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**E-MAIL COMMUNICATIONS AMONG PEOPLE WITH AND  
WITHOUT MAJOR DEPRESSIVE DISORDER**

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**by**

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## **Dedication**

I dedicate this dissertation to my research participants, who entrusted me with access to their private communications. Without them, this research would not have been possible.

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Finally, human subjects research relies on participants' willingness to place trust in the researcher; this project was no exception. My own participants entrusted me with access to their email correspondence, containing potentially very personal information. I am indebted to these women for their willingness to give me insight into their lives.

# **E-MAIL COMMUNICATIONS AMONG PEOPLE WITH AND WITHOUT MAJOR DEPRESSIVE DISORDER**

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Social interactions affect the onset and maintenance of major depressive disorder (MDD; e.g., Hammen, 2006). However, little research has examined depressed people's communications in daily life.

This dissertation's primary aim is to test three models of the association between MDD and everyday communication. The disclosure model suggests that people with MDD, particularly if currently depressed, communicate about themselves and their distress. The social disengagement model suggests that people with MDD, particularly if currently depressed, communicate less. The selectivity model suggests that people with MDD, particularly if currently depressed, communicate more negatively only with people with whom they have closer relationships. This dissertation's second aim is to investigate associations between communication patterns of individuals with MDD and residual depressive symptoms.

Sixteen women with MDD and 15 never-depressed women submitted a year's worth of their e-mails with up to ten correspondents. For participants with MDD the year

included at least one month of depression and one month of remission. E-mails were submitted to computerized text analysis.

For the primary research question, the study design was conceptualized as a 2x2 between-subjects (MDD vs. never-depressed) x within-subjects (currently depressed vs. not currently depressed) ANOVA missing one cell (never-depressed individuals with currently depression). Data were e-mails nested within correspondents within participants and were analyzed using multi-level regression. For the second research question, OLS regression analyses were used.

People with MDD e-mailed their correspondents marginally more frequently when in a depressive episode, suggesting increased efforts at engagement. During episodes, however, participants showed less verbal synchrony with their correspondents. This suggests that despite reaching out more, currently depressed people are less attuned with others.

People with major depressive disorder used more positive emotion words and fewer negative emotion words than never-depressed controls. Although there was a general pattern among participants of using more negative emotion words with correspondents with whom they had closer relationships, this tendency was accentuated in depressed individuals in current major depressive episodes. These findings are consistent with the view that individuals – particularly when depressed – regulate aspects of their communication to protect and manage their social relationships.

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## **Introduction**

Depression has long been known to be an inherently social phenomenon. From Freud's (1917/1957) seminal theoretical contributions to recent empirical studies (Hammen, 2006; Paykel, 2003), negative interpersonal events have been linked to the onset and maintenance of major depressive disorder (MDD). Individuals with MDD experience more interpersonal stress and relationship conflict and report lower levels of social support and social involvement than the never depressed, even during remission (Hammen & Brennan, 2002; Hirschfield et al., 2000; Leskelä, Melartin, Rytsälä, Sokero, Lestelä-Mielonen, & Isometsä, 2008). Hammen's well-supported stress generation theory suggests that people with MDD behave in ways that increase the likelihood of interpersonal problems and future depressive episodes. Research has established the contributions of a number of interpersonal styles such as dependency, insecure attachment, excessive reassurance seeking, and poor social skills (Eberhardt & Hammen, 2009; Segrin, 2000) to interpersonal stress and the maintenance of depressive symptoms. The ultimate irony, however, is that few studies have actually tracked the everyday social interactions which make up the social worlds of those with major depressive disorder.

Monitoring everyday interactions is notoriously difficult. Many methods are obtrusive, potentially altering subjects' behavior (e.g., Craik, 2000). In the electronic age, that is changing. Much social interaction now occurs through the electronic transmission of written text which is often saved by default. Most American internet users between the ages of 18-65 use email daily (Pew Internet & American Life Project, 2009) to meet a variety of social needs including seeking out and providing social support (Hall & Irvine, 2009). Computerized text analytic methods enable researchers to tap texts for indicators

that are of central importance to depression, such as mood (Kahn, Tobin, Massey, & Anderson, 2007) and social engagement (Ireland & Pennebaker, 2010).

The current project is an analysis of e-mail correspondence. It investigates two main questions. First, how do people with MDD communicate with members of their social network (e.g., friends and family) during a depressive episode versus while remitted, and how do the communication patterns of people with MDD differ from the communication patterns of never-depressed controls? Second, are communication style and frequency associated with symptom severity and social support after a depressive episode?

### **MAJOR DEPRESSIVE DISORDER AND INTERPERSONAL RELATIONSHIPS**

Studies have established bidirectional links between MDD and poor interpersonal relationship quality. Longitudinal studies involving in-depth interviews with depressed people about their relationships, life events, and symptoms have demonstrated that a lack of close confidantes increases the risk of having a depressive episode, given the presence of other stressful life events (Brown & Harris, 1978). Individuals with major depressive disorder have more stressful interpersonal relationship events that could be independently judged to be due in part to their own contributions (e.g., a relationship break-up), but the same rate as non-depressed individuals of life events that are independent of their contributions (e.g., the death of a family member; Hammen, 2006). This suggests that not only do depressed people have more stressful relationships, but also that they play a role in perpetuating relationship stress, which may in turn play a role in the recurrence of depression (Coyne, 1976a; Hammen, 2006; Teichman & Teichman, 1990).

The research reviewed above suggests depressed people are caught in a vicious cycle: their relationships make their illness worse, and their illness makes their relationships worse. Two broad patterns of depressive behavior that may perpetuate the

disorder and erode interpersonal relationships are disengagement and excessive disclosure. Theory and evidence describing these two patterns is reviewed below.

**The disengagement model.** Behavioral theories of depression have as a central feature the supposition that depressed individuals fail to actively participate in social life. The symptoms of depression – anhedonia, lack of energy, feelings of guilt or worthlessness – make social life less positively reinforcing, and contribute to depressed people’s reluctance to participate. Depressed people report spending less time with family and friends and doing social things less frequently (e.g., Wells et al., 1989). Laboratory studies have found some evidence that depressed people are socially withdrawn in social situations. In one study, Libet and Lewinsohn (1973) put together groups composed of previously unacquainted depressed and non-depressed undergraduates who participated in structured activities together. The researchers found that depressed people initiated interactions with other members of the group half as frequently as non-depressed people, although the difference became minimal in later group sessions. It was therefore unclear whether this same effect would hold in interactions between depressed people and their existing social contacts.

Studies of depressed individuals’ everyday interactions have found minimal evidence for reduced social involvement. In two daily diary studies, depressed and never-depressed individuals engaged in social interactions with comparable frequency, although the depressed individuals typically found these interactions less rewarding (Nezlek, Imbrie, & Shean, 1994; Nezlek, Hampton, & Shean, 2000). In another study, Baddeley et al. (2011) found only mixed support for depressed individuals’ lack of social involvement; depressed individuals in that study spent less time in groups, but about the same amount of time in dyads compared to controls. Even when interacting, depressed

people may show signs of disengagement, such as saying less, pausing for longer before responding, and not speaking as often as the non-depressed (Segrin, 2000).

Another aspect of engagement in social interactions is the ability to attune to another person. Nonverbal attunement (i.e., similarity between two conversation partners in level of nonverbal indicators of conversational involvement, such as nodding or eye contact) may predict the course of depression. In one study, currently remitted individuals who showed low attunement in a conversation with an interviewer trained to exhibit high or low involvement were more likely to experience a recurrence of depression during the next two years (Bos, Bouhys, Geertz, van Os, & Ormel, 2006), as well as more frequent stressful interpersonal events (Bos, Bouhys, Geertz, van Os, & Ormel, 2007).

Language style matching (LSM; Ireland & Pennebaker, 2010) is a measure of the extent to which two people are verbally attuned to each other in social interaction, assessed through convergence between their speech styles. LSM can be computed quickly from written text. Higher levels of LSM are associated with social skill (Ireland & Pennebaker, 2010) as well as positive social interactions; LSM is related to greater mutual liking and better task performance in small work groups (Gonzales, Hancock, & Pennebaker, 2010), as well as to greater romantic interest and desire for future contact in speed daters and greater relationship stability in couples (Ireland, Slatcher, Eastwick, Scissors, Finkel, & Pennebaker, 2011). LSM may also be associated with emotional health; people with high trait emotional stability show higher language style matching when responding to written questions, although the effect is small (Ireland & Pennebaker, 2010). No studies have yet assessed the relationship between LSM and depression.

**The disclosure model.** It is a central tenet of cognitive theories of depression that people have negative views of themselves, the world, and the future (Beck, 1967), and anhedonia, or lack of pleasure, is a core depressive symptom (DSM-IV). According to the

social skills deficit theory of depression, depressed individuals display their personal distress during social interactions. In interactions with responsive confederates (Jacobson & Anderson, 1982) and with friends (Segrin & Flora, 1998), dysphoric college students are indeed more likely than non-dysphoric college students to make negative emotional disclosures. Some evidence also suggests that dysphoric or depressed college students are less likely to respond positively to others (Libet & Lewinsohn, 1973; Segrin, 2000). According to the social skills deficit theory of depression, both excessive negative disclosure and insufficient positive interaction may disrupt social relationships, leading to a reduction of positive social reinforcement which may maintain depression (Libet & Lewinsohn, 1973; Segrin, 2000).

Negative and positive emotional disclosures have typically been assessed by human coding. A more efficient way of assessing negative emotional expression is to count the numbers of positive and negative words individuals use in their speech. Counts of positive and negative emotion words correspond to human raters' judgments of positive and negative affective expression, respectively, and can therefore be considered valid indices of emotional valence (Kahn, Tobin, Massey, & Anderson, 2007). Studies examining everyday speech have found mixed evidence for the idea that depressed individuals speak more negatively. College students with elevated depressive symptoms do not use more negative emotion words (e.g., sad, lame) or fewer positive emotion words (e.g., fun, great) in their everyday speech (Mehl, 2006), but individuals in a current major depressive episode do use more negative and fewer positive emotion words in their everyday lives (Baddeley et al., 2011).

Interestingly, research has suggested that depressed people's displays of negative emotions depend on who they are talking to and what they are talking about. Dysphoric college students express more negative emotion in conversations with friends than non-

dysphoric college students do, but both groups express relatively little negative emotion in conversations with strangers (Segrin & Flora, 1998). Similarly, people with MDD often show higher rates of negative behavior (e.g., hostile remarks) in their interactions with their spouses (see Rehman et al., 2008, for a review). However, depressed individuals express negative emotions differentially more than non-depressed individuals in conflict interactions between marital partners, but not in neutral interactions (Schmaling & Jacobson, 1990). Together, these findings point to the idea that depressed people may be disclosing negative emotions selectively: with individuals with whom they have close relationships, and in situations that are stressful.

In addition to expressing more negative and less positive emotion, depressed people show high levels of self focused attention and, relatedly, report high levels of rumination, i.e., repetitively thinking about themselves and their own problems (Mor & Winquist, 2002). Consistent with this tendency towards high levels of self focused attention, dysphoric college students have been found to use more first-person singular pronouns in expressive writing (Rude, Gortner, & Pennebaker, 2004) and in their everyday speech (Mehl, 2006). Rumination has been shown to induce and prolong depression, as well as leading to interpersonal strain and conflict (see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008, for a review). Despite the clear costs of rumination for psychological wellbeing, it may carry some social benefits. For example, the mutual sharing of one's ruminative thoughts – known as co-rumination – has been shown to lead to increased intimacy in adolescents girls' friendships even as it maintains depressive symptoms (Rose, Carlson, & Waller, 2007).

In short, if depressed people display distress, we would expect them to frequently use first-person singular pronouns and negative emotion words, and to use few positive

emotion words than never depressed controls, and for this tendency to be more pronounced during depressive episodes.

**The selectivity model.** It is possible that depressed people will vary their style of self-presentation depending on who they are talking to. Clark (1987) has found that people can expect to receive a certain amount of sympathy from members of their social network in periods of misfortune. (She calls it a “sympathy margin” or sympathy bank account because it is a limited quantity subject to rules of exchange). This sympathy margin is greater – allowing for the disclosure of more distress – in closer relationships than in more distant ones. Depressed people, who are by definition in distress, may disclose negative emotions to those who are close to them but not to people with whom they have more distant relationships.

Thus, depressed individuals' communications should be more personal and more disclosing of negative emotions in closer relationships than in more distant relationships. This pattern should be particularly pronounced during depressive episodes. Given that residual depressive symptoms are also present during remission, this pattern should also be present during remission. However, controls are likely to express low levels of negative emotion regardless of the closeness of their relationships with their correspondents.

## **THE CURRENT STUDY**

The current study is an investigation of language use within the email archives of people with a recent episode of MDD and never-depressed controls. Only women were included to avoid the potentially confounding effects of gender differences in communication patterns (Newman, Groom, Handleman, & Pennebaker, 2008, Rehman et al., 2008). Additionally, depression is more prevalent among women than among men (Weissman et al., 1996). Interpersonal stress is a vulnerability factor for the onset of

depression among adolescent girls more than among adolescent boys (Shih, Eberhart, & Hammen, 2006). This makes women a particularly important group in which to study depression's social correlates and potential contributing factors.

Is depression associated with communication? The first research question was whether people with major depressive disorder communicate differently from the never-depressed, and whether people with major depressive disorder communicate differently when depressed than they do when remitted. There are alternative hypotheses for how a person with MDD might communicate differently before, during, and after a depressive episode, and for how a person with MDD might communicate differently from a healthy control participant.

**H1a. The disengagement model.** People with MDD should communicate less frequently with their contacts, each communication should be less lengthy, and language style matching should be lower during an episode than during remission. Similarly, depressed people should communicate less frequently, at less length, and with lower language style matching during both depressive episodes and remission compared with controls.

**H1b. The disclosure model.** Alternatively, people in a major depressive episode may follow the disclosure model of self-presentation. According to this model, they should be communicating in a self-focused way, expressing a high level of negative feelings and a low level of positive feelings. Before and after episodes, formerly-depressed people should communicate with a moderate level of self-focus, a moderate level of negative emotional expression, and a moderate level of positive expression. Never depressed people should show a relatively low level of self-focus, should express relatively few negative emotions, and should express a relatively high level of positive emotions.

**H1c. The selectivity model.** Depressed individuals should express more negative emotions to people with whom they have closer relationships. This difference should be particularly pronounced during a major depressive episode but should also be present during remission. Controls should use a relatively low level of negative emotion words regardless of how close their relationship is with the correspondent to whom they are writing.

Is communication associated with social support and residual depressive symptoms? The second research question asked whether the communication style of individuals with major depressive disorder is associated with residual symptoms and social support.

**H2.** Both disengagement and disclosure should be associated with higher levels of residual symptoms of lower levels of social support after a depressive episode. In other words, people who use higher rates of first-person singular pronouns, high rates of negative emotion, and lower rates of positive emotion should have higher levels of residual symptoms and lower levels of social support. The same should be true for those who write fewer e-mails and shorter e-mails, and those who have lower levels of language style matching.

## **Methods**

### **PARTICIPANTS**

Participants were recruited through emails sent to individuals who had participated in previous research studies through the UT mood disorders lab and had indicated interest in participating in future studies. The email inviting them to participate informed them that the current study would look at how people communicate with friends and family over email. Potential participants were notified that they would be asked to provide a selection of their emails over the course of a year and that they would be paid \$100 for participating. A few of these individuals referred other people to the study. A phone screening interview assessed potential participants to see if they met inclusion criteria. Inclusion criteria were: a history of major depressive disorder or no history of any mood disorder; age of at least 22 years; female gender; use of a webmail account such as Gmail as one's primary e-mail account; and saving all or almost all of one's sent and received e-mail from the past year.

Of the 51 individuals who wrote or called to indicate interest in study, 13 did not return calls or emails. Four were disqualified from participation: two did not meet diagnostic criteria for the MDD or the control group, one had not saved sent email, and one used an email system that did not allow pop access, which meant her email could not be downloaded through our system. Two participants (both with major depressive disorder) were excluded from analyses: one because of early termination of study participation, resulting in incomplete data; the other because of an insufficient number of emails (i.e., two messages) sent to correspondents during the study year.

For studies involving clinical populations in which participant recruitment is costly, difficult, and time-consuming, the feasibility benefits of keeping the sample size

relatively small must be weighed against the decreased likelihood of detecting effects in a small sample. Compromise power analyses allow the investigator to specify the following parameters: (1) estimated sizes of the target effects, and second, (2) a target  $N$  that represents a sample size that can be feasibly obtained. The result is an estimated power to detect the specified effects within the sample. A-priori compromise power analyses were performed for the current study assuming the use of both between-groups and within-groups repeated measures analyses.

Performing power analyses for a study like this is difficult because there is no standard body of literature that uses the same methods. This means that there is no body of literature from which truly valid or reliable effect size estimates can be drawn. The closest thing to a comparable study is Baddeley et al's (2011) research, which provides effect size estimates of differences in the everyday language use during spoken conversations of individuals in a current major depressive episode compared to never-depressed controls.

Between-groups differences in the medium effect size range were uncovered for some of the target variables in the Baddeley et al. (2011) study. For example, Baddeley et al (2011) found a medium effect size of  $f=.29$  ( $d=.57$ ) for the difference in negative emotion word use between depressed and non-depressed individuals.

With a sample of 30 individuals ( $n=15$  in each group) in a 2x2 repeated measures ANOVAs performed on the full sample ( $N=30$ ), medium-sized within-subjects effects of  $f=.29$  are very likely to be detected, with power=.82 and medium-sized between-subjects effects of  $f=.29$  are likely to be detected, with power=.75, (calculated assuming an  $r=.45$  correlation between repeated measures). Subsequent to data collection, analyses were conducted using multi-level models which provide increased power and more accurate parameter estimates than regular repeated-measures designs, which would rely on

aggregated data. A priori power calculations are virtually impossible to perform for these models (Hox, 2002).

The final sample consisted of thirty-one women who either had a history of major depressive disorder ( $n=16$ ) or who were psychiatrically healthy controls ( $n=15$ ). All of the women with a history of major depressive disorder were currently in partial or full remission. The average time since the end of their last episode was 13.62 months ( $SD=13.13$ ). Individuals with major depressive disorder had spent an average of 3.11 months in a major depressive episode during the year for which e-mails were collected ( $SD=1.49$ ). Table 1 shows both groups' demographic characteristics, depressive symptoms, and perceived social support at the time of the study. The table indicates that the groups did not differ significantly in age, race, ethnicity, years of education, or perceived social support. However, the control group was significantly less likely than the major depressive disorder group to be in a romantic relationship. Additionally, the major depressive disorder group had a higher level of depressive symptoms than the control group at the time of study.

Table 1: Participant Characteristics as a Function of Group (Major Depressive Disorder vs. Control)

<b>Characteristic</b>	<b>MDD (n=16)</b>	<b>Control (n=15)</b>	<b>Statistical test of group difference</b>
Age (years)	28.19 (5.12)	29.07 (4.23)	$t(29)=.52, p=.61$
Years of education	16.56 (1.63)	15.87 (1.72)	$t(29)=1.15, p=.26$
Race			$\chi^2(3)=6.37, p=.10$
White	13 (81.25%)	8 (53.33%)	
Asian	3 (18.75%)	2 (13.33%)	
Black	0 (0.00%)	2 (13.33%)	
Other or multiracial	0 (0.00%)	3 (20.00%)	
Ethnicity			$\chi^2(1)=2.39, p=.15$
Non-hispanic	15 (93.75%)	11(73.33%)	
Hispanic	1 (6.25%)	4 (26.67%)	
Relationship status			$\chi^2(1)=3.90, p=.048$
Married or in a relationship	12 (75.00%)	6 (40.00%)	
Single/divorced/separated	4 (25.00%)	9 (60.00%)	
CESD	7.56 (7.25)	3.33 (2.35)	$t(29)=2.15, p=.04$
Social support	79.31 (11.69)	80.93 (14.25)	$t(29)=-.35, p=.73$

*Note.* All individuals with major depressive disorder were in remission when participant characteristics were assessed.

## MEASURES

Structured Clinical Interview for the DSM-IV (SCID). (First, Spitzer, Gibbon, & Williams, 2002). The SCID is widely considered the gold standard interview protocol for diagnosing psychiatric disorders. In the current study, the SCID was used to assess past and present major depressive disorder. The interview also probed for details on the number, length, and timing of any past depressive episodes. For participants with MDD, the SCID interview established start and end dates for the most recent year during which the participant was depressed for at least one month and remitted for at least one month. Only email sent and received during that target year was used in the study.

**Center for Epidemiologic Studies Depression Inventory (CES-D), short form.** (Cole, Rabin, Smith, & Kaufman, 2004). This scale measures the severity of depressive symptoms. For each of 10 statements regarding depressive symptoms, participants indicated how often they had experienced each in the past week. Reliability in the current sample was Cronbach's  $\alpha = .85$ .

**Medical Outcomes Study Social Support Survey.** (Sherbourne & Stewart, 1991). This 19-item scale assesses perceived social support in four broad domains: emotional/informational, tangible, affectionate, and positive social interaction. The scale was validated on a population of adults with chronic medical conditions. Reliability in the current sample was Cronbach's  $\alpha = .95$ .

**Contact list and ratings.** For each contact, participants indicated the type of relationship they have with the person (i.e., family, friend, or other), how long they have known the person, how stressful the relationship is, and how close the relationship is. Closeness was assessed using four items (rated on a 1-7 likert scale where 1=not at all and 7=very much) that asked about whether the relationship was emotionally close and whether the participant was able to confide in the correspondent. The four items formed

an internally consistent measure of closeness, Cronbach's  $\alpha=.82$  and were averaged to form a single closeness score.

Individuals with major depressive disorder indicated whether each correspondent knew about their most recent depressive episode. A binary logistic regression analysis was conducted to determine whether closeness and knowledge of depression overlapped significantly. Participant ID number was included as a random intercept term. The model accurately classified 87% of the correspondents, suggesting significant overlap between a correspondent's knowledge of a participant's depression and the closeness of their relationship with that participant. Primary analyses in the current dissertation explore the association between correspondent closeness and communication patterns, while analyses of the association between communication patterns and correspondent knowledge of the depression are reported in Appendix C.

#### **PROCEDURE FOR COLLECTING E-MAILS.**

Participants all used one of the major webmail providers (hotmail, gmail, or yahoo) as their primary e-mail account. E-mail messages were downloaded into a database that stored the date and time stamp, sender, recipient list, and message body. A computer program designed for this study generated from the sender and recipient lists a list of email addresses in order of the combined frequency with which these addresses appeared in both lists. Participants selected from this list up to 10 correspondents with whom they emailed most frequently and with whom they had personal relationships. The final database included only messages between the participant and one of the selected correspondents during the target year. All sender and recipient email addresses and names were replaced with anonymous identifiers (e.g., "correspondent 1"). All email texts were stripped of headers and footers, forwarded content, and the content of previous messages, so that only the greeting, message body, and closing were retained. See

appendix A for further details on the downloading of e-mail messages and building of the database.

#### **DATA PREPARATION.**

**LIWC analysis.** Each message was saved as its own text file. All messages were analyzed with the Linguistic Inquiry and Word Count (LIWC) program (Pennebaker, Booth, & Francis, 2007). LIWC compares the words in any text file against words contained in its pre-established categories, or “internal dictionary”. It recognizes most of the words in most texts, for example, LIWC recognizes over 80% of the words in blog entries and over 90% of the words in everyday speech. LIWC computes the percentage of words in any given text that fall under a particular category. The relevant categories for the current project were word count, first person singular pronouns, negative emotion words, and positive emotion words.

All messages regardless of length were included in word count calculations. However, to ensure that low word count messages did not distort the LIWC findings, only messages of at least 10 words were submitted to LIWC analysis for all other categories. There were a total of 13,818 messages in the corpus with at least 10 words (73.5% of total emails), including a total of 7013 emails sent by participants (76.5% of all sent emails) and 6805 received emails (70.7% of all received emails).

**Language style matching analysis.** An index of language style matching is calculated by comparing paired texts with each other in terms of their similarity on nine different categories of function words, for example, pronouns, prepositions, and articles. Function words reflect not the content but style of speech, and similarity in the use of function words suggests similar style. The LSM formula for each category subtracts the percentage of words in one text that fall within a given category from the percentage of words in a second text that fall within a that same category, then divides the absolute

value of that difference by the sum of the percentages of words in the category in the two texts plus a negligible .0001 to avoid null sets. The resulting number is subtracted from 1 such that higher numbers indicate higher similarity. Below is the formula written for the prepositions category.

$$\text{LSM}_{\text{preps}} = 1 - [ ( | \text{preps1} - \text{preps2} | ) / (\text{preps1} + \text{preps2} + 0.0001) ]$$

Finally, the separate LSM scores for these nine categories are averaged to form an overall LSM score (Ireland & Pennebaker, 2010).

## **DESCRIPTIVE RESULTS**

**The e-mail corpus.** The final email corpus contained 18,791 messages, 9172 of which were messages that participants had sent to their correspondents and 9619 of which were messages participants had received from their correspondents. Messages were 55.46 words long on average ( $SD=121.28$ ).

Participants sent an average of 295.84 messages ( $SD=378.87$ ) to their selected correspondents during the year. The number of sent messages did not differ significantly between participants with major depressive disorder ( $M=312.25$ ,  $SD=221.12$ ) and controls ( $M=278.33$ ,  $SD=504.54$ ),  $t(29)=-.25$ ,  $p=.81$ . Participants received an average of 310.29 messages ( $SD=428.76$ ). The number of received messages did not differ significantly between participants with major depressive disorder ( $M=303.63$ ,  $SD=248.33$ ) and controls ( $M=317.40$ ,  $SD=572.50$ ),  $t(29)=-.09$ ,  $p=.93$ .

Individuals with major depressive disorder were in a depressive episode for an average of 3.11 months ( $SD=1.49$ ), during which they sent an average of 80.87 e-mails ( $SD=89.98$ ) and received an average of 75.25 ( $SD=96.18$ ). They were remitted for an average of 8.89 months ( $SD=1.49$ ) during which they sent an average of 231.38 e-mails ( $SD=158.44$ ) and received an average of 228.37 ( $SD=177.91$ ).

**The correspondents.** Table 2 provides descriptive information on the correspondents that participants selected for inclusion in the current study. The descriptive data for the correspondents were averaged first within participant and then within group (major depressive disorder vs. control). As table 2 indicates, participants with major depressive disorder and control participants selected comparable numbers of correspondents. Participants in the two groups rated their relationships with these correspondents differently on two dimensions. One, controls were less likely to select a romantic partner as one of their correspondents, which is consistent with their lower likelihood of being in a relationship in the current sample. Two, participants with major depressive disorder described their relationships with their correspondents as more stressful on average than did controls.

Table 2: Characteristics of Selected Correspondents and Correspondent Participant Relationships as a Function of Participant Group.

<b>Characteristic</b>	<b>MDD (<i>n</i>=16)</b>	<b>Control (<i>n</i>=15)</b>	<b>Statistical test of group difference</b>
Number of correspondents	9.06 (1.29)	8.47 (2.00)	$t(29)=.28, p=.33$
Relationship to participant			
Number of romantic partners	.69 (.48)	.27 (.46)	$t(29)=2.50, p=.02$
Number of friends	6.63 (2.13)	5.93 (2.74)	$t(29)=.79, p=.44$
Number of family members	2.13 (1.45)	2.40 (1.68)	$t(29)=-.49, p=.63$
Number of correspondents who knew about the depressive episode	5.00 (2.16)	n/a	n/a
Length of relationship (years)	9.61 (4.17)	10.82 (4.98)	$t(29)=.74, p=.47$
Participant's relationship ratings			
Relationship closeness	5.02 (.54)	5.16 (.54)	$t(29)=-.71, p=.48$
Relationship stressfulness	2.86 (.70)	2.26 (.57)	$t(29)=2.61, p=.01$
Email as a % of total contact	24.73 (10.19)	25.22 (15.56)	$t(29)=.10, p=.92$

*Note.* Relationship ratings were on a 1-7 likert scale where 1=not at all and 7=very much. “E-mail as a percent of total contact” refers the average percentage of participants’ contact with each correspondent that occurred through e-mail versus other means of communication (e.g., phone, face-to-face, text messaging).

#### **DATA ANALYSIS**

One of the challenges of analyzing data from our study was that for the major depressive disorder group, we had data from two clinically and theoretically distinct time

periods for each person (depressed and remitted). By definition, the control group had neither “depressed” nor “remitted” time periods. We therefore conceptualized the controls’ data as all belonging to a single time period in which the person was not depressed. Essentially, the study design is a 2x2 between-subjects (major depressive disorder versus never-depressed control) x within-subjects (currently depressed versus not currently depressed) ANOVA which is missing one cell (data for the never-depressed controls in a currently depressed time).

The data had a nested structure in which e-mail messages were nested within correspondents who were nested within participants. Random intercept terms are included in multi-level models to model the within-participant variability in the outcome variable which accounts for non-independence of multiple observations from the same person. In some analyses, the dependent variable was a feature of individual e-mail messages (word count, first-person singular pronouns, positive emotion words, and negative emotion words). In these analyses, each message was included as a case in the analysis. A random intercept term for each correspondent was included to account for non-independence among multiple messages sent to a given correspondent. In other analyses, the dependent variable was a feature of e-mail messages aggregated within a correspondent (number of messages sent by the participant, LSM). In these analyses, each correspondent was a case in the analysis and a random intercept term for each participant was included to account for non-independence among multiple correspondents nested within a given participant.

There was significant variability from participant to participant in the numbers of messages sent. This poses a problem: in an analysis in which each message is a unit of analysis, people who sent more messages would weigh more heavily than people who sent fewer messages. There are two ways of thinking about this problem. One is that the

data points are more stable from people who are sending more messages and therefore should be given more weight in analyses; the other is that allowing people who sent more messages to be weighted more heavily essentially makes the number of messages a confound in any analysis, and therefore each person should be weighted equally regardless of the number of messages that she sent. The second approach was chosen so that everyone was weighted the same regardless of how many messages they had sent.

To weight each participant equally, each control participant was assigned a weight inversely proportional to the number emails that she had sent that were included in the dataset under analysis. Emails from each participant with major depressive disorder sent within a depressive episode were weighted inversely to the number of emails sent by that participant during the depressive episode; similarly, emails sent by each participant with major depressive disorder during remission were weighted inversely to the number of emails sent by that person during remission.

## **Results**

The current project was designed to assess associations between depression and how people communicate with members of their social networks. Analyses addressed three broad research questions. One, is depression history and current depression associated with social engagement in email communication (length of emails, frequency of emails, and language synchrony with correspondents) and with negative emotional disclosure in email communication (more negative emotion words, fewer positive emotion words, and more first person singular)? Two, does negative emotional disclosure differ depending on how close and how stressful people's relationships are with the people to whom they are writing? Three, are social engagement and negative emotional disclosure associated with residual symptoms and social support after a depressive episode? The results section is laid out in three sections to address each of these three questions.

### **IS DEPRESSION ASSOCIATED WITH FREQUENCY AND CONTENT OF EMAIL COMMUNICATION? A TEST OF THE DISCLOSURE AND DISENGAGEMENT MODELS.**

The first research question asked whether depressed people tended to disengage and/or engage in negative disclosures more during in a major depressive episode than they did when remitted. Additionally, it asked whether individuals with major depressive disorder disengaged and/or engaged in negative disclosures more than never depressed controls. To answer these questions, weighted multilevel regression analyses were performed. Depression status was the independent variable(s) and the indicators of disclosure (first person singular, negative emotion and positive) and disengagement (word count, number of e-mails sent per month, and LSM) and were the dependent variables in the analyses.

For each of the six dependent variables, analyses addressed four different questions: (1) whether individuals with major depressive disorder differed from controls; for this analysis we compared the major depressive disorder group's data, collapsed across remission and depression, with the control group's data. (2) Whether people with major depression talk differently during remission than they do during a depressive episode; for this analysis we compared data from the depressed group during depression with their data during remission. (3) Whether people with major depressive disorder talk differently during a depressive episode than controls do; for this analysis we compared data from the depressed group during depression with controls' data. (4) whether people with major depression, when remitted, talk differently from controls; for this analysis, we compared only the depressed people's data from remission with the controls' data.

Table 3 shows predicted values for the major depressive disorder group during remission and during a depressive episode, and for the control group. Means in the same row with different superscripts are different at  $p < .05$ .

**The disclosure model.** Contrary to the disclosure hypothesis, individuals with major depressive disorder used fewer negative emotion words than controls,  $B = -.14$ ,  $SE = .07$ ,  $t(254) = -2.17$ ,  $p = .031$ . As table 3 shows, controls' negative emotion word use was lower than that of remitted individuals with major depressive disorder, but not currently depressed individuals. Also contrary to the disclosure hypothesis, individuals with major depressive disorder used marginally more positive emotion words than controls,  $B = .45$ ,  $SE = .24$ ,  $t(254) = 1.92$ ,  $p = .056$ . The contrasts between controls and currently depressed individuals and controls and currently remitted individuals with major depressive disorder were both marginally significant,  $ps < .06$ . Although individuals with major depressive disorder did not use more first-person singular pronouns than

controls overall, these individuals did use more first-person singular pronouns when they were depressed than when they were remitted.

**The disengagement model.** Overall, individuals with major depressive disorder did not send a significantly different number of messages each month compared to controls, but there was a non-significant trend for individuals with MDD to send more messages when depressed than they did when remitted,  $B=.57$ ,  $SE=.32$ ,  $t(227)=1.73$ ,  $p=.08$ . Controls and individuals with major depressive disorder sent e-mails of similar length; message length also did not differ significantly for the major depressive disorder group as a function of currently depression status. The one finding that was consistent with the disengagement hypothesis was the finding that LSM is lower during depression than during remission.

Table 3. Frequency of and Language Use in E-mail Communication as a Function of Depression Status.

	MDD		Control
	Depressed	Remitted	
Word count	57.46	58.73	56.08
First person singular pronouns	6.73a	6.27b	5.96ab
Negative emotion words	1.17ab	1.05a	1.46b
Positive emotion words	4.70	4.99	4.04
Language style matching	0.77a	0.81b	0.77ab
Emails/month	3.97	2.89	2.63

*Note.* Numbers are predicted values calculated from multi-level regression models comparing the major depressive disorder group during remission vs. during depression;

the control group with the major depressive disorder group during depression; and the control group with the major depressive disorder group during remission. These three comparisons yielded two sets of predicted values for each group. For simplicity, the average of these predicted values was included in the table.

Degrees of freedom for the major depressive disorder during remission vs major depressive disorder during depression comparisons were: 4855 for word count, 3643 for first person singular, negative emotion, and positive emotion 183 for language style matching, and 227 for emails per month.

Degrees of freedom for the control vs major depressive disorder during depression were: 230 for word count, 221 for first person singular, negative emotion, and positive emotion, and 29 for language style matching and emails/month.

Degrees of freedom for the control vs major depressive disorder during remission were: 256 for word count, 249 for first person singular, negative emotion, and positive emotion, and 29 for language style matching and emails/month.

Predicted values for first-person singular pronouns, negative emotion words, positive emotion words, and language style matching were calculated from analyses including only e-mails at least 10 words long. Predicted values for word count and e-mails per month per correspondent were computed from analyses including all e-mails regardless of word count.

Given the correlation between language style matching and number of emails sent and received, language style matching scores were computed controlling for number of emails sent between participant and correspondent.

Predicted values in the same row with different superscripts differed in simple contrast analyses at  $p < .05$ .

## **DO DEPRESSED PEOPLE SELECTIVELY DISCLOSE, DEPENDING ON WHO THEY ARE COMMUNICATING WITH? A TEST OF THE SELECTIVITY MODEL**

Analyses of the selectivity model aimed at assessing whether individuals with major depressive disorder (regardless of current depression status) communicated more negatively than never-depressed controls with individuals with whom they had closer relationships. Additionally, analyses assessed whether any differences in negative communication to closer correspondents were a function of current depression status either instead of or in addition to history of depression.

To answer these questions, a multilevel regression model was run with correspondent ID as the random intercept (to account for the non-independence of multiple emails sent to the same correspondent) and negative emotion word use as the dependent variable. The predictor variables were three main effect terms: current depression status, history of depression (major depressive disorder versus never depressed control), and correspondent closeness; and the 2-way interactions between correspondent closeness and current depression status and correspondent closeness and history of depression. Non-significant fixed effect terms were removed from the model one by one with the resulting models estimated using maximum likelihood estimation. The final model was estimated using restricted maximum likelihood estimation.

Table 4 shows the final regression model. As Table 4 indicates, participants (regardless of depression status) used more negative emotion words with correspondents to whom they felt closer. Additionally, a significant interaction effects emerged between current depression status and closeness of relationship. Figure 1 displays the mean percent of negative emotion words used in emails to correspondents at each of the seven possible closeness scores. These means were aggregated first within participant and then within group (currently depressed, remitted, and never-depressed). As Figure 1 shows, currently depressed participants tended to use more negative emotion words with

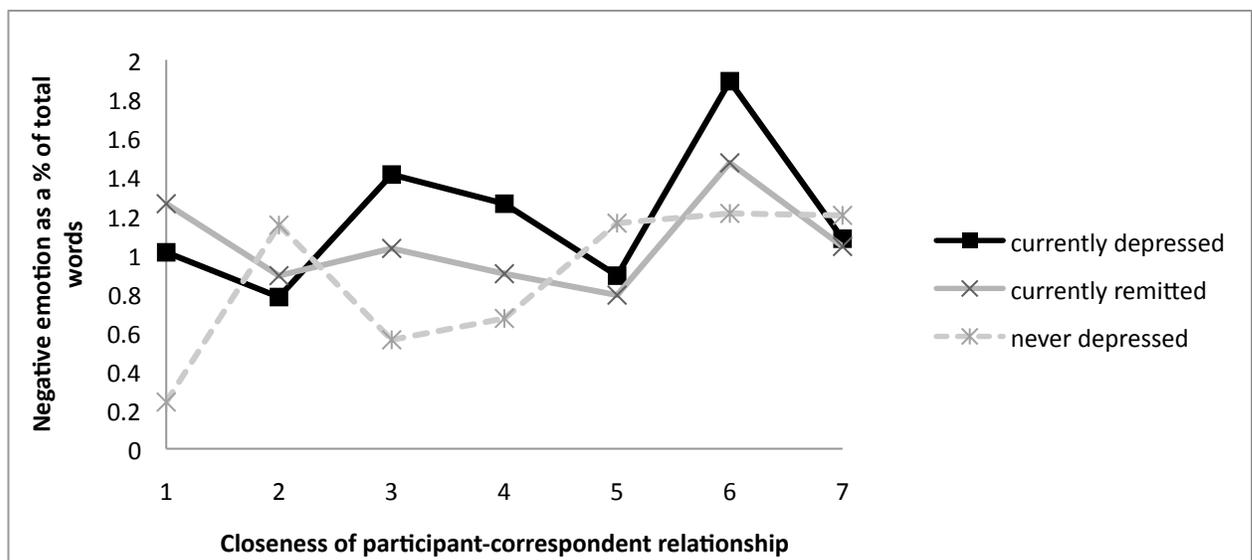
correspondents with whom their relationship was closer. This pattern did not hold for participants who were either remitted or never-depressed.

Table 4. Multilevel Linear Regression Predicting Negative Emotion Word Use from Depression Status and Participant-Correspondent Relationship Closeness.

Variable	beta	df	t	p
Current depression status (depressed or not)	.03	6754	-1.57	.11
History of depression (MDD vs control)	-.11	253	-2.65	.01
Closeness of relationship	.03	253	2.33	.02
Current depression*Closeness of relationship	.02	6754	2.13	.03

*Note.* The “beta” column shows standardized betas.

Figure 1. Negative emotion language use as a function of depression status and correspondent closeness.



## **IS COMMUNICATION STYLE ASSOCIATED WITH RESIDUAL SYMPTOMS AND SOCIAL SUPPORT?**

Two regression models tested whether frequency and content of email communication predicted later psychological and social adjustment. One regression model had residual depressive symptoms as the outcome variable; the other had social support as the outcome variable.

The number of months since the last depressive episode varied considerably between individuals in the major depressive disorder group. Given that people with more recent episodes may have more residual symptoms and less social support, the number of months since the last episode was a predictor variable in step one of each regression model. The presence or absence of suicidal ideation during the most recent episode was treated as an approximate indicator the severity of symptoms during that episode (see Uebelacker, Strong, Weinstock, & Miller, 2010). To control for the effects of symptom severity during the episode on symptom severity after the episode, suicidal ideation during the episode was included as a predictor variable in step one of the regression predicting severity of depressive symptoms after the episode. In both models, number of sent emails, word count, first-person singular pronoun use, negative emotion word use, positive emotion word use, and LSM scores from both the depressed and the remitted periods were additional predictor variables. For each regression model, step two variables with non-significant coefficients were eliminated one by one from the model to arrive at a final model.

**Predicting residual symptoms from e-mail communication.** The regression model with CESD as the outcome variable included months since the most recent depressive episode and severity of the most recent depressive episode (indexed by suicidal ideation during that episode). As table 5 shows, individuals who had been remitted for longer had milder residual symptoms and individuals whose last depressive

episode was more severe had more severe residual symptoms. The step one model explained 36% of the variance,  $F(2, 13)=3.70$ ,  $p=.05$ . Adding first person singular pronoun use significantly improved the model,  $R^2$  change=.45,  $F$  change (1,12)=28.06,  $p<.001$ . The final model explained 81% of the variance in CESD,  $F(3, 12)=16.90$ ,  $p<.001$ . These results suggest that individuals who use more first-person singular pronoun during their depressive episodes have higher levels of residual symptoms afterwards, even controlling for the severity of their symptoms during the episode. Appendix B shows partial correlations between CESD and all of the features of email communication originally entered into the model as predictor variables, controlling for time since the depressive episode and suicidal ideation during the episode.

Table 5: Linear Regression Predicting Depressive Symptoms from E-mail Communication.

Variable	<i>r</i>	<i>B</i>	<i>SE</i>	beta	<i>t</i>	<i>p</i>
Months since episode	-.35	-.33	.07	-.59	-4.45	.001
Suicidal ideation	.39	5.13	2.03	.34	2.52	.027
First person singular during depression	.67	3.22	.61	.71	5.30	.001

*Note.* *r*s are simple correlations between each dependent variable and CESD score. The “b” column shows unstandardized betas. The “beta” column shows standardized betas.

**Predicting social support from e-mail communication.** In the regression model with social support as the outcome, step one included only months since the episode; this model did not significantly predict social support,  $F(1,14)=2.95$ ,  $R^2=.17$ . Including LSM during remission and word count during remission in step two significantly improved the model,  $R^2$  change =.45,  $F$  change = 7.23. As table 6 shows, individuals who had higher

LSM and higher word count during remission also had higher social support after their most recent depressive episode. The final model significantly predicted social support  $F(12)=6.68$   $p=.007$ ,  $R^2=.63$ . Appendix B shows partial correlations between social support and all of the features of email communication originally entered into the model as predictor variables, controlling for time since the depressive episode.

Table 6. Linear Regression Predicting Social Support from E-mail Communication.

<b>Variable</b>	<i>r</i>	<i>B</i>	<i>SE</i>	<b>beta</b>	<i>t</i>	<i>p</i>
Months since episode	.41	.29	.17	.33	1.76	.10
LSM during remission	.63	121.40	48.31	.47	2.51	.03
Word count during remission	.47	.17	.07	.42	2.31	.04

*Note.* *r*s are simple correlations between each independent variable and social support. The “b” column shows unstandardized betas. The “beta” column shows standardized betas.

#### **OTHER RELEVANT ANALYSES.**

Exploratory multi-level regression analyses similar to those described in previous sections tested whether correspondent closeness was associated with social disengagement (number of messages sent per month, word count, and language style matching) or aspects of disclosure other than negative emotion (first-person singular pronoun use, positive emotion word use), and whether such associations differed depending on current depression status and/or the presence of major depressive disorder. No significant main effects of closeness emerged, nor did any significant interaction effects of closeness x current depression status or closeness x presence or absence of major depressive disorder.

Additionally, exploratory correlation analyses examined associations among the six main dependent variables (word count, first person singular pronouns, positive emotion words, negative emotion words, language style matching and e-mail frequency) separately for never-depressed controls, currently depressed individuals with major depressive disorder, and currently remitted individuals with major depressive disorder (see Appendix B).

## **Discussion**

The first aim of the current study was to assess whether depression is related to social disengagement and/or disclosure of distress in everyday e-mail communications with friends, family, and romantic partners. The second aim was to assess whether disclosure and/or disengagement were associated with residual symptoms and social support after a depressive episode.

### **RETHINKING SOCIAL DISENGAGEMENT**

The results suggest that when people are depressed, they engage differently with their social contacts than they do when remitted. Contrary to the disengagement model's predictions, individuals with major depressive disorder emailed more frequently during a depressive episode than when remitted. The finding that individuals do not withdraw from day-to-day interactions with others is consistent with other studies of everyday behavior (e.g., Nezlek et al., 1994, 2000). However, this is the first study to find an increase in social contact. It may be that depressed individuals are preferentially turning to email as a medium through which they can reach out to others without expending as much effort as they would in face-to-face or phone conversations.

Despite the increased frequency with which individuals reach out to others (via email) during a depressive episode, they show less language style matching with their correspondents than they do when they are remitted. This suggests that they are less engaged with and less attuned to their interaction partners. Remember that mimicry in general and language style matching in particular is associated with smoother interpersonal interactions and greater interpersonal liking, and that depression is associated with less rewarding social interactions. Decreased language style matching

during depression may both reflect and perpetuate social interactions that are less rewarding for both partners.

The current findings suggest that interpersonal engagement during remission predicts social support more strongly than interpersonal engagement during depression. Individuals who wrote longer e-mails and had higher levels of language style matching with their social contacts while remitted reported more social support after their most recent depressive episode. Studies of social behavior have typically taken communication length as an indicator of social effort and involvement (Segrin, 2000). Others may reward and welcome an individual's efforts at reaching out socially when he or she is not actively depressed.

The finding that higher language style matching during remission predicts higher social support afterwards is consistent with previous research in which depressed individuals' ability to attune nonverbally to an interviewer predicts better social outcomes (Bos et al., 2007). It is interesting, however, that language style matching during depression does not predict social support after an episode (although note that the effect, though non-significant, was in the same direction; see Appendix D). It may be that language style matching indicates somewhat different (and socially healthier) processes during remission than they do during depression. Despite broad associations between LSM and liking, LSM is better understood as an indicator of attunement rather than valence of interactions. Individuals may have high LSM when are engaged in conflict situations (Ireland & Pennebaker, 2010). It is possible that LSM during remission reflects largely positive engagement, whereas LSM during depression reflects some amount of conflict as well as positive engagement between interaction partners.

## **SELF-FOCUSED COMMUNICATION IS ASSOCIATED WITH CURRENT DEPRESSION AND FUTURE SYMPTOMS**

Individuals with major depressive disorder used first-person singular pronouns more frequently when depressed than they did when remitted, suggesting a higher level of self-focused attention. This is consistent with the established association between self-focused attention and depression (see Mor & Winquist, 2002, for a review). Additionally, individuals who used more first-person singular pronouns while depressed had significantly higher levels of residual symptoms afterwards, even controlling for symptom severity during the episode and time elapsed since the episode. Note that first-person singular pronoun use during depression was not associated with social support. First-person singular pronoun use during depression may indicate a process that is largely intrapersonal (e.g., rumination). It is interesting to note that the use of first-person singular pronouns during remission was not associated with residual symptoms. It may be that self-focused communication in the context of a more euthymic mood does not reflect the depression-maintaining process of rumination (a focus on one's current misery and the reasons for it) and is therefore less toxic.

## **EMOTIONAL DISCLOSURE OR CONCEALMENT?**

Contrary to the disclosure hypothesis, individuals with major depressive disorder communicated less negative emotion and marginally more positive emotion than never-depressed controls. Additionally, individuals with major depressive disorder, whether currently depressed or not currently depressed, used more positive emotion words than controls. One explanation for these findings is that individuals with major depressive disorder are trying to sound positive and avoid sounding negative in order to avoid overdrawing their social contacts' reserves of sympathy (Clark, 1987).

Currently-depressed individuals' greater selectivity in negative emotional disclosure (compared to remitted and never-depressed individuals) suggests that they are both relying more heavily on closer correspondents for support. It may also indicate that they are more attuned to the potential social drawbacks of disclosing negative emotion to the more distant members of their social networks, and are more carefully concealing their negative feelings from these correspondents. An alternate explanation is that the sharing of negative emotions reflects process through which closeness developed, rather than an existing level of closeness dictating the extent to which negative emotions are shared. However, given that participant-correspondent relationships were generally long-standing (the average relationship length was a decade), it is likely that existing levels of closeness played a large role in shaping the sharing of negative emotions.

#### **LIMITATIONS**

The current study's small sample size limits the precision of parameter estimates as well as its power to detect effects. Thus, the current results represent a conservative test of differences in language use between depressed individuals and normal controls. Additionally, given that the sample included women only, it is unclear how much the results would generalize to men. Finally, people's email communication may differ in important ways from their face-to-face communication, so caution is recommended in generalizing the current findings to face-to-face communication.

Another limitation was that although the e-mail data spans a year for each participant, the self-report data was only collected at one time point after the year of e-mail correspondence. This means that we did not have CESD or social support scores from before and during the most recent depressive episode. Although we were able to use suicidal ideation during the depressive episode as a marker of depressive symptom severity, this is a more approximate marker of severity than a CESD score would be.

## **IMPLICATIONS**

The current study is one of the few to examine the real-world social communication patterns of depressed individuals. As such, it provides unique insights into how depressed people communicate with people that are important in their lives – friends, romantic partners, and family members. These are the relationships that are sources of social support as well as interpersonal stress in depressed individuals' lives. Insofar as depressed individuals' social behavior plays a role in generating interpersonal stress and perpetuating their depression (Hammen, 2006), it is in these relationships that we would expect the action to be happening.

The findings have clinical implications. Assuming that first-person singular pronoun use is indeed an index of self-focused attention, the finding that first-person singular pronoun use predicts residual symptoms even when controlling for depressive episode severity suggests that self focused attention can perpetuate depression, which in turn suggests the need for interventions aimed at reducing self focused attention. Additionally, the findings suggest that people prone to depression who also attend more to their social contacts during remission perceive higher levels of social support. The directionality of this effect is not clear, however. It is possible that greater attention to one's social contacts during remission promotes more social support, but it may be that those who perceive more social support are more likely to reach out to their contacts during remission.

This study presents a novel method for assessing everyday social communication and how it changes over the course of time. For many individuals, their e-mail archives contain records of a substantial percentage of their communications with the people in their lives. Participants in the current study reported that about one quarter of their interactions with their selected correspondents occurred over email. E-mail archives

enable researchers to study how social communication changes over time or in relationship to major life events. In the current study, the life event under question was a major depressive episode. The method's promise is quite broad, however: it could be used to explore changes in the social worlds of people undergoing almost any other life event.

Future work will pursue further questions in the current data set. Analyses in the current dissertation treated all time periods during which individuals with major depressive disorder were not depressed as "remitted" periods, which may have masked meaningful differences between communication during before versus after a depressive episode.

Additionally, future analyses could examine how frequently correspondents are responding to currently depressed, remitted, and control individuals; examining differences in communication frequency and content in correspondence with family, friends, and romantic partners; and exploring how language changes over time within a depressive episode or remission). Additionally, the current results point to the usefulness of expanding the scope of the project as well as examining email interaction in other populations.

## **Appendix A: Procedures for preparing the database of e-mail messages**

### **PROCEDURE FOR COLLECTING E-MAILS**

Participants all used one of the major webmail providers (hotmail, gmail, or yahoo) as their primary email account. The Microsoft Outlook program was used to download copies of participants' sent and received e-mails from their webmail accounts. Next, e-mails were exported into a Microsoft Access database. For each participant, we needed to select only e-mails between the participant and up to 10 designated correspondents over the course of one year. Each participant deleted e-mails in the access database that were sent or received before or after the target year. Using a program developed for this project, a new database containing only e-mails to and from up to 10 selected correspondents was generated. This program compiled a list of all of the e-mail addresses in the database in order of the number of messages involving (sent to or received from) that e-mail address. Next to each e-mail address the program listed the total number of messages either sent to or received from that address. Participants selected all e-mail addresses belonging to each of their correspondents and to themselves and indicated which e-mail addresses belonged to the same correspondent. The program then created a new database that contained only messages sent to or received from the selected e-mail addresses, and that had anonymous identifiers in place of actual e-mail addresses (e.g., "[joesmith@gmail.com](mailto:joesmith@gmail.com)" became "correspondent 1").

### **PROCEDURE FOR REFINING THE DATABASE**

After the database was constructed, some e-mails still had to be deleted to make sure that the database was limited to messages between the participant and her selected correspondents, for which either the participant or a selected correspondent was one of

the primary recipients. Thus, messages sent from the participant to herself and no one else were deleted. Messages to the participant from a correspondent were deleted if the participant was on the “cc” list rather than the “to” list, as these messages were determined to be not primarily intended for the participant. Similarly, messages from the participant were deleted if none of the selected correspondents was on the “to” list even if one or more correspondents was in the “cc” list.

Most messages from participants (92.6%) were sent to only one recipient. Messages that were to multiple correspondents only one of whom was in the participant’s selected list of correspondents were assigned as being to the one recipient who was one of the (up to 10) designated correspondents. Messages that were to only one person who was in the correspondent list, and CCed to at least one other person in the correspondent list were assigned as being to the person in the to list. When messages had more than one correspondent in the “to” list, they were assigned to the correspondent who was listed closest to the front of the list.

#### **PREPARING THE EMAIL TEXTS FOR ANALYSIS**

E-mails downloaded into Outlook and then into Access still had information (headers, footers, forwarded content, and previous messages) that had to be deleted before processing the content of the message. Because SMTP headers and footers differ between e-mail systems, this process could only be semi-automated. For each email address, it was necessary to identify the basic format of the e-mail headers (e.g., the time stamp), footers (e.g., “sent from my iphone”), forwarded content, and the content of previous messages. After identifying the formatting of these types of content, it was possible to write macros in visual basic to remove all these pieces of information so that only the content that the sender wrote remained in the texts that were submitted for analysis.

## Appendix B: Correlations among frequency of and language use in e-mail communications

### CORRELATIONS AMONG FREQUENCY OF AND LANGUAGE USE IN E-MAIL COMMUNICATIONS: NEVER-DEPRESSED CONTROLS.

	Word count	First person singular pronouns	Positive emotion words	Negative emotion words	Emails/ month	Language style matching
Word count		-.03	.52*	.16	-.19	-.12
First person singular pronouns			-.29	-.12	-.23	-.27
Positive emotion words				.16	-.28	-.27
Negative emotion words					.09	-.12
Emails/month						.53*
Language style matching						

*Note.* Correlations are calculated from means of emails aggregated first within correspondent and then within participant. First person singular, posemo, negemo, and LSM are calculated only from emails at least 10 words long. \* indicates  $p < .05$

**CORRELATIONS AMONG FREQUENCY OF AND LANGUAGE USE IN E-MAIL COMMUNICATIONS: INDIVIDUALS WITH MAJOR DEPRESSIVE DISORDER.**

	<b>Word count</b>	<b>First person singular pronouns</b>	<b>Positive emotion words</b>	<b>Negative emotion words</b>	<b>Emails/month</b>	<b>Language style matching</b>
Word count		-.29	-.09	.06	.01	.41
First person singular pronouns	-.23		.17	.06	-.09	-.44
Positive emotion words	.49	.19		.13	-.10	-.36
Negative emotion words	-.18	.18	-.22		-.15	-.29
Emails/month	-.22	-.22	-.00	-.19		.43
Language style matching	.03	.20	.49	-.44	.60*	

*Note.* Correlations are calculated from means of emails aggregated first within correspondent and then within participant. First person singular, posemo, negemo, and LSM are calculated only from emails at least 10 words long. Correlations for the depressive episode are above the diagonal; those for the remitted period are below the diagonal. \* indicates  $p < .05$

## **Appendix C: Do depressed people communicate differently with people who know about the depression than with people who do not know?**

Exploratory analyses assessed whether depressed people communicate differently with people who know about their depression and with people who don't know about their depression, and whether these differences depend on whether the participant is currently depressed. Here, multilevel regression analyses were conducted within the major depressive disorder group only, with controls excluded. Each communication variable (word count, first person singular, negative emotion, positive emotion, language style matching, and e-mails per month per correspondent) was a dependent variable in its own analysis. Independent variables were current depression status, correspondent knowledge of depression, and their interaction. For analyses in which a message level variable was the most basic unit of analysis (word count, first person singular, negative emotion, and positive emotion) correspondent ID was included as a random intercept. In these analyses, messages were assigned weights inverse to the number of messages from each participant within each time period (depression vs remission) to each group of correspondents (those who knew about the depression vs those who didn't know). In this way, each participant's messages within a given time period to a given group of correspondents was given equal weight in the analysis. For analyses in which a correspondent-level variable was the most basic unit of analysis (language style matching and number of e-mails per month per correspondent) participant ID was included as a random intercept. As the table below shows, participants with major depressive disorder used more negative emotion words with people who knew about their depression than with people who did not, regardless of current depression status. The relationship between correspondent knowledge of depression and language use is very similar to that between correspondent closeness and language use.

**FREQUENCY OF AND LANGUAGE USE IN E-MAIL COMMUNICATION AS A FUNCTION OF DEPRESSION STATUS AND CORRESPONDENT KNOWLEDGE OF DEPRESSION.**

	<b>MDD</b>				<b>Control</b>
	<b>Depressed</b>		<b>Remitted</b>		
	<b>No</b>	<b>Yes</b>	<b>No</b>	<b>Yes</b>	
<b>Correspondent knowledge of depression</b>					
Word count	85.86 (72.72)	58.20 (34.31)	76.24 (39.25)	57.73 (40.90)	71.68 (53.60)
First person singular pronouns	6.51 (2.55)	6.94 (2.04)	6.23 (1.36)	6.46 (1.58)	6.44 (1.61)
Negative emotion words	1.27 (.67) <sup>a</sup>	1.18 (.76) <sup>b</sup>	1.09 (.50) <sup>a</sup>	1.20 (.49) <sup>b</sup>	1.11 (.54)
Positive emotion words	5.23 (1.66)	4.59 (1.11)	5.42 (1.08)	5.02 (1.55)	4.60 (.93)
Language style matching	.77 (.11)	.76 (.12)	.78 (.16)	.80 (.04)	.77 (.08)
Emails/month/correspondent	3.22 (3.09)	4.40 (4.56)	.209 (1.42)	3.98 (3.67)	2.46 (4.16)

*Note.* Numbers for first-person singular pronouns, negative emotion words, positive emotion words, and language style matching are means (standard deviations) calculated from e-mails at least 10 words long. Numbers for word count and e-mails per month per correspondent are means (standard deviations) calculated from all e-mails regardless of word count.

Means for word count, first-person singular pronouns, negative emotion words, and positive emotion words were calculated from messages averaged within participant. Means for language style matching and number of e-mails per month

were averaged first within correspondent and then within participant. Given the correlation between LSM and number of emails sent and received, language style matching scores were computed controlling for number of emails sent between participant and correspondent.

There were two outliers in the distribution of numbers of e-mails sent per month per correspondent. One was from a participant who sent a very high number of e-mails during remission to correspondents who knew about the depression; the other was from a different participant who sent a very high number of e-mails during the depressive episode to correspondents who knew about the depression. Prior to calculating and presenting descriptive and inferential statistics that describe the central tendencies of the sample, these two outliers were reduced in size to two standard deviations above the mean. The reduction in the size of these outlying datapoints did not change the direction of the results.

Means in the same row with different superscripts are different at  $p < .05$ .

**Appendix D: CESD and social support as a function of frequency of,  
and language use in, e-mail communication**

	<b>CESD</b>	<b>Social support</b>
Word count during depression	.08	-.43
Word count during remission	-.31	.55*
First person singular during depression	.84**	-.12
First person singular during remission	.28	.56
Negative emotion during depression	.26	.18
Negative emotion during remission	.53	-.28
Positive emotion during depression	.21	.41
Positive emotion during remission	-.11	.34
Language style matching during depression	-.24	.23
Language style matching during remission	-.12	.59*
E-mails sent per month during depression	.26	-.05
E-mails sent per month during remission	-.00	.10

*Note.* Figures represent partial correlations controlling for time since the depressive episode. \* indicates  $p < .05$ ; \*\* indicates  $p < .001$ .

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