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Implicit communication of emotions via written text messages

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ABSTRACT

In this research I explored the communication of emotions in digital contexts. Specifically, how well are people able to implicitly communicate discrete emotional states with words alone, and what are some of the correlates of this ability? In two experiments, senders created text messages designed to communicate 22 specific emotions (e.g., disgust), without naming the emotion, and receivers were asked to identify the emotion being conveyed. Senders and receivers indicated their degree of confidence that they successfully conveyed/recognized each emotion, and all participants completed measures of empathy and perspective taking. Emotion recognition (50%) far exceeded chance (5%) when a multiple-choice procedure was used (Experiment 2) and was substantial (20%) when participants were required to generate their own emotion labels (Experiment 1). When receivers failed to recognize the specific emotion, their errors were almost always of the same valence as the conveyed emotion (85% in Experiment 1 and 91% in Experiment 2), a rate that far exceeded chance (50%). Even though implicit emotional communication was relatively successful, the confidence rating of senders (but not receivers) was unrelated to communicative success. Emotion communication was more successful when the receiver was female and higher in empathy and perspective taking. In contrast, the gender and empathy level of senders was unrelated to communicative success. Overall, these results demonstrate that people can, to varying degrees, communicate emotions in digital contexts with words only.

People usually intend to perform specific actions with their utterances (e.g., criticizing, begging, offering, etc.), and this sometimes includes conveying their emotional states. Although it is possible to directly convey one's emotional state by using a performative verb (e.g., "I am angry"), direct emotional communication does not appear to be the norm (e.g., Fussell, 2002; Shaver et al., 1987; Shimanoff, 1985). Instead, people often communicate their emotional states indirectly (i.e., without explicitly naming the emotion), partly because the direct expression of emotions may, at times, be disruptive, and threaten the image of interactants (Brown & Levinson, 1987; Goffman, 1959). Another likely reason for the lack of direct emotional communication in face-to-face contexts is that facial expressions and tone of voice are often relied upon to convey one's emotions, and one's words become less important. But what about digital contexts? How successful are people at communicating emotions when there are no facial expressions or tone of voice?

Investigations of the communication of specific emotions in digital contexts are relatively rare. Computer scientists, of course, have developed sophisticated algorithms for detecting the emotional tone of digital communication (often termed sentiment analysis, e.g., Batbaatar et al., 2019). And researchers have examined the ability of people (rather than algorithms) to convey broad emotions in digital contexts (e.g., Hancock et al., 2007). However, the extent to which people can convey specific emotions via text is largely unexplored. As well, there is a substantial literature demonstrating the existence of individual differences in the ability to recognize the emotions displayed by others (e.g., Schlegel et al., 2014). This research, however, has focused primarily on the detection of emotional states from facial expressions and paralinguistic cues, leaving unexplored the issue of whether these differences hold for the detection of emotions in digital contexts. The primary purpose of this research was to examine these issues. Specifically, how good are people at communicating specific emotional states in digital contexts via written language? And to what extent do individual differences in emotion recognition ability extend to the digital realm?

Language and emotion

Early approaches to computer mediated communication (CMC) assumed that the absence of nonverbal cues would make socioemotional communication in this realm very difficult (i.e., the cues filtered out approach; Culnan & Markus, 1987). In contrast, the approach developed by Walther and colleagues (1992; Walther & Ramirez, 2009) suggested

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that, rather than being impoverished, CMC allows communicators to successfully convey emotional content in a variety of ways (without emoji and emoticons), especially over multiple exchanges. In other words, a verbal channel alone was sufficient for communicating emotions. For example, Walther et al. (2005) asked participants to convey their liking or disliking of another person, either via face-to-face or digitally (i.e., CMC). Participants in both conditions were successful at this task; i.e., recipients correctly identified whether it was liking or disliking being conveyed. Hancock et al. (2007) examined the communication of happiness in a digital context. Participants were instructed to either convey happiness or sadness to a recipient, and the strategies used to accomplish this, as well as the recipients' ability to recognize the conveyed emotion, were examined. In general, recipients were able to identify whether the sender was displaying happiness or sadness. Linguistic analyses of the texts with the Linguistic Inquiry and Word Count program (LIWC; Pennebaker et al., 2015) indicated that the linguistic features carrying the most weight in judgments of the senders' conveyed affect were exclamation points (positive emotions) and negations (negative emotions). Note that these studies focus primarily on broad emotional reactions or sentiments, and not whether people are able to successfully convey specific, discrete emotions in digital contexts.

Although research on the intended communication of specific emotions is lacking, there are studies demonstrating the existence of linguistic correlates of specific emotional states, as well as personality traits. Much of this research involves the use of the Linguistic and Inquiry Word Count program (LIWC; Pennebaker et al., 2015) to analyze language differences as a function of a person's emotional state or personality (for a review see Ireland & Mehl, 2014). For example, in terms of emotionality, anger (both state and trait), has been demonstrated to be related to an increased use of second-person pronouns (Simmons et al., 2005; Simmons et al., 2008; Weintraub, 1981). Depressive states have been linked to increased use of first-person pronouns (Mehl & Pennebaker, 2003; Rude et al., 2004). Mood changes following tragedies (e.g., Sandy Hook) have been documented as well (Doré et al., 2015). In terms of personality traits, extraversion, for example, has been shown to be positively related (and neuroticism negatively related) to positive emotion words (Holtgraves, 2011; Yarkoni, 2010). A meta-analysis conducted by Tskhay and Rule (2014) demonstrated that observers are able to accurately (i.e., at a rate greater than chance) judge a person's standing on four of the Big Five traits based on samples of their writing (the exception being Neuroticism). Hence, this research suggests that people can recognize, with some degree of accuracy, another person's emotional state or personality trait, from their writings.

Finally, much of the current research on emotion recognition in text has been conducted by computer scientists who have developed algorithms for identifying emotions from texts, a process referred to as sentiment analysis. There are two main approaches in this regard. The first approach is lexicon-based and uses a pre-existing list of words, typically normed in some way, that are used for identifying emotions in text. Examples include the Affective Norms for English Language (ANEW; Bradley & Lang, 1999), the Linguistic Inquiry and Word Count program (LIWC; Pennebaker et al., 2015), WordNet (Miller, 1995), among others. With this approach, samples of text are analyzed in terms of the extent to which words in the text match the words in the dictionary. Scores for texts can then be obtained based on the extent to which the words in the text match the categories in the dictionary. For example, LIWC contains both high level (positive, negative) as well as a few more specific (e.g., anger) emotion categories. Texts can be scaled in terms of their degree of positivity, negativity, anger and so on. There are, of course, limitations with this approach, as context and syntax play no role in the analysis of texts.

The second approach is generally referred to as machine learning or deep learning. Machine learning approaches are completely atheoretical and attempt to uncover broad (and generally not specific) emotions in texts. The general procedure is to harvest words from available texts for which there is some indicator of emotional valence. These indicators are typically emoji (which are classified a priori as positive or negative), although other images and hashtags have been used as well (Hu & Flaxman, 2018). Then, algorithms are trained to identify words associated with positive and negative (and sometimes neutral) texts. Note, in general these approaches focus on emotional polarity – i.e., positive or negative – rather than specific emotions, although there are some exceptions (e.g., Hu & Flaxman, 2018).

Individual differences in emotion recognition

Assuming people can communicate discrete emotions via text, a corollary question becomes whether there are individual differences in this ability. The ability to recognize the emotional states of others (emotion recognition ability, or ERA) is a critical component of emotional intelligence (EI) when it is viewed as an ability, and a fair amount of research has been devoted to identifying correlates of ERA. One robust finding, for example, is the superiority of females over males in emotion recognition, an effect that has been documented in two meta-analyses (Hall, 1978; Thompson & Voyer, 2014). These effects have been explained both in terms of biological differences (Thompson & Voyer, 2014) as well as socio-cultural factors. I expected a similar pattern to occur for the recognition of emotions via text messages, i.e., females would be superior at text-based emotion recognition than males.

Another strand of research has focused on individual differences in empathy, and how those differences are related to emotion identification. According to Baron-Cohen et al. (2003), empathy is "the drive to identify another person's emotions and thoughts, and to respond to these with an appropriate emotion" (p. 361), thereby allowing the empathizing person to predict a person's behavior and to care about how others feel. Several different measures of empathy, and related constructs, have been developed. One of the most popular measures is the Interpersonal Reactivity Index (IRI: Davis, 1980; 1983). This measure consists of four subscales (empathic concern, personal distress, fantasy, perspective taking), with empathic concern being the primary measure of empathy. Another frequently used measure is the Empathy Questionnaire (EQ; Baron-Cohen & Wheelwright, 2004), a measure developed with a clinical concern for the lack of empathy associated with certain pathologies such as autism spectrum disorder and psychopathy.

Research on the relationship between empathy and emotion recognition ability has produced mixed results, partly due to the multidimensional nature of the empathy construct. For example, Israelashvili et al. (2020), argue that researchers often fail to differentiate between empathic concern (the experience of compassion for others) and personal distress (experience of discomfort at witnessing another's distress). In their research, performance on a variety of (nonverbal) emotion recognition tests was positively correlated with the empathic concern subscale of the IRI and negatively correlated with the personal distress subscale of the IRI.

Overall, then, ERA does appear to be positively related to more narrowly focused empathy constructs such as the IRI measure of empathic concern, and researchers have reported substantial correlations between ERA assessed over different modalities (Bänziger et al., 2009; though see Scherer & Scherer, 2011). Based on demonstrations of individual differences in personality judgments based on text alone (Hall et al., 2016), as well as demonstrations that ERA is not modality specific (Bänziger et al., 2009), I expected empathy to be related to communicators' ability to recognize emotions conveyed via written texts.

Awareness of emotional communication

Regardless of whether emotions can be conveyed successfully in digital contexts, there is a parallel issue of whether communicators are aware of their success at emotional communication in these contexts. That is, do senders have any awareness of their success at conveying an emotion, and do recipients have any awareness of their success at

identifying a sender's emotion? Past research has demonstrated an asymmetry in dyadic communication such that senders tend to overestimate the extent to which their conveyed meanings will be recognized by recipients (Keysar & Henly, 2002; Kruger et al., 2005; Savitsky, Keysar, Epley, Carter, & Swanson, 2011). I expected this pattern to emerge in the present context; hence, I expected senders to be more confident that recipients would be able to recognize the emotion they were conveying, than recipients were of their ability to recognize the conveyed emotion. A related issue is whether this asymmetry would reflect reality, that is, whether senders' and receivers' confidence would be related to actual communicative success. Past research on this point is mixed. There is some research demonstrating that communicators are sometimes unaware of the extent to which their communications are successful (Galantucci et al., 2020; Galantucci & Roberts, 2014). Other researchers, however, have demonstrated that communicators do have an awareness of their communicative success (Micklos et al., 2020), and conversation analytic researchers have demonstrated how conversationalists are sensitive to the occurrence of miscommunication (Schegloff, 1992).

The present research

I conducted two experiments to examine the implicit communication of emotion in digital contexts. The basic procedure for both experiments was as follows. One set of participants were asked to create text messages designed to communicate specific emotions (e.g., disgust) to another person. Importantly, these messages could not include the word naming the emotion they were trying to communicate. Then, a second group of yoked participants were presented with one set of these messages and asked to identify the emotion being conveyed. Emotion identification was assessed with a free-response procedure in Experiment 1, and with a multiple-choice procedure in Experiment 2.

The first and most basic issue I examined was whether communicators can successfully convey specific emotional states (e.g., angry, sad, etc.) non-performatively (i.e., without specifically naming the emotion). Based on research demonstrating successful intentional displays of broad band emotions in digital contexts (Hancock et al., 2007; Walther et al., 2005), as well as research demonstrating that individuals are able to accurately judge the personality traits of others from samples of their writing (Tskhay & Rule, 2014), I expected that participants would be able to recognize specific, conveyed emotions in digital contexts. The second issue I examined was the nature of the errors participants made when they failed to correctly identify the conveyed emotion. It seems likely that even if the recipient failed to identify the specific emotion being conveyed, they would still be able to identify the valence of the conveyed emotion. Hence, I expected the within-valence error rate (e.g., failing to correctly identify the specific emotion but being correct in terms of the valence of the conveyed emotion) to be significantly greater than chance (50%).

The third issue was whether senders and receivers would be able to judge their success at conveying and recognizing emotions. Based on prior research demonstrating an egocentric communication bias (e.g., Keysar & Henly, 2002), I expected the confidence of both senders and receivers to be independent of actual communicative success, with this effect being larger for senders than for receivers. The final issue I examined was individual differences in the ability to convey and recognize emotions in digital contexts. Based on research demonstrating that the relationship between empathy and emotion recognition is not modality specific (Bänziger et al., 2009), I expected that there would be a significant, positive correlation between the receiver's level of empathy and emotion recognition. In this research I used both a measure of global empathy – the Empathy Quotient (Baron-Cohen & Wheelwright, 2004) – as well as more specific types of empathy (the empathic concern and perspective-taking subscales of the Interpersonal Reactivity Index (IRS; Davis, 1980; 1983). I also examined gender differences. Based on past research demonstrating the superiority of females at emotion recognition (Thompson & Voyer, 2014), as well as female superiority at judging personality from texts (Hall et al., 2016), I expected females to display greater success at emotion recognition than males.

The experiments presented in this manuscript were approved (exempt status) by the Institutional Review Board of Ball State University. All experimental materials are provided in the Supplementary File.

Experiment 1

Method

Participants

Part 1 participants (senders) were students enrolled in introductory psychology courses who participated for partial course credit (N = 68; 44 females, 24 males). Yoked Part 2 participants (receivers) were also introductory psychology students (18 males, 50 females) recruited from the same research participation pool. There was no attempt to match the gender of the participants. The resulting gender mix of the Part1-Part2 dyads was as follows: 8 Male-Male; 12 Male-Female; 10 Female-Male; 34 Female-Female. The age of the participants ranged between 18 and 27 ($M = 18.94$; $SD = 1.20$). Sensitivity analyses for the individual differences in empathy component were conducted (power = .80, alpha = .05) and indicated the sample size was able to detect a small to medium effect ($r = 0.201$).

Materials

There were 22 specific emotions which were selected from the lists provided in the emotion classification research of Storm and Storm (1987) and Clore et al. (1987). All emotions used in this research were included in both taxonomies. Emotions were selected from each of the seven high-level categories in the Storm and Storm taxonomy in order to capture variability in valence (the primary dimension of interest). Valence ratings were provided by Bradley and Lang (1999). The valence of positive emotions ($M = 7.861$; $SE = 0.189$) was significantly higher than the valence of the negative emotions ($M = 2.691$; $SE = 0.213$), $t(20) = 17.155$, $p < .001$. All emotions, and their categories are presented in Table 1.

Two brief situation descriptions were written for each emotion, one for the senders (part one participants) and a corresponding one for the receivers (part two participants). All emotions and scenarios are presented in the Supplementary File. The following were the scenarios for the "Happiness" emotion:

> *Part 1 (Sender) Scenario:* You see on Facebook that a good friend just landed their dream job after almost a year of being out of work. You have emotionally supported this friend while they searched for a good job. You are thrilled for them about this opportunity. You want to convey your happiness, and so you text your friend:
>
> *Part 2 (Receiver) Scenario*: You just landed your dream job after almost a year of being out of work. Later, your friend texts you: (Message from a Part 1 Participant)

Procedure

The experiment was conducted using Qualtrics software and participants were able to complete the experiment wherever they chose. Part-1 participants (senders) were asked to read each description and to imagine that they wanted to send a text message in order to convey their experience of a specific emotion (e.g., anger, anxiety, happiness, etc.). There were no time or space constraints on the messages that the created. Participants were not allowed to include the specific emotion in their message. In addition, these participants indicated on an 11-point scale their confidence that the recipient would accurately recognize the emotion that they were conveying with this text. Part-2 participants (receivers) were presented one set of text messages (and corresponding receiver scenarios) produced by a sender and asked to generate a word

Table 1
Emotion Recognition in Experiment 1 (Free Response) and Experiment 2 (Multiple Choice).

Emotions[a]	Experiment 1		Experiment 2	
	Free Response		Multiple Choice	
	Mean	St. Dev	Mean	St. Dev
Emotion Categories and Specific Emotions				
Positive Cognitive	.142	.350	.562	.497
Confidence	.162	.371	.600	.492
Fascinated	.015	.121	.548	.500
Surprise	.250	.436	.539	.501
Positive Individual	.193	.396	.388	.488
Happiness	.239	.430	.365	.484
Joy	.074	.263	.296	.458
Hope	.269	.447	.504	.502
Positive Interpersonal	.144	.352	.455	.499
Admiration	.162	.371	.539	.501
Respect	.015	.121	.296	.458
Love	.258	.441	.530	.501
Negative Cognitive	.333	.473	.484	.500
Boredom	.448	.501	.539	.501
Confusion	.537	.502	.469	.501
Helplessness	.015	.122	.444	.499
Negative External	.385	.488	.463	.499
Anger	.388	.491	.400	.492
Jealousy	.471	.503	.530	.501
Frustration	.191	.396	.304	.462
Disgust	.492	.504	.617	.488
Negative Internal	.267	.443	.448	.498
Fear	.132	.341	.409	.494
Anxiety	.191	.396	.591	.494
Embarrassment	.298	.461	.513	.502
Sadness	.691	.465	.574	.497
Guilty	.206	.407	.478	.502
Upset	.076	.267	.122	.328

[a] Emotion categories parallel the groups derived by Storm and Storm (1987), although sometimes with slightly different group names.

naming the emotion being conveyed. In addition, receivers indicated their degree of confidence on an 11-point scale that they correctly identified the emotion being conveyed with the text. Presentation order of the 22 emotion/scenarios was randomized for each participant. After completing the text message task, participants completed (in a random order) the EQ (Baron-Cohen & Wheelwright, 2004) and the IRI (Davis, 1980, 1983).

Results

Preliminary analysis

The judgments of the receivers (i.e., Part 2 participants) were scored as correct if their interpretation contained the root of the emotion word. For example, "angry" was coded as correct when the presented emotion had been "anger". Close synonyms (e.g., "mad" for "angry") were not coded as correct. There were three text messages (out of 1496, or 0.2%) produced by senders that contained the emotion word; these trials were not included in any analyses. The number of words in the messages varied between 1 and 73 ($M = 20.88$; $SD = 14.16$).

In order to verify that the senders were creating texts that varied in emotional valence, the text messages produced by the senders were analyzed using the Linguistic Inquiry and Word Count program (LIWC; Pennebaker et al., 2015). The LIWC positive emotion and negative emotion categories were analyzed with a mixed effects linear model that included emotion valence as a fixed effect and participant and emotion as random intercepts. The texts designed to convey positive emotions scored higher on the positive emotion category ($M = 9.898$) than texts designed to convey negative emotions ($M = 2.924$), F (1,20) = 30.778, $p < .001$, with the reverse occurring for texts designed to convey negative emotions ($Ms = 5.678$ vs 1.090), F (1,20) = 26.061, $p < .001$.

All reported sensitivity analyses were conducted using either G*Power (Faul et al., 2009) or (for linear mixed model analyses) the app (https://jakewestfall.shinyapps.io/crossedpower) provided in Westfall et al. (2014).

Emotion identification accuracy

I first analyzed identification accuracy with a mixed effects log-linear model that included emotion valence as a fixed effect and the intercepts for dyads and emotions as random intercepts.

Participants accurately identified the conveyed emotion approximately one fifth of the time ($M = 20.1\%$; $SE = 0.04$; $CI_{95} = 0.130$ - 0.297). Emotional identification accuracy did not vary as a function of the valence of the emotion, F (1,27) = 2.822, $p = .105$. Identification accuracy for each specific emotion can be seen in Table 1.

To examine the nature of the errors that occurred when recipients did not correctly identify the conveyed emotion, I created a variable that captured whether the error was within-valence (i.e., the valence of the incorrectly identified emotion was the same as the valence of the conveyed emotion) or not (i.e., the valence of the incorrectly identified emotion was the opposite of the valence of the conveyed emotion). I analyzed this variable with a linear mixed effects ANOVA that included emotion valence as a fixed effect and dyad and emotion as random variables. Sensitivity analyses indicated an 80% probability of detecting a small effect size (d = 0.101). The within-valence error rate was 84.5% ($SE = 0.029$) and the confidence interval ($CI_{95} = 0.784$ - 0.907) did not include chance recognition (i.e., 50%). Hence, when participants incorrectly identified the specific emotion, it was very likely that they still correctly recognized the valence of the conveyed emotion. However, this effect was significantly larger for positive emotions ($M = 96\%$) than for negative emotions ($M = 73.1\%$), F (1, 19.077) = 15.621, $p < .001$. Hence, participants displayed something of a positivity bias.

Sender and receiver confidence

To examine whether senders and receivers were able to judge their success at conveying and recognizing emotions, I added sender and receiver confidence to the log linear model with emotion identification accuracy as the criterion, emotion valence as a fixed effect, and the intercepts for dyads and emotions as random intercepts. Sender confidence was not related to emotion identification accuracy, F (1, 232) = 1.381, $p = .241$. In contrast, receiver confidence was significantly and positively ($b = 0.192$) related to emotion identification accuracy, F (1, 1090) = 10.383, $p < .001$. In order to examine this further I conducted linear mixed effects ANOVAs examining confidence as a function of emotion valence and whether the conveyed emotion was recognized. Consistent with the log linear model, senders were no more confident when the receiver correctly identified the conveyed emotion ($M = 5.746$) than when they failed to identify the emotion ($M = 5.804$), F (1, 1360.607) = 0.943, $p = .277$. In contrast, receivers were significantly more confident when they correctly identified the emotion ($M = 5.647$) than when they failed to recognize the emotion ($M = 5.458$), F (1, 1345.907) = 6.128, $p = .013$.

To examine differences between senders and receivers in their degree of confidence, I analyzed confidence with a linear mixed effects ANOVA that included role (sender vs. receiver) as a fixed effect, and dyad and emotion as random intercepts. Sensitivity analyses indicated an 80% probability of detecting a small effect size (d = 0.10). In this analysis there was a clear asymmetry in the confidence of senders and recipients. Senders were significantly more confident ($M = 5.751$) that the emotion they conveyed would be recognized than recipients were that they were able to correctly recognize the conveyed emotion ($M = 5.458$), F (1,1477.12) = 45.267, $p < .001$. Sender confidence was greater than recipient confidence for all but two emotions (confidence and respect).

Individual and gender differences

I examined relations between emotion recognition accuracy (both overall and separately for positive and negative emotions) and scores on empathy (EQ and the empathic concern subscale of the IRI) and

perspective taking (perspective taking subscale of the IRS). Analyses were conducted separately for senders and receivers. As can be seen in Table 2, senders' levels of empathy and perspective taking were not significantly associated with any emotion recognition accuracy measures. In contrast, for recipients there were several significant positive correlations. For positive emotions, EQ, EC, and PT were all significantly and positively related to emotion recognition. EC was significantly and positively related to overall emotion recognition.

I analyzed gender differences separately for senders and receivers. Sensitivity analyses indicated an 80% probability of detecting a small to medium effect size ($d = 0.34$). Consistent with past emotion recognition research, female receivers were significantly better at identifying the emotions conveyed with text messages ($M = 0.274$) than were the male receivers ($M = 0.196$), $F(1, 64) = 8.315$, $p = .005$. In contrast, there was no difference between males and females for senders, $F(1, 65) < 1$, nor was there a sender gender by receiver gender interaction, $F(1, 65) < 1$.

Discussion

This experiment was an initial attempt to examine implicit emotional communication in digital contexts. Receivers recognized a little over 20% of the specific emotions that senders attempted to convey. Although this seems relatively low, part of this was due to the use of a strict scoring criteria whereby close synonyms were not counted as correct recognition. And when receivers failed to correctly identify the specific, conveyed emotion, their ability to recognize the valence of the convey emotion was quite high (85%). Note also that most emotion recognition research uses the much easier emotion discrimination task, a task which was used in Experiment 2.

Participants' ability to assess their accuracy in emotional communication was relatively poor. There was a clear asymmetry in communicator's confidence as senders were significantly more confident of communicative success than were receivers. At the same time, the confidence ratings of receivers were more accurate than those of senders. In fact, the confidence ratings of the latter were independent of whether the receiver recognized the emotion. Finally, variables previously demonstrated to be related to emotion recognition – empathy and gender – were found to be related to successful emotion recognition in this context, suggesting that emotion recognition is a general skill that transcends specific modalities.

Experiment 2

The purpose of Experiment 2 was two-fold. First, the task for the recipients was changed from a free response task to a multiple-choice task; rather than asking receivers to generate the conveyed emotion on their own, these participants were provided with a list of emotions from which to choose when interpreting the senders' texts. This procedure most closely parallels the emotion recognition task used to examine emotion recognition in other contexts (Schlegel et al., 2014); in essence it is an emotion discrimination task. Second, in an attempt to replicate the results with a more diverse sample, approximately one-half of the of participants in this experiment were recruited from MTurk.

Table 2
Correlations between Emotion Recognition Accuracy and Empathy measures.

Emotion Recognition Accuracy						
	Negative Emotions		Positive Emotions		All Emotions	
	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Receivers						
EQ	.026	.337**	.229*	.312**	.146	.362**
PT	.002	.172*	.260*	.112	.143	.163*
EC	.151	.273**	.290*	.179*	.276*	.260*
Senders						
EQ	.083	.051	−.054	−.018	.033	.011
PT	−.020	−.012	.054	−.076	.016	−.056
EC	.022	−.072	.045	−.109	.040	−.104

Note: EQ = Empathy Quotient - Baron-Cohen & Wheelwright, 2004; PT = Perspective Taking and EC = Empathic Concern, both from the Interpersonal Reaction Index, Davis, 1983.

Method

Participants

Approximately one-half of the participants were recruited from MTurk; these participants served as both Part 1 senders (N = 52; 28 males, 22 females, 2 transgender) who generated texts designed to convey specific emotions, and Part 2 receivers (N = 52; 33 males, 19 females) who judged the conveyed emotion with a multiple-choice format. MTurk participants were paid either $3.00 (Part 1 participants) or $3.50 (Part 2 participants) for their participation. In addition, a set of Part 2 receivers (N = 63; 21 males; 42 females) were recruited from the same participant pool as in Experiment 1; these participants were asked to interpret the Part 1 texts from Experiment 1 using the multiple-choice format. As in Experiment 1, there was no attempt to match the gender composition of the dyads. The resulting gender mix of the Part1-Part2 dyads was as follows: 18 Male-Male; 31 Male-Female; 22 Female-Male; 42 Female-Female; 2 Transgender-Male. The age of the participants ranged between 18 and 67 (M = 27.27; SD = 11.46). Sensitivity analyses for the individual differences in empathy component were conducted (power = .80, alpha = .05) and indicated the sample size was able to detect a small effect ($r = 0.154$).

Materials

The materials were the same as those used in Experiment 1.

Procedure

The procedure was identical to that used in Experiment 1 with the following exception. Sender participants were provided a list of 22 emotions (the 22 emotions used in the production task) and asked to indicate which of the 22 emotions was being conveyed with the text. There was no constraint on the number of times an emotion from this list could be chosen. After completing the text message production or interpretation task, participants completed (in a random order) the EQ (Baron-Cohen & Wheelwright, 2004) and the IRI (Davis, 1980, 1983).

Results

There were eight text messages (out of 2530, or 0.32%) that contained the emotion word; these trials were not included in any analyses. The number of words in the messages varied between 1 and 72 (M = 17.91; SD = 11.80). Analyses of the texts using LIWC showed that texts designed to convey positive emotions scored higher on the positive emotion category (M = 10.62) than texts designed to convey negative emotions (M = 2.91), F (1,20) = 58.46, $p < .001$, with the reverse occurring for texts designed to convey negative emotions (Ms = 5.985 vs 0.825), F (1,20) = 38.03, $p < .001$.

Emotion identification accuracy

Identification accuracy was analyzed with a mixed effects log-linear model that included emotion valence as a fixed effect and the intercepts for dyads and emotions as random intercepts. As in Experiment 1, recognition accuracy did not vary as a function of emotion valence, F (1,2497) = 0.165, $p = .685$. However, recognition accuracy was much higher than in Experiment 1, and participants accurately identified the conveyed emotion close to half of the time ($M = 0.463$; $SE = 0.021$; CI_{95} = 0.422 - 0.504), a rate which far exceeds the chance recognition rate of 0.045. Recognition accuracy for each of the specific emotions can be seen in Table 1.

I analyzed within-valence errors with a linear mixed effects ANOVA

that included emotion valence as a fixed effect and dyad and emotion as random variables. Sensitivity analyses indicated an 80% probability of detecting a small effect size ($d = 0.073$). The within-valence error rate was 90.6% ($SE = 0.02$) and the confidence interval ($CI_{95} = 0.866$ - 0.945) did not include chance recognition (i.e., 50%). Hence, when participants incorrectly identified the specific emotion, it was very likely that they correctly recognized the valence of the conveyed emotion. However, this effect was significantly larger for positive emotions ($M = 0.946$) than for negative emotions ($M = 0.865$), F (1, 20) = 7.36, $p = .013$. Hence, as in the first experiment, participants displayed a positivity bias.

Sender and receiver confidence

To examine whether senders and receivers were able to judge their success at conveying and recognizing emotions, I added sender and receiver confidence to the log linear model with emotion identification accuracy as the criterion, emotion valence as a fixed effect, and the intercepts for dyads and emotions as random intercepts. Sender confidence was not related to recognition accuracy, F (1, 1656) = 0.113, $p = .737$. In contrast, receiver confidence was significantly and positively ($b = 0.349$) related to recognition accuracy, F (1, 2400) = 57.888, $p < .001$. Parallel linear mixed effects ANOVAs were conducted examining confidence as a function of emotion valence and whether the conveyed emotion was recognized. Senders were no more confident when the receiver correctly recognized the conveyed emotion ($M = 5.802$) than when they failed to recognize the emotion ($M = 5.774$) F (1, 2322.338) = 0.509, $p = .476$. In contrast, receivers were significantly more confident when they correctly recognized the emotion ($M = 5.775$) than when they failed to recognize the emotion ($M = 5.427$), F (1, 2280.428) = 55.570, $p < .001$.

To examine sender-receiver asymmetry, I analyzed confidence with a linear mixed effects ANOVA that included role (sender vs. receiver) as a fixed effect, and dyad and emotion as random intercepts. Sensitivity analyses indicated an 80% probability of detecting a small effect size ($d = 0.071$). As in Experiment 1, senders were significantly more confident ($M = 5.749$) that the emotion they conveyed would be recognized than recipients were confident that they were able to correctly recognize the emotion ($M = 5.55$), F (1, 4717.08) = 39.661, $p < .001$. Sender confidence was greater than receiver confidence for all emotions except for the emotion of "helplessness".

Individual and gender differences

I examined relations between emotion recognition accuracy (both overall and separately for positive and negative emotions) and scores on empathy (EQ and the empathic concern subscale of the IRI) and perspective taking (perspective taking subscale of the IRI). Analyses were conducted separately for senders and receivers. As in Experiment 1, none of the correlations for sender accuracy were significant. However, for receivers, there were significant positive correlations between measures of empathy (EQ and EC) and perspective taking (PT) and overall emotion recognition and recognition of negative emotions (see Table 2). Recognition of positive emotions was significant for measures of empathy (EQ and EC) but not perspective taking. These correlations were larger than those observed in the first experiment, suggesting that, at least in these contexts, empathy and perspective taking are more highly associated with emotion discrimination than with emotion identification.

The gender difference observed in Experiment 1 was in the same direction ($M_{females} = 0.488$ vs. $M_{males} = 0.442$) but not significant, F (1,112) = 2.559, $p = .113$. As in Experiment 1, neither sender gender, F (1,110) < 1, nor the sender gender by receiver gender interaction, F (1,110) = 2.108, $p = .149$, were significant. Sensitivity analyses indicated an 80% probability of detecting a small effect size ($d = 0.264$).

Discussion

Emotion recognition in this study, using an emotion discrimination task, was close to 50% and much higher than what was observed in Experiment 1. Also, as in Experiment 1, when receivers failed to recognize the specific emotion, they almost always recognized the valence of the conveyed emotion. There was also a significant relationship between emotion recognition and empathy. These relationships were larger than those observed in Experiment 1, most likely due to the use of an emotion discrimination task. In addition, the same pattern of results for communicator confidence was observed. Specifically, senders were more confident of communicator success than were receivers, and the confidence ratings of the latter, but not the former, were related to actual communicative success.

General discussion

The communication of emotions is central to human interaction and is a critical component of emotional intelligence. Yet interaction today is frequently digital, with interactants having no access to facial expressions or voice, and this raises the question of how good people are at communicating emotions in these contexts. Early CMC approaches assumed that emotional communication in digital contexts would be relatively impoverished, due to the absence of a nonverbal channel. Alternative approaches, in particular that of Walther (1992), soon emerged and suggested that socioemotional communication, at least in broad terms, was possible in digital settings, even without emoji and emoticons. The present research was designed to extend and examine this in more detail, focusing on the communication of discrete emotions in single exchanges.

To do this, I developed an implicit emotion communication task in which participants attempted to convey an emotion implicitly with a text message, and other participants attempted to identify which emotion was being conveyed with the text. In two experiments, receivers were able to discern the emotions implicitly conveyed by senders. This effect occurred with both a free response format (Experiment 1), as well as with a multiple-choice format (Experiment 2). The free response format is relatively difficult, and the scoring of responses in this experiment followed a relatively strict criteria; if a receiver classified the sender as being mad when the conveyed emotion was anger, it was not counted as correct. Still, receivers were able to successfully identify the emotion approximately one-fifth of the time. And when receivers failed to identify the specific emotion, the valence of their interpretation was correct approximately 85% of the time. Emotion identification was substantially better in Experiment 2, when a multiple-choice format was used, the format that is typically used in studies of emotion recognition. And when the specific emotion was not identified, the valence of the receivers' interpretation was correct over 90% of the time.

This implicit emotion communication effect occurred for a variety of emotions, with relatively little variability over the type and valence of emotions. Prior research has demonstrated the digital communication of broad-band emotions such as liking/disliking or happiness/sadness (Hancock et al., 2007; Walther et al., 2005). As well, researchers have demonstrated the recovery of personality traits from digital communications (Hall et al., 2016; Tskhay & Rule, 2014). The present experiments, however, represent the first research demonstrating the ability of people to identify specific emotions from texts alone.

How are people able to judge others' emotions from their digital messages? The examination of individual differences in empathy and perspective taking provide a partial answer to this question. Overall, the receiver's level of empathy, and to a lesser extent perspective taking, were positively related to the ability to recognize the emotions being conveyed by the sender. This positive relationship between empathy and successful recognition of emotions is consistent with past research demonstrating an association between empathy and emotional recognition ability (Bänziger et al., 2009). What is new is the finding that this

relationship extends to the purely digital realm, an environment in which communicators do not have access to facial expressions or voice tone. Hence, the ability to empathize, even in digital contexts, seems to allow one to discern the specific emotions of a communicator.

Note that the relationship between empathy and successful emotion recognition was larger in the multiple-choice task (Experiment 2) than in the free response task (Experiment 1). The difference between free response and multiple choice can be viewed as the difference between emotion identification and emotion discrimination. The former requires a more sophisticated vocabulary than the latter, and as a result, factors other than empathy will play a larger role. This is the likely reason the individual difference effects were stronger for the multiple-choice task than for the free response task.

In contrast to the findings for receivers, for senders there was no relationship between empathy or perspective taking and the extent to which receivers successfully conveyed the intended emotion. Many major theories of language use (e.g., Clark, 1996) assume coordination on the part of conversationalists. Speakers are assumed to construct messages that take into account what the receiver can be assumed to know. It seems likely, then, that people with enhanced perspective-taking abilities would be able to construct messages that would be easier for receivers to decode. But that did not happen in the present research. Again, this may reflect the difference between face-to-face and digital communication. In the former, interactants have a wealth of information that allows them to tailor their messages for a receiver; in the latter, it is difficult to know what the recipient knows, especially in a one-off situation as examined here. In digital communication with strangers, sender empathy and perspective-taking may be somewhat irrelevant due to the lack of context which would allow for the construction of recipient-designed communications. Future research should investigate variables that might be associated with enhanced sender ability to communicate emotions in digital contexts.

What is not clear is how people are able to empathize in digital contexts. Mimicry has been suggested as a fundamental mechanism in empathy and emotional communication (Sato et al., 2013), but mimicry is not really possible in digital contexts. Exploratory analyses of the texts, using LIWC, failed to identify any significant linguistic correlates of successful emotion recognition. Somewhat surprisingly, for example, it was not the case that successful emotion recognition was driven by the percentage of positive or negative emotion words contained in a message. In both experiments, the correlation between the percentage of positive (for positive emotions) or negative (for negative emotions) emotion words and successful emotion recognition was small and nonsignificant. On the other hand, when receivers failed to recognize the specific conveyed emotion, these variables did predict the receiver's ability to recognize the correct valence. That is, the higher the percentage of positive (negative) emotion words, the greater the likelihood that the receiver (when they failed to identify the specific emotion) correctly identified the emotion as positive (negative). There are, of course, limitations of analyses based on LIWC, and it is likely that identification of the linguistic mechanisms involved in implicit emotional communication will require more fine-grained analyses, analyses that consider word associations, syntax, and so on.

Confidence and emotion communication

In this research I also examined participants' confidence in their ability to successfully send and recognize communicated emotions. Two related findings emerged. First, communicator confidence varied as a function of the communicator's role. Specifically, senders were significantly more confident that recipients would recognize the emotion they intended to convey, than receivers were that they had correctly recognized the intended emotion. This pattern was robust and occurred in both experiments and for almost every emotion. This overall pattern is consistent with prior communication research demonstrating that speakers generally tend to overestimate their communicative success (e.g., Keysar & Henly, 2002).

The second finding extends this and demonstrates a disconnect between emotion recognition accuracy and confidence. Although senders were significantly more confident than receivers regarding communicative success, it was the confidence judgments of the receivers that displayed a significant degree of accuracy; their confidence ratings covaried with the extent to which they correctly recognized the conveyed emotion. In contrast, the confidence judgements of senders were divorced from actual communicative success; their confidence ratings were independent of whether the receiver actually recognized the emotion they were attempting to convey. Taken together, these findings demonstrate quite clearly that senders display an overconfidence bias regarding their emotional communications. As a result, senders may come away from an exchange believing that they have successfully conveyed a specific emotion, when in fact, they have not.

Limitations and future directions

There are several limitations of this research that I note here. First, in this research senders were not allowed to include emoji or emoticons in their messages. It has been noted that one of the main functions of emoji is the communication of emotion (e.g., Gesselman et al., 2019), in effect they serve as a substitute for facial expressions and hence facilitate emotional communication (see Holtgraves & Robinson, 2020). It is possible, then, that allowing for the use of emoji would increase the extent to which emotions are successfully communicated in digital contexts. On the other hand, however, emoji can be ambiguous (Miller et al., 2016) and could possibly undermine emotion communication. Hence, the role of emoji in implicit emotional communication is an avenue that is worth investigating further.

Second, there are, no doubt, multiple variables, none of which were examined here, that likely will have an impact on both how digital emotion communication occurs, as well as its likelihood of success. The nature of the relationship between the communicators, differences in their roles, power differentials, cultural background, and so on, will all play a role in how people communicate their emotions, as well as their success at doing so. To take one example, emotional communication in face-to-face contexts has been demonstrated to be less successful when interactants are from different cultures (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004). An interesting question would be to see whether this pattern extends to the digital realm. And the present task involving a one-off exchange is different from the multiple exchanges that people sometimes have, as multiple exchanges provide communicators with the opportunity to elaborate and clarify their intended meanings, including their emotions. Note, of course, that this is no guarantee of successful communication (e.g., Galantucci & Roberts, 2014), but it is certainly an avenue worth pursuing.

Overall, the present results provide an initial glimpse into emotional communication in digital contexts, demonstrating the relative level of success with which individuals are able to do so, as well as individual variability in this process and interactants awareness (and sometimes lack thereof) of communicative success. Implicit emotional communication is not new of course. Writers of letters, novels, poems, and so on have, to varying degrees, successfully conveyed specific emotions with their writings. What is new, however, is scale. Written, digital communication is now the norm. As communication continues to become increasingly digital, the examination of emotional communication in these contexts should yield insights that are both practical and theoretical.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chbr.2022.100219.

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