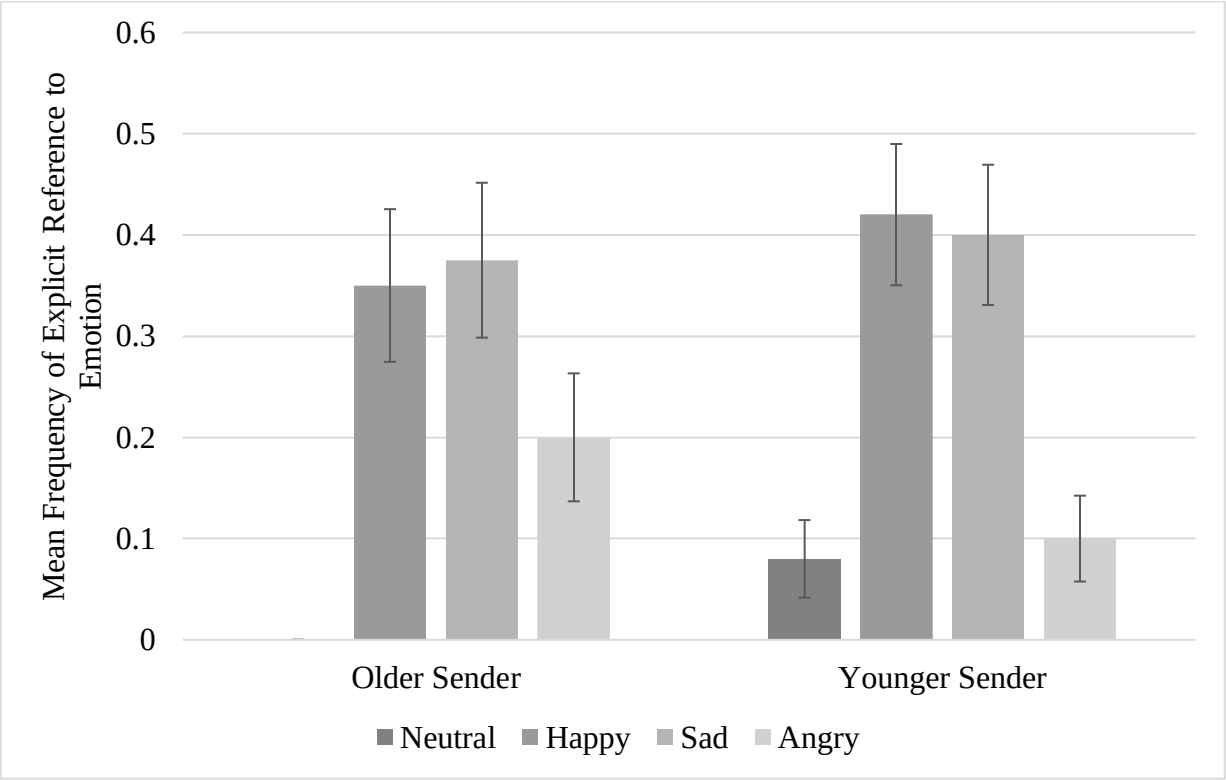


Figure 2 Senders' Use of Explicit Reference to Emotion

Note. Error bars represent standard error of the mean. Older Senders produced 0 explicit references to emotion in the Neutral condition. Younger Senders referenced emotion 4 times across Neutral texts: “oh hey sorry i was sleeping;” “i personally hated the class and i usually like reading and writing (…);” “I’m ok;” and “I’m good.”

Table 3 Fixed Logistic Effects of Emotion Condition and Age on Explicit Reference to Emotion

	$\widehat{\beta}$	*SE*	*t*	*p*
Intercept	-0.91	0.15	-6.24	< .001 ***
Sender Age	0.14	0.29	0.47	.64
Happy (vs Sad and Angry)	0.65	0.29	2.26	.02 *
Angry (vs Sad)	-1.33	0.38	-3.54	< .001 ***
Sender Age x Happy (vs Sad and Angry)	-0.65	0.58	-1.12	.26
Sender Age x Angry (vs Sad)	0.92	0.75	1.22	.22

2.2.4 Emoticons

Across all conditions, only 2.18% (8/367) of texts contained emoticons. Thus, neither Older nor Younger Senders were likely to use emoticons. With such a low rate of emoticon usage, a statistical test would likely need far more total texts to detect differences among the conditions. Indeed, there were no significant effects of Age or Emotion in the production of emoticons, *p*s > .34. While these are text-based features that could be used by Senders to convey emotional information, the current sample is not large enough to determine how (or if) they vary across age and emotion.

2.3 Discussion

The above three measures are potential ways Senders could directly express emotion to their intended recipient. The increased use of a text-final period when expressing a negative emotion in both age groups indicates this feature does coincide more with negative affect. However, Older Senders were more likely to use this feature across all emotion conditions. Thus, if Recipients also expect a text-final period to indicate negative valence, Older Senders may be opening themselves for misunderstanding in more positive (Happy or Neutral) contexts.

Additionally, Senders were more likely to explicitly reference an emotion when texting to convey an emotion (Happy, Sad, Angry) compared to when no emotion was meant to be conveyed (Neutral). Further, Senders were more likely to reference emotion when happy or sad than when they were angry. Together, this suggests that both Older and Younger Senders *do* rely on explicit language within texts to convey emotion, which is to be expected, but also that explicit language may sometimes be insufficient and thus optional use of text-final period may be useful in adding negative valence to the tone of a message. It may be the case that Younger Senders rely on the negativity of the text-final period to convey anger, since this condition did not differ from Neutral in the use of explicit language to convey emotion. Finally, emoticons allow Senders to convey emotional intention, as happy and sad faces can be easily assigned to their respective valence. However, the low level of production of these features suggests that the Senders in this study may not have relied on them to help convey their emotion. It is possible that Senders selected texts that did not contain emoticons (or emojis) or omitted them when submitting their texts. Further work could focus more on these features to identify any age-related differences in usage. Overall, in expressing their emotions, Senders were more likely to use text-final punctuation (specifically the

period) and/or to use a word specifically reflecting the emotion they intended to convey. Further, these patterns were largely similar across age groups.

3.0 Experiment 2

Experiment 1 highlighted the prevalence of paralinguistic features of text messages among Older and Younger Senders across multiple emotion conditions. In Experiment 2, participants received a subset of the texts from Experiment 1 to determine how well Recipients from two different age groups would be able to interpret the intended emotion of the Senders. Thus, Experiment 2 considers the original variables from Experiment 1 (Sender Age x Emotion) and adds a new variable (Recipient Age).

3.1 Method

3.1.1 Participants

A power analysis for a repeated measures ANOVA (using G*Power version 3.1.9.3; Faul et al., 2007) was conducted using an effect size (Cohen's d = -0.39) extrapolated from the findings of Riordan et al. (2018) for the main effect of age. Based on the analysis, participants (N = 120, 80 female) were recruited and compensated in the same manner as Experiment 1. Thus, Recipient Age was divided into two groups: those born after 1996 (N = 60, M_{age} = 19, SD = 1.07) and before 1971 (N = 60, M_{age} = 55, SD = 4.28). Summary data for participants in Experiment 2 is listed in Table 4.

Table 4 Descriptive Statistics for Experiment 2

Group	Education	Race	Income[3]	Age
Younger Recipients	Some college = 95.00% Bachelor's degree = 5.00%	White = 61.67% Black or African American = 8.33% Asian = 23.33% Multiple = 5.00% Other = 1.67%	$87,500	19 (1.07)
Older Recipients	Less than high school = 1.67% High School Diploma = 20.00% Some college = 18.33% Associate degree = 16.67% Bachelor's degree = 31.67% Master's degree or Higher = 11.67%	White = 93.33% Black or African American = 0% Asian = 3.33% Multiple = 3.33%	$62,500	55 (4.28)

Note. Values in parentheses indicate standard deviation.

[3] Income was reported for the individual's household, which may have included spousal or parental incomes.

3.1.2 Materials

Forty text messages from those submitted in Experiment 1 were selected for Experiment 2 based on the following: (a) texts must contain between 6 and 25 words. This range was determined to ensure enough content was available for Recipients to interpret. The average word count of submitted texts was 12 words, but Older Senders tended to submit longer texts (average word count for Older Senders, 13.09; for Younger Senders, 10.24). To decrease the number of texts excluded, the maximum number of words was set at 25. (b) Texts must not contain any explicit reference to emotion, and texts must not contain any emojis or emoticons. This ensured Recipients would need to rely on non-explicit features of the text message when interpreting emotion. Although explicit reference to emotion was common in Experiment 1, the absence of words referencing emotion even more common, and Experiment 2 seeks to understand how well Recipients can understand the tone of the text when the Sender *does not* provide explicit emotion reference. Thus, limiting texts to those without explicit content referencing emotion was critical to the hypotheses. After exclusions, 40 of the remaining texts were selected to ensure an equal number of texts across conditions. Further, within each emotion condition, an equal number reflected the emotion at a stronger or weaker level and either did or did not have text-final punctuation. Text-final punctuation was balanced across Sender Age, such that each emotion condition had the same number and type of punctuation used (i.e., 3 texts contained a text-final period and 2 texts had no text-final punctuation) within each Sender Age condition. Only one Happy, Sad, or Angry text was used from any participant. However, due to the limited sample, three of the Neutral texts were selected from participants whose texts were already being used in another emotion condition (but not another in the Neutral condition). Any names or identifying

information included in these submitted texts was blocked out and was not presented to participants. A complete list of texts used in Experiment 2 is available in Appendix B.

Table 5 Descriptive Statistics of Experiment 2 Stimuli

Emotion and Sender Condition	Mean Word Count	Mean Sender Valence	Number of Texts
Neutral - Younger	7.40	8.20	5
Neutral - Older	11.00	6.60	5
Happy - Younger	7.20	10.80	5
Happy - Older	10.60	10.20	5
Sad - Younger	10.60	4.00	5
Sad - Older	14.00	2.80	5
Angry - Younger	7.40	3.80	5
Angry - Older	11.00	2.60	5

3.1.3 Procedure

Forty text messages in a 2 (Sender Age) x 4 (Emotion Condition) design were presented to participants, such that all participants received text messages from all levels of the Emotion condition. The texts appeared to participants as screenshots of a cell phone in a Qualtrics survey (See Figure 3). For each text, participants provided a rating for the text's emotional tone (Recipient Valence) on the same scale as Experiment 1 (1: extremely negative – 12: extremely positive). After providing tone ratings for all texts, participants were randomly presented one text again from each condition and answered two brief questions targeting their reasoning for the rating they provided, as in (1) and (2). Participants then completed the Text Features survey from Experiment 1 (15

questions targeting the frequency with which they use certain paralinguistic features, their internet use, and cell phone ownership and use) and provided answers to the same demographic questions.

(1) You rated the above text as [value from 1 to 12] . Please tell us which of the below influenced your opinion. You may select more than one answer. (Options: punctuation, word meanings, length of text, capitalization of specific letters or words, spelling choices within the text, other)

(2) How old do you think the sender of this text is? (Options: Under 18, 18 to 25, 26 to 49, 50 or older)

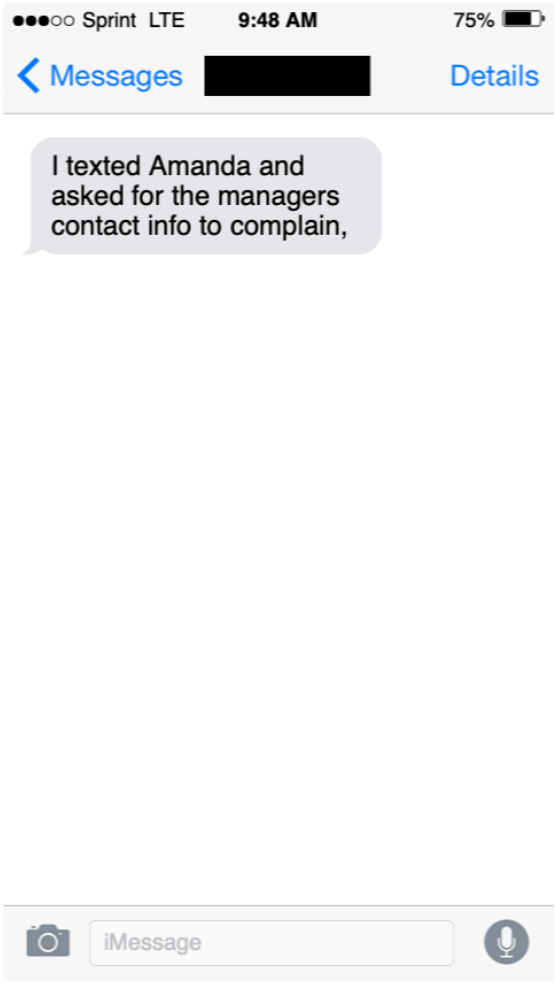


Figure 3 Sample Screenshot Presented to Participants in Experiment 2

3.1.4 Data Analysis Plan

Two models were conducted based on the valence responses from participants in Experiment 2. The first assessed how accurate Recipients were in interpreting the valence of the text messages. The Valence Accuracy value for each Recipient in Experiment 2 was calculated as the absolute difference between Recipient Valence and Sender Valence. The absolute value was used to determine the magnitude of difference between the two valence scores. The absolute value was used because some of difference scores may be negative while others were positive. Thus, if some participants were off by -10 points and others by +10 points, the group mean might reflect 0 error when in reality error was quite large. Using the absolute values allows for more accurate detection of the extent of variance (positive or negative) in the interpretation of the text's emotion from the intended emotion.

Although calculating Valence Accuracy allowed me to determine the accuracy of participants, it would not allow me to test one of the critical hypotheses, that Younger Recipients would interpret texts more negatively than Older Recipients. Thus, a second model was run using the signed difference between values. The signed difference, which I call Valence Difference, was calculated as the actual difference between Recipient Valence and Sender Valence, centered.

For both models, a linear mixed effects regression was performed with Sender Age, Recipient Age, and Emotion Condition as fixed effects, and Participant and Texts as random intercepts. Again, models with random slopes did not converge.

3.2 Results

3.2.1 Absolute Valence Accuracy Results

3.2.1.1 Sender and Recipient Age Differences

I hypothesized that texts would be more accurately interpreted when Senders and Recipients were in the same age group. However, the results suggest that the age of the Sender may be more important than a match between the age of the Sender and the age of the Recipient. An interaction between Sender Age and Recipient Age demonstrated that both Recipient age groups were more accurate in their ratings of Neutral texts from Younger Senders than from Older Senders, $t(4633.99) = 2.28$, $p = .02$. Despite the greater accuracy among both groups for interpreting Neutral tone from Younger versus Older Senders, Younger Recipients' accuracy in interpreting tone within Neutral texts was 0.215 (95% CI:[.062, .268]) points lower than Older Recipients, $t(607.58) = 2.76$, $p = .006$.

3.2.1.2 Valence Related Differences

I also hypothesized that Happy texts would be more accurately interpreted across Sender Age groups, because it is commonly communicated via CMC (Pirzadeh & Pfaff, 2014). The above regression did not reveal differences in the Happy condition relative to Neutral, $t(32.00) = 1.07$, $p = .29$; however, there were differences in the interpretation of Sad versus Neutral texts. The rate of accuracy for Sad texts decreased by 1.38 (95% CI:[0.560, 2.20]) points relative to neutral texts, $t(32.00) = 3.30$, $p = .002$. There were no further effects related to the Angry condition, $p = .41$.

3.2.1.3 Valence x Age Interactions

Accuracy in interpreting text messages varied for each Recipient Age group based on the type of emotion the Sender intended to convey. Older Recipients were less accurate in their interpretations of Sad (versus Neutral) texts from all Senders than were Younger Recipients, $t(4633.99) = -3.38$, $p < .001$. Both groups of recipients numerically declined in their interpretation of Angry texts as compared to the Neutral condition, however the magnitude of the differences was greater for Older Recipients than for Younger Recipients, $t(4633.99) = -1.96$, $p = .05$. Finally, while accuracy in interpreting Happy (versus Neutral) texts from Younger Senders increased for both Recipient Age groups, accuracy for Happy texts from Older Senders declined, and this discrepancy in the direction of change in accuracy was greater for Younger versus Older recipients, $t(4633.99) = -4.17$, $p < .001$. In this interaction, it is true that Younger Recipients were more *in*accurate in their interpretation of Happy texts from Older Senders than Older Recipients, $z = 6.16$, $p < .001$ in a pairwise comparison. However, it should be noted that it was not the case that Younger Recipients were numerically more accurate in their interpretation of Happy texts from Younger Senders than Older Recipients, $p = .16$ in a pairwise comparison. Rather Younger Recipients (as compared to Older Recipients) were less accurate in their interpretation of the Neutral texts from Younger Senders, $z = 3.58$, $p < .001$ in a pairwise comparison, and thus improved more in their interpretation of the Happy texts. Even after this improvement, their accuracy only reached a similar level as Older Recipients, it did not actually surpass them in accuracy (See Figure 4). Rather Younger Recipients were less accurate in their interpretation of the Neutral texts and thus improved more in their interpretation of the Happy texts. Even after this improvement, their accuracy only reached a similar level to Older Recipients, it did not actually surpass them in accuracy (See Figure 4).

In a final set of pairwise comparisons, I checked to determine if Happy texts were more accurately interpreted than Sad and Angry texts within Sender and Recipient groups. The model had already shown, as reported above, that Happy texts were not reliably more accurately interpreted than Neutral texts, $p = .29$. This was broadly true in comparisons between Happy versus Sad texts, $p = .11$ following Tukey correction, and Happy versus Angry texts, $p > .99$. However, for Older Recipients, Happy texts from Older Senders were interpreted more accurately than Sad texts, $z = -2.64$, $p = .04$. All other pairwise comparisons between Happy and Sad texts within groups were non-significant, ps > .41.

Additional marginally significant interactions are reported in Table 5 but are not discussed here because they do not add anything further to the interpretation of the results reported in the text or can be more clearly described when looking at the signed differences.

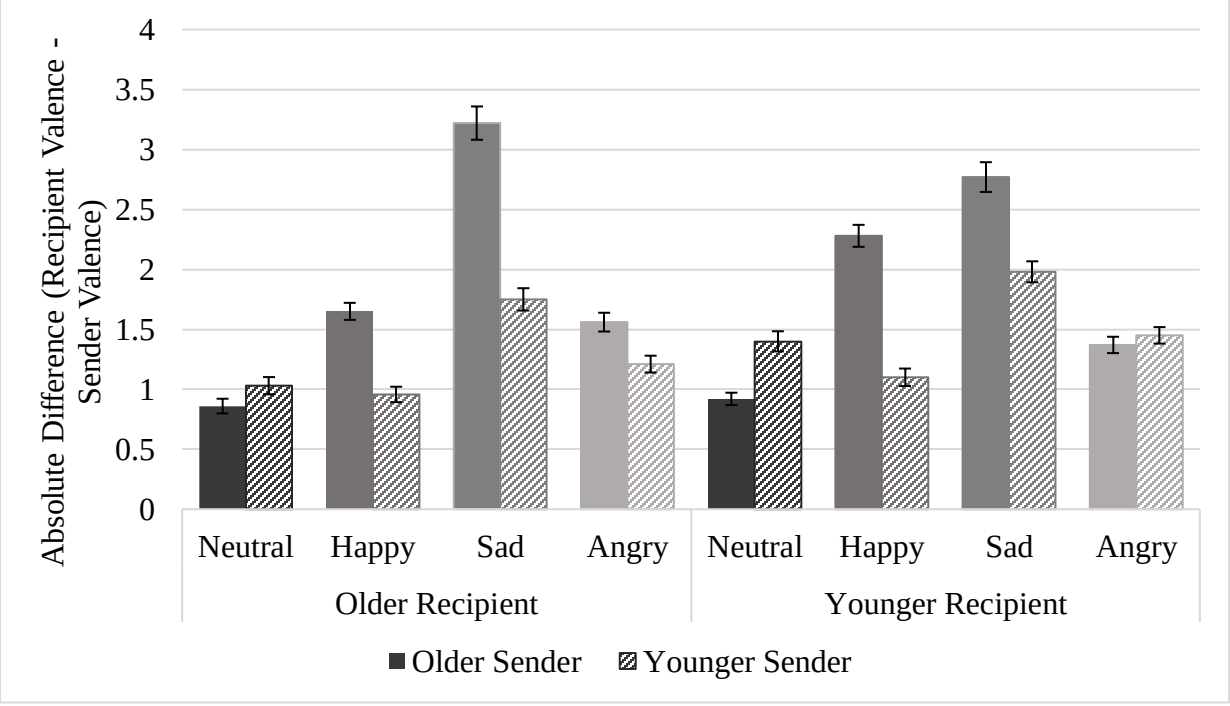


Figure 4 Absolute Valence Accuracy

Note. Error bars represent standard error of the mean.

Table 6 Fixed Effects of Emotion, Sender Age, and Recipient Age on Absolute Valence Accuracy

	$\hat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	1.05	0.30	32.27	3.55	.001 **
Happy (vs Neutral)	0.45	0.42	32.00	1.07	.29
Sad (vs Neutral)	1.38	0.42	32.00	3.30	.002 **
Angry (vs Neutral)	0.35	0.42	32.00	0.83	.41
Sender Age	0.32	0.59	32.00	0.55	.60
Recipient Age	0.22	0.08	607.58	2.76	.006 **
Happy x Sender Age	-1.26	0.84	32.00	-1.50	.14
Sad x Sender Age	-1.45	0.84	32.00	-1.74	.09
Angry x Sender Age	-0.46	0.84	32.00	-0.55	.59
Happy x Recipient Age	-.18	0.10	4633.99	1.84	.07
Sad x Recipient Age	-0.33	0.10	4633.99	-3.38	< .001 ***
Angry x Recipient Age	-0.19	0.10	4633.99	-1.96	.05 *
Sender Age x Recipient Age	0.31	0.14	4633.99	2.28	.02 *
Happy x Sender Age x Recipient Age	-0.80	0.19	4633.99	-4.17	< .001 ***
Sad x Sender Age x Recipient Age	0.36	0.19	4633.99	1.86	.06
Angry x Sender Age x Recipient Age	0.12	0.19	4633.99	0.64	.52

3.2.2 Signed Valence Difference Results

The previous model considered the absolute difference between Sender and Recipient ratings. This was ideal for a measure of how aligned Senders and Recipients were in their perceptions of text messages. However, it does not show the direction of the difference. I hypothesized that Younger Recipients would rate texts from Older Senders more negatively across conditions, because Older Senders would be more likely to include text-final periods. Thus, although Younger Recipients were more accurate than Older Recipients, it was still possible that the direction of the Recipients error diverged with Younger Recipients interpreting texts more negatively and Older Recipients interpreting them more positively. To test these signed differences, I used the Signed Valence Difference by taking the difference between Recipient Valence and Sender Valence, so negative values correspond to interpreting more negative emotion than was intended. I ran a new linear regression model on the Signed Valence Difference using the same fixed and random effects from the prior mode.

Recipients in both age groups rated Neutral texts from both Sender Age groups numerically more negatively than the Senders had intended but the degree of inaccuracy did not reliably vary based on Sender or Recipient Age, $t(4633.99) = -1.33$, $p = .18$.

Recipients interpreted Sad texts from all Senders more positively than they were intended, $t(32.00) = 4.002$, $p < .001$. Younger Recipients rated Neutral texts more negatively than Older Recipients, across Sender Age, $t(413.74) = -2.455$, $p = .01$.

I also found three, three-way interactions between Emotion (compared to Neutral) x Sender Age x Recipient Age: Happy, $t(4633.99) = 3.13$, $p = .001$; Sad, $t(4633.99) = 4.54$, $p < .001$; Angry, $t(4633.99) = 2.46$, $p = .01$. Recipients rated Happy texts from Older Senders more inaccurately than they rated their Neutral texts, specifically more negatively, but they were slightly more

accurate for Happy texts from Younger Senders, though they still interpreted these texts more negatively than the Senders intended. This change in accuracy was larger for Younger Recipients than for Older Recipients, see Figure 5.

Recipients rated Sad texts from Older Senders more inaccurately than their Neutral texts but interpreted them more positively than the Sender intended in all cases. Recipients were again more inaccurate for texts from Older Senders than for Younger Senders. Older Recipients were more accurate for Sad texts from Younger Senders than Younger Recipients but were less accurate for Sad texts from Older Senders than Younger Recipients.

Finally, Angry texts from Older Senders were perceived more positively than intended, compared to Neutral, while Angry texts from Younger Senders were perceived more negatively than intended. Younger Recipients were more accurate in their perception of Older Senders' Angry texts than Older Recipients, but Older Recipients were slightly more accurate in their perception of Younger Senders' Angry texts.

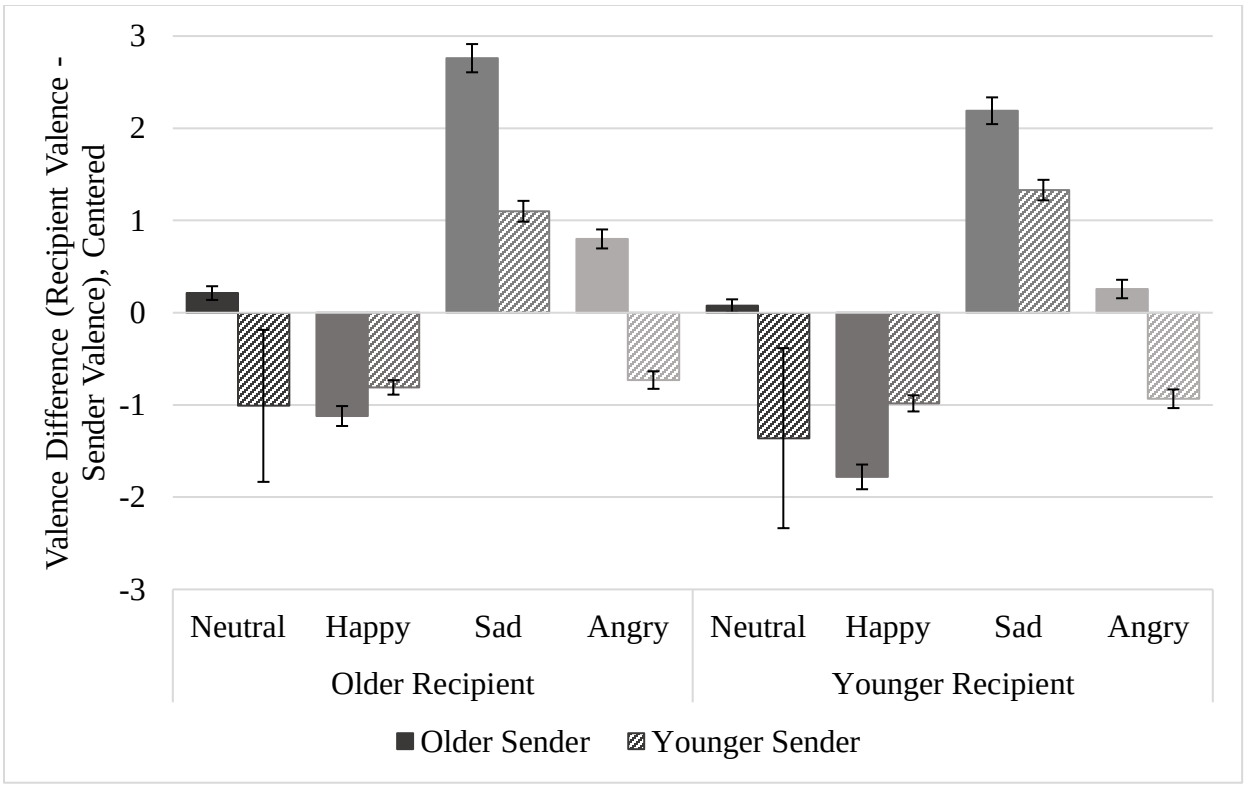


Figure 5 Signed Valence Differences

Note. Error bars represent standard error of the mean.

Table 7 Fixed Effects of Emotion, Sender Age, and Recipient Age on Signed Valence Difference

	$\hat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	-0.52	0.42	32.34	-1.24	.22
Happy (vs Neutral)	-0.66	0.59	32.00	-1.11	.28
Sad (vs Neutral)	2.36	0.59	32.00	4.00	< .001 ***
Angry (vs Neutral)	0.37	0.59	32.00	0.62	.54
Sender Age	-1.33	0.84	32.00	-1.59	.12
Recipient Age	-0.25	0.10	413.74	-2.46	.01 *
Happy x Sender Age	1.88	1.18	32.00	1.59	.12
Sad x Sender Age	0.07	1.18	32.00	0.06	.96
Angry x Sender Age	-0.04	1.18	32.00	-0.03	.98
Happy x Recipient Age	-0.17	0.11	4633.99	-1.55	.12
Sad x Recipient Age	0.07	0.11	4633.99	0.64	.52
Angry x Recipient Age	-0.13	0.11	4633.99	-1.15	.25
Sender Age x Recipient Age	-0.21	0.16	4633.99	0.18	.18
Happy x Sender Age x Recipient Age	0.70	0.22	4633.99	3.13	.002 **
Sad x Sender Age x Recipient Age	1.02	0.22	4633.99	4.54	< .001 ***
Angry x Sender Age x Recipient Age	0.55	0.22	4633.99	2.46	.01 *

3.2.3 Text Interpretation Reasoning Results

After rating all 40 experimental texts, participants in Experiment 2 were presented with 8 texts again, one from each Sender Age x Emotion condition, and were asked to provide the reasoning for the rating they provided. Participants could select more than one of the following options, or provide their own reasoning: capitalization, punctuation, the length of the text, word meanings, or spelling. Chi-squared goodness of fit tests were used to evaluate whether or not the percentages were different from chance. Younger Recipients reported that capitalization (or lack thereof), $\chi_1^2 = 31.36$, $p < .001$, text length, $\chi_1^2 = 9.00$, $p = .003$, spelling, $\chi_1^2 = 10.24$, $p = .001$ and punctuation, $\chi_1^2 = 14.44$, $p < .001$ influenced their interpretations more than Older Recipients, while Older Recipients reported that word meaning mattered numerically more, but this difference was not significantly different from what would be expected by chance, $\chi_1^2 = 1.96$, $p = .16$. See Figure 6.

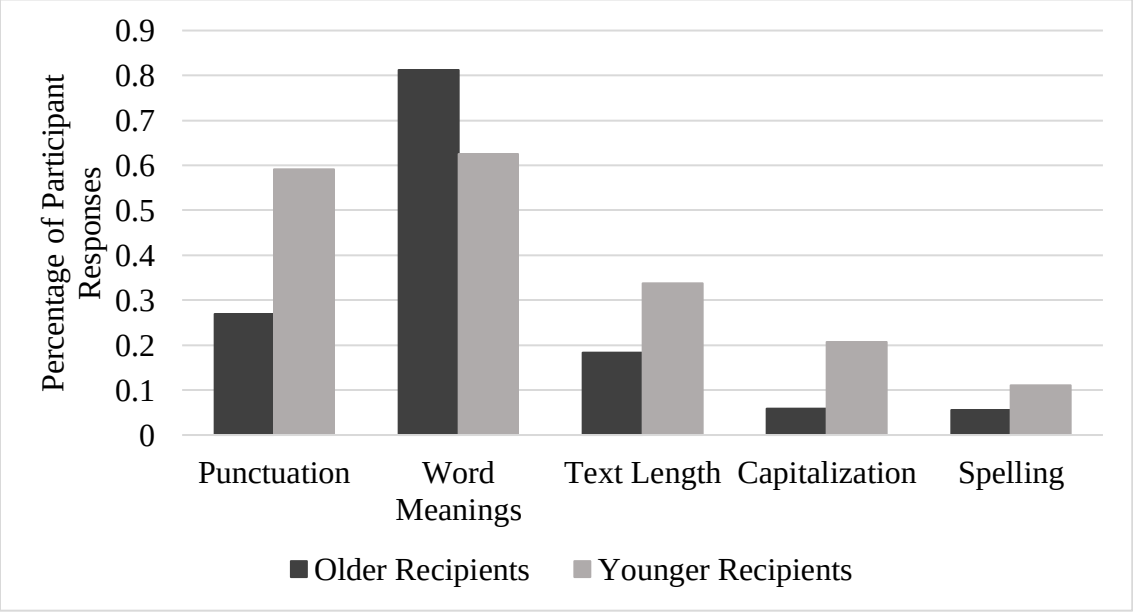


Figure 6 Influential Factors on Recipient Ratings, Across Recipient Age

Participants largely did not differ on what impacted their ratings when texts were from Older or Younger Senders, *p*s > .05, though Recipients reported being marginally more influenced by capitalization and spelling when texts were from Younger versus Older Senders, $\chi_1^2 = 3.24$, $p = .07$ for both (see Figure 7). It is possible that this marginal difference was related to the Younger Senders having more spelling errors. Recipients saw 5 texts from Younger Senders that had misspellings (intentional or unintentional), while they saw only 1 text from Older Senders that had misspellings. Finally, collapsing across age differences, participants did differ when considering what text features mattered most for different emotion conditions. Critically, although the texts may have different rates of each of the above features, ratings were not necessarily tied to the presence of the feature. Raters could also have been considering the absence of a feature in their evaluation. There was a marginal difference in the reporting of the influence of punctuation across emotion conditions, with punctuation being numerically more likely to influence ratings of Happy versus Neutral, Sad, or Angry texts, $\chi_3^2 = 6.56$, $p = .09$. Similarly, capitalization was listed at a greater rate for Neutral and Happy texts versus Sad and Angry, $\chi_3^2 = 12.72$, $p = .005$, while spelling was listed more often as influential for Sad and Angry versus Happy and Neutral, $\chi_3^2 = 27.07$, $p < .001$. There were no differences in rates for word meaning or text length across emotion conditions, *p*s > .20. See Figure 8.

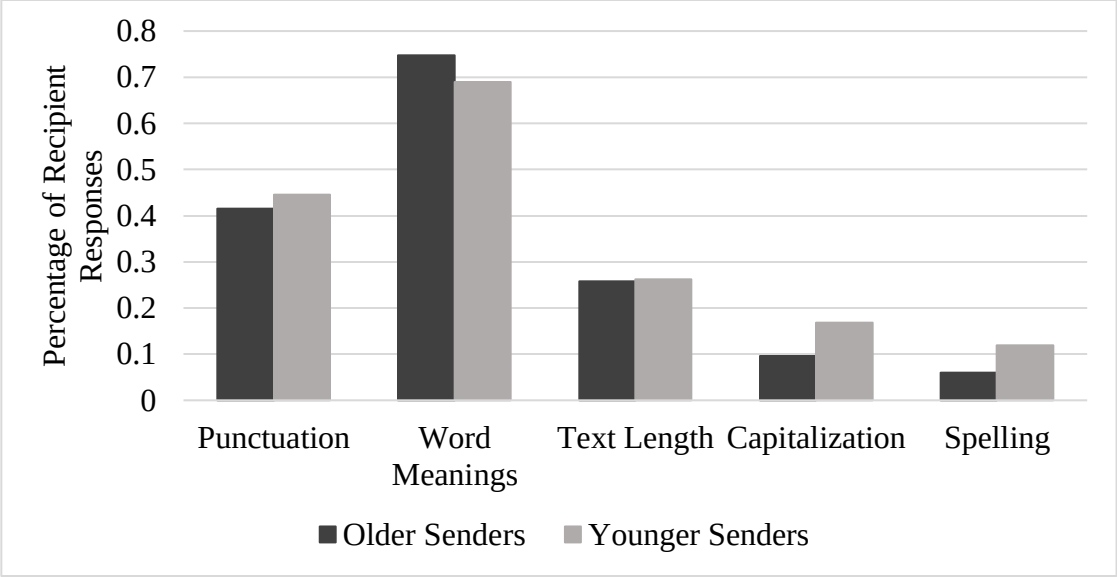


Figure 7 Influential Factors on Recipient Ratings, Across Sender Age

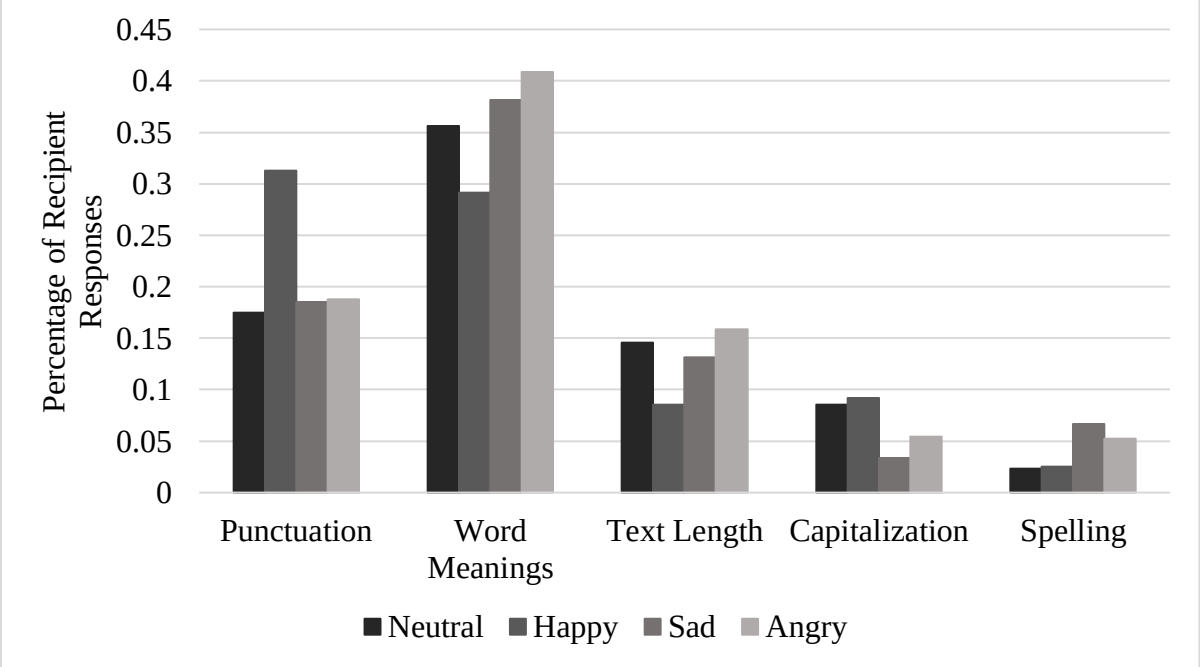


Figure 8 Influential Factors on Recipient Ratings, Across Emotion Condition

I also asked Recipients to estimate the age of the Sender for each of these 8 texts. Younger Recipients reported Senders as being younger than Older Recipients did, $t(504.12) = -3.01$, $p = .002$. Thus, Younger Recipients perceived Senders to be younger, and Older Recipients perceived

Senders to be older, generally. See Figure 9. However, Recipients were also generally accurate at estimating age, when considering Sender Age groups, $t(31.42) = -2.84$, $p = .008$. See Appendix E for the full model. They generally rated texts from Younger Senders as coming from younger individuals, and vice versa. See Figure 10. However, being asked to consider all of these factors after providing their valence rating does not allow for me to determine if these factors *actually* impacted the ratings. Participants may have been able to take more time to consider the contents of a text and who may have sent it for these questions than when they initially provided their valence ratings.

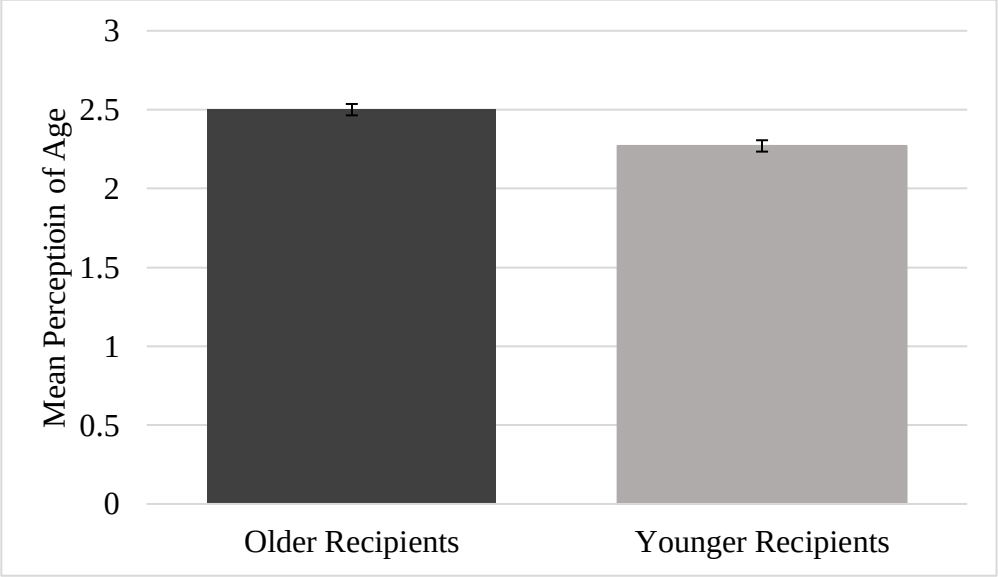


Figure 9 Recipient Perception of Sender Age, Across Recipient Age

Note. Error bars represent standard error of the mean. Values under 2 correspond to a perception of Sender Age of 25 years old or younger; values under 3 correspond to a perception of Sender Age of 49 years old or younger; values over 3 correspond to a perception of Sender Age of 50 years or older.

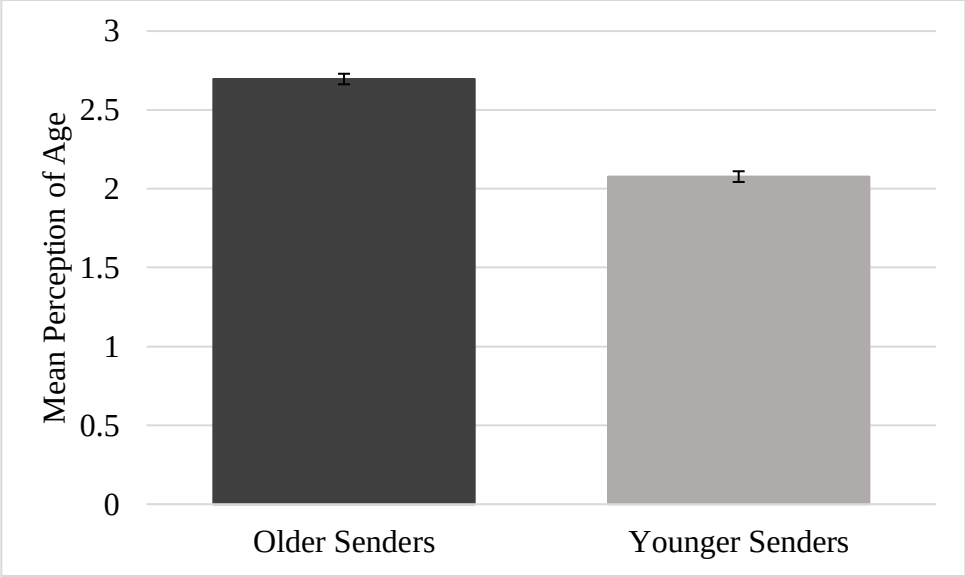


Figure 10 Recipient Perception of Sender Age, Across Sender Age

Note. Error bars represent standard error of the mean. Values under 2 correspond to a perception of Sender Age of 25 years old or younger; values under 3 correspond to a perception of Sender Age of 49 years old or younger; values over 3 correspond to a perception of Sender Age of 50 years or older.

3.3 Discussion

When participants were asked to provide reasonings for the ratings they gave, Younger Recipients did seem to be more report attending to a greater number of paralinguistic features, like capitalization and punctuation. This could reflect greater awareness on the part of the younger group that meaning may be communicated in texts in a less overt way than the meanings of the words themselves. Indeed, the results from Senders suggest that younger text users have an edge over older groups, as recipients were more inaccurate in their interpretations of tone in texts from Older versus Younger Senders. However, it was the Older Recipients who were generally more

accurate than the Younger Senders in their perceptions of texts. When considering the signed differences, the greater accuracy among Older Recipients appeared to be related to bias toward negativity on the part of the Younger Recipients. Such a bias would be consistent with prior findings in the literature (Gunraj et al., 2016; Houghton et al., 2018; Riordan et al., 2018).

In Experiment 1, Older and Younger senders appeared sensitive to the ways in which paralinguistic features can be added to texts to convey a specific emotional nuance (though, to preview upcoming results, Younger Senders were more explicitly aware of this tendency). That emotion in texts from Younger Senders was more likely to be interpreted accurately, then, may have been related to combinations of features which Younger Senders may be more adept at using to convey meaning. What is intriguing is that the Younger Recipients were broadly not as accurate in their interpretation as the Older Recipients. Indeed, consistent with results from (Riordan et al., 2018) Younger Recipients were overall more negative in their interpretations of texts (though this could also be framed as a positivity bias on the part of Older Recipients).

I expected a within-generation benefit of communication, such that Older Recipients would be better at interpreting texts from Older Recipients (and the opposite for Younger Recipients). However, I instead observed more of a between-generation benefit. As discussed above, Older Recipients were more accurate at interpreting texts from Younger Senders than Younger Recipients. However, Younger Recipients were better at interpreting negative texts from Older Senders than Older Recipients were. For Happy texts, the Younger Recipients, as expected based on the above, were less accurate than Older Recipients overall. These results could also reflect a negativity bias on the part of the Younger Recipients, though it is unclear why this accuracy benefit appears only for negative (Sad and Angry) texts from *Older* Senders. The only potential within-generation accuracy benefit for Younger Recipients appears for Happy texts, for which accuracy

increases more from Neutral compared to Older Recipients. However, again, Older Recipients are generally more accurate at interpreting texts, they just differ to a lesser degree from their interpretations of Neutral texts. It is also important to note, however, that, for the texts in Experiment 2, Older Senders rated their own negative texts slightly more negatively than Younger Senders (a difference of 1.2 in both cases, see Table 5). Thus, inaccuracies in perception may be tied more closely to the *Sender*'s positivity/negativity bias which, in fact, appears to be opposite those suggested by these results.

I also expected Happy texts to be most accurately interpreted by all Recipients, though there were no reliable differences found between the perception of Happy and Neutral texts across age. Nevertheless, interpretation of Happy texts was more accurate than Sad texts. Recipients were largely inaccurate in their perception of Sad texts, meaning Senders may not be effective at communicating the level of negative emotion they intended when they are Sad rather than Happy. The misinterpretation of Sad and Angry texts was worse for Older Recipients than Younger Recipients for texts from all Senders. This inaccuracy in the negative conditions may again reflect a positivity bias in the Older Recipients, which may impair their perception of negative tone.

Recipients also showed a slight bias toward assuming the senders were closer in age to themselves, such that Older Recipients estimated the Senders were generally older than the Younger Recipients did. However, both groups were generally accurate at determining the age of the Sender and estimated that Older Senders were generally older than the Younger Senders. These age interpretations do not entirely explain the interpretation results discussed above, as I would expect Recipients similar in their accuracy across Sender Age if they perceive the Sender to be close to their age. It may be that perception of age is not directly related to the accuracy of interpretation, as there is other information the recipient can rely on to interpret a text message.

4.0 Text Features Survey

4.1 Method

4.1.1 Participants

Because participants from Experiment 1 and Experiment 2 completed the Text Features survey, I collapsed the responses from both groups into one dataset to facilitate data analysis and interpretation. Thus, 165 participants (85 Younger) completed the survey. Both pre-survey tasks involved rating the emotional valence of text messages, though in one task the valence ratings required reflecting on their own text messages (Experiment 1) while in the other it required reflecting on the texts messages of unknown people (Experiment 2). Further, in Experiment 2, participants were asked about how specific features of text messages influenced their valence ratings. It was possible that the differences between experiments could have affected participants awareness of their own texting habits. Thus, in this final set of models, Experiment was included as a control variable.

4.1.2 Procedure

After either text collection (Experiment 1) or text rating (Experiment 2), participants completed a 15-question survey examining the frequency with which they use certain paralinguistic features in text messaging, how often they use the internet, for what they frequently

use the internet, and how long they have owned a smartphone (See Appendix A for exact questions).

4.1.3 Data Analytic Plan

For each survey question, I used a linear regression with Age Group (Older/Younger) and Experiment Number (1 vs 2) as predictors. Experiment Number was included in each model to control for effects of pre-survey task on participant responses.

4.2 Results

I hypothesized that older individuals would report higher usage of text-final periods and ellipses than younger individuals. Consistent with the results reflecting actual usage from Experiment 1, younger individuals reported lower usage of text-final periods, $t(162) = -7.14$, $p < .001$. However, the two age groups did not report using ellipses at different frequencies, $t(162) = -0.89$, $p = .37$. I also hypothesized that younger individuals would report higher usage of abbreviations and vocal spellings than older individuals. Younger individuals did report higher usage of abbreviations, $t(162) = 7.07$, $p < .001$, and higher usage of vocal spellings, $t(162) = 7.76$, $p < .001$. Experiment number was not a significant predictor in any of the above models, ps > .65. Models are reported in Appendix D.

5.0 General Discussion

I aimed to determine (1) how individuals from two different age groups use paralinguistic text features to convey emotion in text messages and (2) how the emotional content of these text messages is interpreted by individuals in these age groups. I had 3 initial hypotheses. (1) I expected that younger individuals would vary more in their usage of paralinguistic features to convey emotional tone, while older individuals use these features more consistently. (2) I expected texts to be most accurately interpreted when the Sender and Recipient were more similar in age, and that Younger Recipients would perceive texts from Older Senders more negatively across conditions. Finally, (3) I expected that Happy texts would be more accurately interpreted than negatively valenced texts. The first hypothesis was partially supported, as older individuals did have a higher baseline level usage of text-final periods, but both groups showed similar patterns of frequency across emotion conditions. In particular, both groups tended to include more text-final periods in negative texts than positive or neutral texts. The second hypothesis was also partially supported, as both age groups were better at interpreting texts from Younger Senders, but Older Recipients were even more accurate at doing so than Younger Recipients. My third hypothesis was not supported, as Happy and Angry texts were each not interpreted differently from Neutral texts. Further, Happy texts were not broadly interpreted differently than Sad and Angry texts. Rather, Happy texts were interpreted more accurately than Sad texts only by Older Recipients when the texts were sent by Older Senders, and no within group differences emerged for a comparison between Happy and Angry texts.

5.1 Text Production Differences

Several studies have analyzed text features contained in natural CMC produced by either college students or corporate employees (Pirzadeh & Pfaff, 2014; Kalman & Gergle, 2014). However, these two studies focused on emails (Kalman & Gergle, 2014) and instant messaging on a computer (Pirzadeh & Pfaff, 2014). Each also focused on one specific population and age group and would not be able to determine if the usage of features they examined changed with age. In the current study, I tested for differences in the usage of emotion words and abbreviations (two of the feature the prior literature tested for) in *text* messages and across ages, but I did not find an age-related difference. Thus, age-related differences in the usage of these features may be diminishing or not as likely to be present in a text modality. Further, older and younger groups may be equally likely to make use of these features.

There were, however, differences in the rate of text-final period production with respect to both Sender Age and Emotion condition. When Riordan et al. (2018)'s participants were asked to produce texts to complete a conversation, the two age groups (born before or after 1985) produced text-final periods at equal frequencies. However, I found that Older Senders in this study (born before 1971) showed higher odds of including a text-final period across Emotion conditions than Younger Senders. Additionally, both groups had higher odds of including a text-final period in the Sad and Angry conditions than the Neutral condition, highlighting the period's association with negative tone in text messaging. It is not surprising that the Younger Senders used text-final period to convey negative tone, considering they are more likely to interpret it negatively (Gunraj et al., 2016; Houghton et al., 2018; Riordan et al., 2018). However, it is interesting that Older Senders showed the same pattern of text-final period usage, increasing its use for negative emotions, despite having a higher baseline level of production at the Neutral level. While Older individuals

may not be as familiar or as likely to interpret text-final periods as negative (Riordan et al., 2018), they do appear to use it to convey such emotion. The difference in baseline levels of production, specifically in the Neutral condition, suggests that any miscommunication in emotional tone may occur in neutral or positive contexts.

5.2 Awareness of Text Feature Production

Through the Text Features survey, I was able to determine individuals' awareness of the text features they are most likely to use. Matching the above finding that Older Senders have higher odds of including text-final periods than Younger Senders, older individuals did report higher usage of text-final periods than younger individuals. While they may be less aware of the negative implications of the period, they are conscious of its use in their own texts. I also expected that older individuals would report using ellipses more than younger individuals (McCulloch, 2020), however, there was no difference in the frequency of usage based on the self-report measure. This could be due to generally low levels of production across both groups, indeed only nine of the submitted texts contained ellipses. Despite a non-significant finding regarding the actual rate of usage of vocal spellings and abbreviations, the two age groups did differ in their self-reported frequency of vocal spellings and abbreviations, with the younger group reporting higher usage of both compared to the older group.

5.3 Text Interpretation Differences

One novel feature of this study was the use of authentic texts, as well as the comparison of the Sender's interpretation of emotion to the Recipient's. By comparing these two sets of ratings, I found that texts from Younger Senders were more accurately interpreted than those from Older Senders, but that each Recipient group's accuracy differed based on Emotion condition. While there was no "within-generation" accuracy effect, there did appear to be a "between-generation" effect: Older Recipients were more accurate than Younger Recipients at interpreting texts from Younger Senders. Conversely, and only in negative contexts, Younger Recipients were more accurate than Older Recipients at interpreting texts from Older Senders. Younger Senders may have been more skilled at communicating their emotional intention in a general manner, such that it could be interpreted by a wider age group. The findings for Older Senders are more interesting, though, in that Younger Recipients are more accurate in specific conditions. This could be related to the types of emotions conveyed and the texting habits of the Older Sender group. In these two conditions, the Younger Recipients had a unique benefit: Older Senders follow similar patterns of usage of text-final periods as Younger Senders (increasing usage in negative conditions) and younger individuals have been shown to interpret the text-final period to be more negative (Gunraj et al., 2016; Houghton, et al. 2018; Riordan et al., 2018). However, in the Happy (positive) and Neutral conditions, with no text-final periods, Younger Recipients may not have been able to rely on these assumptions. Thus, (1) their interpretations of Happy texts from Older Senders were less accurate than Older Recipients and (2) they were still slightly less accurate at interpreting texts from Younger Senders.

It seems that the Younger Recipients' convention to interpret text-final periods as conveying negative tone is only beneficial when reading texts from Older Senders, who already

produce text-final periods at a higher rate than Younger Senders. Further, the Older Recipients' *lack* of awareness of these features permits them to be more accurate at reading texts from Younger Senders, though this could also be related to the Younger Senders' skill at communicating emotional tone. Another explanation for these findings is that Younger Recipients are negatively biased in their interpretation of text messages (or that Older Recipients are more positively biased). This could make Younger Recipients more accurate for some emotions and less for others. However, I think this is unlikely to fully explain the results, especially considering the differences in Sender Valence discussed previously. While the Younger Recipients may show a negativity bias, it also appears that Older Senders show a similar bias. Thus, the miscommunication of tone could be due not only to biases within the Recipients, but also a misperception of conveyed tone on behalf of the Sender. Ultimately, further research will have to be done to determine the direction of this relationship and whether it is due to the Recipient or the Sender and to what extent bias plays a role for each.

5.4 Explicit Influences on Text Interpretation

Finally, I asked participants which features of the texts influenced their ratings. It appeared that the Younger Recipients read more into punctuation, capitalization, and the length of the text to guide their interpretation, while Older Recipients relied more on word meanings within the text. The Younger Recipients seem to be aware of the implications of certain text features and try to use these when reading texts, while Older Recipients may be less aware of the potential meanings of these features. Riordan et al. (2018) asked participants to report their confidence in their ratings of texts that did or did not contain text-final periods. They concluded that older individuals were

likely unaware of the effects of the text-final period, shown in their increased confidence in their text ratings, compared to younger individuals. While I am not able to fully determine whether the older group is aware of the meanings of paralinguistic features like the text-final period, it appears they may not rely on them as strongly as younger individuals to interpret the emotion of a text.

Overall, these findings support the idea that individuals from different generations do differ in their knowledge of the potential interpretations of several text features, namely the text-final period (Houghton et al., 2018; Gunraj et al., 2016; Riordan et al., 2018). However, when context is limited, such as it is in the case of the current study, younger individuals may rely too strongly on such cues, resulting in a more negative interpretation than the Sender intended. It may also be the case that the limited context was not the issue, but the actual knowledge of the cue itself. When someone is aware that the text-final period can carry negative tone, it may influence their initial perception too strongly to allow for rereading and reinterpretation of the text. While there were no time limits in the current study, it is unlikely each participant read each text more than once or twice, and thus relied on their initial interpretation. Therefore, when texts were presented at the end for Recipients to provide their reasoning for the rating they provided, they may have thought more closely about the content of the text to do so, rather than reflecting on what they actually used to process it.

5.5 Limitations

The current study does, however, have some limitations, especially regarding the text selections and presentation. First, with only 8 texts collected from each participant in Experiment 1 and a relatively small group of participants, only 367 texts were collected. For features with low

levels of production (emoticons, abbreviations, misspellings, ellipses), there were so few occurrences that I was not able to determine group or emotion differences. However, some of these showed differences in results in the self-report measures obtained through the Text Features survey, though it may be that participant responses to the survey reflect a *potential* to use a given feature, rather than the actual use. After exclusions based on emoji use, word count, and reference to emotion, the set of potential texts was even more limited, and was further constrained when the groups were balanced for text-final punctuation and emotion level. With more texts in the sample, actual differences in the production of paralinguistic features can be better determined and greater control can be obtained over the texts presented in Experiment 2.

Further, one feature of this study was the use of authentic text messages which genuinely reflected attempts by participants to convey specific emotions in their everyday life. However, retaining this authenticity also meant that texts could not be counterbalanced across conditions and the presence of paralinguistic features was not experimentally manipulated. Thus, the results here are correlational and a causal relationship between interpretations of valence across conditions cannot be drawn. Nevertheless, there is some justification in assessing the predictors as causal influencers of the outcome as a reverse causality scenario is not possible in this circumstance. The recipient's accuracy in interpreting valence could not have caused the age of the Sender or Recipient and could not have influenced the valence the Sender initially gave to their text. In this case, it was only the predictors which could cause differences in Recipient Accuracy to occur although there is always the possibility that an unseen variable (e.g., negativity bias) was also at play in the outcomes.

5.6 Future Directions

While a strength of this study was the use of authentic texts from participants, a future study could manipulate features within these texts and determine the effects of these on participant ratings. For instance, adding or removing text-final periods from negative texts may soften their tone for younger individuals, but may not impact older individuals' perceptions. It would also be interesting to see the ways subtle cues like the period may interact with more overt features, like emoticons, that clearly convey an emotion. Additionally, considering all of the texts in this study did not have the same text-final punctuation (i.e., some Sad texts had no text-final punctuation, some Happy texts had exclamation points), further analyses could be done by item to determine if there was an interaction of Recipient Age with any of these features. These could potentially help describe the between-generation accuracy effects, for instance, if Younger Recipients show better performance on negative texts that have text-final periods but perform similarly to Older Recipients when this feature is absent.

6.0 Conclusion

I showed that individuals under 25 and over 50 show similar patterns in text-final period usage but differ in their baseline levels of production. This has important implications for the ways these groups interact in positive or neutral contexts, though it suggests negative contexts may be less susceptible to miscommunication as a result of this cue. While I did not find benefits of communicating within one's generation, Recipients were generally better at interpreting texts from Younger Senders. Thus, it may not be the skill of Recipient at interpreting cues but the skill of the Sender at effectively conveying their message (Maneerutt, 2021). Older Senders, potentially having less experience with texting, may be less adept at conveying emotion than Younger Senders, at least within text messages. While the Sender's skill appears to play a role in the Recipient's interpretation, the Recipient may also rely on paralinguistic cues to guide their judgment about the tone of a text. Younger Recipients may apply their understanding of the text-final period and its negativity more successfully in negative contexts but fail to accurately interpret texts in its absence. This accuracy in negative contexts could potentially be due to a negativity bias within the Younger Recipients, such that they generally interpret texts to be more negative as a whole. With lower knowledge of text features, Older Recipients may rely more on the content and the word meanings in the text, resulting in a more accurate interpretation. Overall, the results of this study suggest there are differences in the ways individuals of different ages construct (neutral) texts, and there is general miscommunication of emotion via text message, though several factors may impact the extent of this miscommunication.

Appendix A Text Survey Questions

1. Text messaging users send or receive an average of 41.5 messages per day. How frequently do you think you text compared to the average?
2. How frequently do you include a period at the end of a text message?
3. How frequently do you use ellipses (…) in a text message?
4. How frequently do you use texting abbreviations (LOL/lol, OMG/omg, TBH/tbh, etc.)?
5. How frequently do you add extra letters to words when texting to communicate better (weeeeeell, soooooo, thissss, etc.)?
6. When texting, how frequently do you capitalize the first word of sentences?
7. Currently, how frequently do you purposefully un-capitalize something while texting?
8. Have you ever turned off the auto-capitalization feature on your cell phone?
9. Do you regularly engage in a texting conversation (i.e., at least once per week) with someone much older or younger (20+ years) than you? Click all that apply.
10. How long have you used the internet?
11. How often do you use the internet (including social media sites, work, etc.)?
12. For what do you most frequently use the internet?
13. What type of cell phone do you have?
14. At approximately what age did you first get a smartphone?
15. At approximately what age did you first start texting frequently?

Appendix B Experiment 2 Texts

Appendix Table 1 Texts Presented in Experiment 2 with Sender Age, Condition, and Emotion Level

Emotion	Sender Age Group	Text Content	Emotion Level
Happy	Older	"So James on the 20th and Mom and Mary the 4th?" This is what the girls are thinking for birthdays	Strong
		Sounds like fun. I can't wait!	Strong
		Oh. Okay that would be easier	Somewhat
		Still on for sushi tomorrow night? It's been so long, I can't wait!	Somewhat
		Oh thank you for solving the lumberjack mystery!	Strong
	Younger	THIS IS HUGE FOR THE PROGRAM	Strong
		I can't wait to see Sarah!!!!	Somewhat
		i think i passed the test	Somewhat
		This is margaret can't wait to meet u as well!	Strong
		I got a 92 on my psych exam!	Strong
Sad	Older	I wish I could have been there at the hospital when you gave birth	Somewhat
		I can't believe you let that happen.	Strong

		I think he was giving me space because of the other issue we are dealing with.	Somewhat
		Wow. I cannot believe that she passed. I hope someone was with her by her side	Strong
		If he does remember any of it, he'll know you did it out of love	Somewhat
	Younger	Im fine, itll just be a bit of a weight on my shoulders	Strong
		Since its almost 10, maybe we wait and try again tomorrow instead.	Somewhat
		do i get myself boba even tho i failed my quiz	Strong
		Hey im not gonna go out tonight	Somewhat
		bummer! well i'll just see u sat. then.	Somewhat
Angry	Older	Hope you enjoy it you're burning a lot of bridges tonight	Strong
		Target did not have my favorite drinks. This is the second time it happened.	Somewhat
		I can not believe that you canceled our plans last night	Strong
		Fine. i didn't expect anything different.	Strong
		I texted Amanda and asked for the managers contact info to complain,	Somewhat
	Younger	I have had enough of this!! I am done	Strong

		Bro he getting on my last nerve	Somewhat
		I don't want to come home.	Strong
		I want my hoodies back. Tonight.	Strong
		they got my order wrong at Starbucks	Somewhat
Neutral	Older	Honey, is it going to be cold tomorrow	N/A
		Yeah I got that stuff packed	N/A
		Is it going to be cold on Saturday night?	N/A
		What time do you think you are getting home tonight?	N/A
		I'm going to make salmon patties today I hope to see you at lunch	N/A
	Younger	studying abroad will now definitely be attainable	N/A
		Hey where do you want to go and get lunch?	N/A
		what are your plans for tonight	N/A
		are you still in macy's or no??	N/A
		are you on campus or going home	N/A

Note. All names submitted in texts in Experiment 1 were changed before Experiment 2. Table 1 reflects those changes.

Appendix C Text Production Features Supplemental Information

Appendix Table 2 Fixed Logistic Effects of Emotion Condition and Sender Age on First-Word Capitalization

	$\hat{\beta}$	*SE*	*z*	*p*
Intercept	3.05	1.08	2.84	.005 **
Sender Age	6.65	2.15	3.09	.002 **
Happy (vs Neutral)	10.9	8463.27	.001	.99
Sad (vs Neutral)	8.93	1618.18	.006	.99
Angry (vs Neutral)	-0.40	0.98	-.41	.68
Sender Age x Happy	17.44	16926.53	.001	.99
Sender Age x Sad	14.82	3236.36	.005	.99
Sender Age x Angry	-1.70	1.96	-.87	.39

Note. Inter-rater reliability on 10% of the data was high for this measure was high, $K = .96$.

Appendix Table 3 Fixed Effects of Emotion Condition and Age on Intentional Misspellings

	$\hat{\beta}$	*SE*	*z*	*p*
Intercept	0.20	0.05	3.86	< .001 ***
Sender Age	-0.25	0.1	-2.39	.018 *
Happy (vs Neutral)	-0.07	0.07	-1.02	.31
Sad (vs Neutral)	-0.06	0.07	-.83	.41
Angry (vs Neutral)	-0.05	0.07	-.68	.50

Sender Age x Happy	-0.02	0.13	-.11	.91
Sender Age x Sad	-0.01	0.13	-.08	.94
Sender Age x Angry	-0.01	0.13	.08	.94

Note. Inter-rater reliability on 10% of the data was high for this measure, K = .98.

Appendix Table 4 Fixed Effects of Emotion Condition and Age on Unintentional Misspellings

	$\hat{\beta}$	*SE*	*z*	*p*
Intercept	-2.85	0.52	-5.48	< .001 ***
Sender Age	-1.04	0.93	-1.12	.26
Happy (vs Neutral)	-0.01	0.60	-0.02	.98
Sad (vs Neutral)	0.09	0.61	0.16	.87
Angry (vs Neutral)	-0.11	0.62	-0.18	.86
Sender Age x Happy	0.94	1.20	0.79	.43
Sender Age x Sad	-0.20	1.22	0.16	.87
Sender Age x Angry	0.22	1.25	0.18	.86

Note. Inter-rater reliability on 10% of the data was moderate for this measure, K = .84.

Appendix Table 5 Fixed Logistic Effects of Emotion Condition and Age on the Ratio of Proper Noun Capitalization

	$\hat{\beta}$	*SE*	*z*	*p*
Intercept	1.96	0.77	2.55	< .001 ***
Sender Age	4.29	1.53	2.80	.005 **

Happy (vs Neutral)	0.60	0.86	0.70	.48
Sad (vs Neutral)	2.68	3.54	0.76	.45
Angry (vs Neutral)	0.45	0.87	0.52	.61
Sender Age x Happy	-1.83	1.71	-1.07	.29
Sender Age x Sad	2.57	7.08	0.36	.72
Sender Age x Angry	-2.37	1.74	-1.37	.17

Note. Calculated as # capitalized / total number. Inter-rater reliability on 10% of the data was high for this measure, $K = .90$.

Appendix Table 6 Fixed Effects of Emotion Condition and Age on Number of Complete Thoughts Expressed

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	1.42	0.13	122.13	10.58	< .001 ***
Sender Age	0.16	0.27	122.13	0.60	.55
Happy (vs Neutral)	0.39	0.14	309.00	2.70	< .001 ***
Sad (vs Neutral)	0.41	0.14	309.00	2.89	.007 **
Angry (vs Neutral)	0.50	0.14	309.00	3.49	.005 **
Sender Age x Happy	0.18	0.29	309.00	0.61	.16
Sender Age x Sad	0.23	0.29	309.00	0.78	.54
Sender Age x Angry	0.40	0.29	309.00	1.39	.43

Note. Inter-rater reliability on 10% of the data was high for this measure, $K = .91$.

Appendix D Text Features Survey Supplemental Information

Appendix Table 7 Self-Reported Frequency of Text-Final Period Usage

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	3.89	0.50	162	7.73	< .001 ***
Age	-1.79	0.25	162	-7.14	< .001 ***
Experiment Number	0.10	0.28	162	0.37	.72

Appendix Table 8 Self-Reported Frequency of Ellipses Usage

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	3.28	0.52	162	6.35	< .001 ***
Age	-0.23	0.26	162	-0.89	.37
Experiment Number	-0.09	0.29	162	-0.31	.76

Appendix Table 9 Self-Reported Frequency of Abbreviation Usage

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	2.01	0.25	162	8.07	< .001 ***
Age	-0.51	0.12	162	-4.12	< .001 ***
Experiment Number	0.26	0.14	162	1.86	.06

Appendix Table 10 Self-Reported Frequency of Vocal Spelling Usage

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	3.28	0.48	162	6.83	< .001 ***
Age	1.86	0.24	162	7.76	< .001 ***
Experiment Number	-0.01	0.27	162	-0.03	0.98

Appendix Table 11 Self-Reported Frequency of First-Word Capitalization

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	4.63	0.57	162	8.14	< .001 ***
Age	-1.50	0.28	162	-5.3	< .001 ***
Experiment Number	0.317	0.32	162	0.99	0.32

Appendix Table 12 Self-Reported Frequency of Un-Capitalization

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	-0.33	0.46	162	-0.30	.48
Age	0.96	0.23	162	4.20	< .001 ***
Experiment Number	1.60	0.26	162	6.22	< .001 ***

Appendix Table 13 Self-Reported History of Turning Auto-Capitalization Feature Off

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	2.01	0.25	162	8.07	< .001 ***
Age	-0.51	0.12	162	-4.12	< .001 ***
Experiment Number	0.26	0.14	162	1.86	.06

Note: For this question 1: "Yes, I have it off currently"; 2: "Yes, I used to have it off, but I turned it back on"; and 3: "No, I have never turned it off."

Appendix Table 14 Self-Reported Internet Use in Years

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	4.67	0.24	162	19.8	< .001 ***
Age	-1.89	0.12	162	-16.05	< .001 ***
Experiment Number	-0.01	0.13	162	-0.08	.94

Appendix Table 15 Self-Reported Frequency of Internet Usage

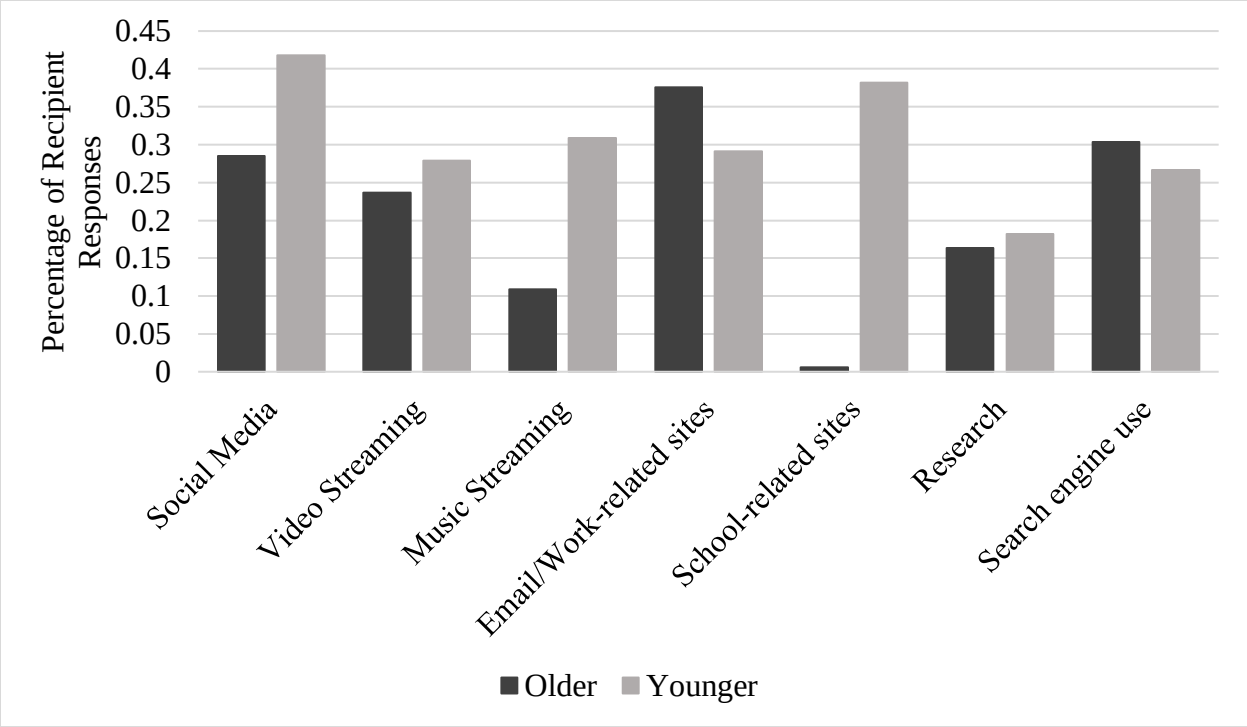
	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	5.83	0.20	162	29.14	< .001 ***
Age	0.17	0.10	162	1.70	.09
Experiment Number	-0.04	0.11	162	-0.36	.72

Appendix Table 16 Age of Smartphone Acquisition

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	31.16	1.96	162	15.93	< .001 ***
Age	-30.10	0.98	162	-30.81	< .001 ***
Experiment Number	-2.04	1.10	162	-1.86	.06

Appendix Table 17 Age Participants Began Texting Frequently

	$\widehat{\beta}$	*SE*	*DF*	*t*	*p*
Intercept	31.09	2.07	162	15.03	< .001 ***
Age	-29.88	1.03	162	-28.92	< .001 ***
Experiment Number	-1.67	1.16	162	-1.44	.15



Appendix Figure 1 Frequent Types of Internet Usage

Appendix E Experiment 2 Supplemental Information

Appendix Table 18 Fixed Effects of Emotion Condition, Sender Age, and Recipient Age on Recipients' Perception of Sender Age

	$\hat{\beta}$	*SE*	*df*	*t*	*p*
Intercept	2.48	0.12	33.45	20.22	< .001 ***
Happy (vs Neutral)	-0.06	0.17	31.41	-0.35	.73
Sad (vs Neutral)	-0.05	0.17	31.41	-0.30	.77
Angry (vs Neutral)	-0.28	0.17	31.42	-1.61	.12
Sender Age	-0.69	0.24	31.42	-2.84	.008 **
Recipient Age	-0.27	0.09	504.12	-3.01	.002 **
Happy x Sender Age	0.16	0.34	31.41	0.47	.64
Sad x Sender Age	0.13	0.34	31.41	0.37	.71
Angry x Sender Age	-0.01	0.34	31.42	-0.02	.98
Happy x Recipient Age	0.15	0.11	796.13	1.35	.18
Sad x Recipient Age	0.07	0.11	796.91	0.67	.50
Angry x Recipient Age	0.01	0.11	796.59	0.05	.96
Sender Age x Recipient Age	-0.08	0.16	797.53	-0.51	.61
Happy x Sender Age x Recipient Age	-0.14	0.22	795.77	-0.62	.54
Sad x Sender Age x Recipient Age	-0.13	0.22	796.64	-0.60	.55
Angry x Sender Age x Recipient Age	0.25	0.22	796.30	1.11	.27

Bibliography

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. Journal of Statistical Software, 67(1), 1-48. https://doi.org/10.18637/jss.v067.i01

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

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191.

Frissell, N. A. (2019). Text As Speech: A New Analytical Framework for Computer Mediated Communication.

Gunraj, D. N., Drumm-Hewitt, A. M., Dashow, E. M., Upadhyay, S. S. N., & Klin, C. M. (2016). Texting insincerely: The role of the period in text messaging. *Computers in Human Behavior*, *55*, 1067-1075.

Hancock, J. T., Landrigan, C., & Silver, C. (2007, April). Expressing emotion in text-based communication. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 929-932).

Houghton, K. J., Upadhyay, S. S. N., & Klin, C. M. (2018). Punctuation in text messages may convey abruptness. Period. *Computers in Human Behavior*, *80*, 112-121.

Kalman, Y. M., & Gergle, D. (2014). Letter repetitions in computer-mediated communication: A unique link between spoken and online language. *Computers in Human Behavior*, *34*, 187-193.

Kelly, H. (2012, December 3). *OMG, the text message turns 20. but has SMS peaked?*. CNN. Retrieved April 6, 2022, from https://www.cnn.com/2012/12/03/tech/mobile/sms-text-message-20/index.html.

Lenth, R. (2019). Emmeans: Estimated marginal means, aka least-squares means. R package version 1.3.4. https://CRAN.R-project.org/package=emmeans.

Mallenbaum, C. (2020, September 29). *Is your texting punctuation sending the wrong message? Yes. Maybe! Think so ...* USA Today. Retrieved September 9, 2021, from https://www.usatoday.com/story/life/2020/09/28/texting-etiquette-what-exclamation-point-period-ellipses-mean-to-different-generations/3524169001/.

Maneerutt, G. (2021). Miscommunication at the Workplace: Causes and Ways to Improve Internal Communication. *AU-GSB e-JOURNAL*, *14*(2), 155-166.

Martineau, P. (2018, February 8). *Why... do old people... text... like this...? an investigation...* The Outline. Retrieved September 9, 2021, from https://theoutline.com/post/3333/why-do-old-people-text-like-this-an-investigation.

Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of memory and language*, *94*, 305-315.

McCulloch, G. (2020). *Because internet: Understanding the new rules of language*. Riverhead Books.

Pew Research Center. (2021, April 26). *Demographics of mobile device ownership and adoption in the United States*. Pew Research Center: Internet, Science & Tech. Retrieved September 9, 2021, from https://www.pewresearch.org/internet/fact-sheet/mobile/.

Pirzadeh, A., & Pfaff, M. S. (2014, November). How do you IM when you get emotional?. In *Proceedings of the 18th international conference on supporting group work* (pp. 243-249).

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Reynolds, K., Casaratto, B., Noviski, S., & Roche, J. M. (2017, July). Using punctuation as a marker of sincerity and affective convergence during texting. In R. Granger, U. Hahn, & R.S. (Eds.), *Proceedings of the 39th Annual Meeting of the Cognitive Science Society* (pp. 2986–2991).

Riordan, M. A., Kreuz, R. J., & Blair, A. N. (2018). The digital divide: Conveying subtlety in online communication. *Journal of Computers in Education*, *5*(1), 49-66.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161.

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research*, *19*(1), 52-90.

York, D. (2021, February 1). *Best practices for instant messaging at work*. Harvard Business Review. Retrieved September 9, 2021, from https://hbr.org/2020/03/best-practices-for-instant-messaging-at-work.