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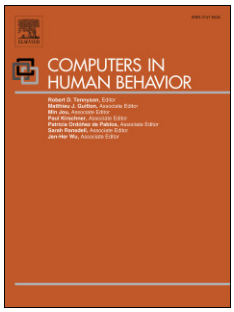

The influence of depression and personality on social networking

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The Influence of Depression and Personality on Social Networking

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Abstract

Established literature supports the notion that depressed individuals tend to be socially maladjusted and behave differently from those who aren't depressed. Yet, previous studies seem to overlook the influence of personality on behavior. Particularly, neuroticism may moderate the effect of depression on the way people behave. As one of the Big-Five factors of personality, neuroticism refers to a trait of one's capability to control emotional distress. Based on behavioral data from 393 Facebook users, current research demonstrates the interaction between depression and personality. Users engaged in activities at different levels of activities corresponding to their depression levels. Further, the effect of depression on social networking was regulated by personality: once neuroticism exceeded certain points, an increase in depression led to a decrease in social networking activities.

Keywords: Depression, Neuroticism, Personality, Online Behaviors, Social Networking Services (SNSs)

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Abstract

Established literature supports the notion that depressed individuals tend to be socially maladjusted and behave differently from those who aren't depressed. Yet, previous studies seem to overlook the influence of personality on behavior. Particularly, neuroticism may moderate the effect of depression on the way people behave. As one of the Big-Five factors of personality, neuroticism refers to a trait of one's capability to control emotional distress. Based on behavioral data from 393 Facebook users, current research demonstrates the interaction between depression and personality. Users engaged in activities at different levels of activities corresponding to their depression levels. Further, the effect of depression on social networking was regulated by personality: once neuroticism exceeded certain points, an increase in depression led to a decrease in social networking activities.

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1. Introduction

Depression is a mental health problem that includes symptoms such as temporal depressed mood, feelings of guilt, worthlessness, hopelessness, helplessness, and loss of appetite (Hankin, Fraley, Lahey & Waldman, 2005; Radloff, 1977). Unlike temporal depressive symptoms, depression is a mental disorder that lasts for a relatively long period. Since it occurs throughout one's entire lifetime, depression not only severely impacts individuals, but also society in general.

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Accordingly, extensive research has focused on the way people with depression act and their tendencies in managing social relationships (De Choudhury, Counts & Horvitz, 2013; Hokanson, Rubert, Welker, Hollander & Hedeen, 1989; Libet & Lewinsohn, 1973; Moreno, Jelenchick, Egan, Cox, Young, Gannon & Becker, 2011; Park, Lee, Kwak, Cha & Jeong, 2013; Park, Kim, Lee, Yoo, Jeong & Cha, 2015; Tsugawa, Kikuchi, Kishino, Nakajima, Itoh & Ohsaki, 2015).

In particular, recent studies used social network services(SNSs), such as Facebook and Twitter, to identify users with depression by examining the linguistic features of the posts they uploaded (De Choudhury et al., 2013; Moreno et al., 2011; Neuman, Cohen, Assaf & Kedma, 2012), personal SNS usage (Park et al., 2013), and social interaction (Park et al., 2015; Tsugawa et al., 2015). Based on a "depression lexicon," Neuman et al. (2012) showed promising results automatically screening for depression in texts uploaded to web blogs. Also, considering that 25% of posts uploaded by college students on Facebook contain textual expressions signaling depression (Moreno et al., 2011), there is a high possibility that symptoms of depression can be observed in SNSs via users' behaviors within the network (De Choudhury et al., 2013; Tsugawa et al., 2015). Among various SNSs, Facebook is most widely used with more than one billion users and is relatively more relationship-focused than other services, showing dynamic social interaction (Burke, Kraut & Marlow, 2011; Ryan & Xenos, 2011). Therefore, this study takes a special interest in observing the effects of depression on communication behaviors on Facebook.

Research Question 1. How does the mental state of depression affect users' communication activities?

It was found that users with depression were more likely to post new status updates actively than those who did not show any reference to depression (Moreno et al., 2011). In their study, Moreno et al. (2011) determine the prevalence of depressive symptoms displayed in status updates by counting keywords or synonyms used in each post. Also, Park et al. (2015) discovered that wall-posting activities in diverse forms, such as texts, photos, and links, become more prevalent for the more depressed individuals. It has been suggested that the result may be due to the depressed user's effort to compensate for loneliness in the offline world through online activities (Park et al., 2015). Why users keep uploading posts, even when they don't intend to directly communicate with specific people, i.e. broadcasting, can be further explained by "self-disclosure." Self-disclosure is a construct defined as any message about an individual that he or she communicates to another along multiple dimensions, e.g. honesty, amount, valence, and depth (Cozby, 1973). While the majority of research on self-disclosure has focused on its effect on dyadic relationship development and on comparing the effects between face-to-face and computer-mediated settings (Gibbs, Ellison & Heino, 2006), not much has been explored on why individuals may show such disclosing behaviors. The necessity to examine self-disclosure behaviorally as a dependent variable was also emphasized by Cozby (1973).

One possible explanation for why users with depression engage in such Facebook activities can be obtained by investigating the relationship between mental health and self-disclosure. Those with maladjustment tend to exhibit either high or low disclosure to virtually everyone in their network, deviating from the expected norm (Cozby, 1973). Bonetti, Campbell & Gilmore (2010) suggested those who reported being lonely tended to use online communication more frequently in order to fulfill needs of social interactions, self-disclosure, and identity exploration. Moreover, De Choudhury et al. (2013) discovered that those suffering from depression turn to SNSs to simply share their feelings, receive social support, or to express feelings of helplessness and insecurity. The tendency indicates that users also express their thoughts or emotional states

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on SNSs publicly, without communicating with a designated partner. Other than in the context of relational development, self-disclosing behaviors are also exhibited in the context of self-promotion and narcissism. People with depression revealed increased use of first-person singular pronouns, and further, the usage of pronoun "I" can differentiate between the depressed and the non-depressed (Rude, Gortner & Pennebaker, 2004). Particularly on Facebook, narcissistic self-disclosures are mostly found in broadcasting activities, such as status updates and self-generated wall posts, which do not directly target certain users but are intended to be shown to one's entire network (Ryan & Xenos, 2011). Thus, the current study expects that the more a user is depressed, the more the user will employ broadcasting activities (RQ1-H1).

Hypothesis 1: Users with more severe depression will engage in more frequent broadcasting activities than those with less severe depression.

However, directed-communication behaviors appear to demonstrate different tendencies. In the case of emitted behaviors in small groups, i.e. outbound activities, depressed people carried out far fewer actions than the non-depressed (Libet & Lewinsohn, 1973). The reduced level of social activity appears to be a rather stable characteristic of those who have ever experienced depression (Rottenberg & Gotlib, 2004). A study comparing users with depression and without depression on Twitter observed that those with depression replied to others less than the non-depressed (De Choudhury et al., 2013). Park et al. (2015) discovered that the more severe the depression, the less users uploaded posts on others' walls or left comments on others' posts. Even at the aggregate level, depressed users wrote fewer posts and comments responding to the posts of others than the non-depressed (Park et al., 2015).

The reluctance, or possibly inability, to interact directly with others can be partially explained by "unwillingness-to-communicate" (Burgoon & Burgoon, 1974; Burgoon, 1976). The construct is strongly supported by established literature on anomie, alienation, introversion, self-esteem, and communication apprehension (Burgoon, 1976). Anomia(0.45), alienation(0.41), and communication apprehension(0.43) showed particularly high correlations with unwillingness-to-communicate, and the three in combination explained 35% of the variance in unwillingness-to-communicate (Burgoon & Burgoon, 1974). Anomie is described to have symptoms of feeling insecure, powerless, alone, and viewing life as meaningless (Burgoon, 1976), which are similar to depression. Depression and anomie share not only similar symptoms but also share similar measures (Bloom, 1970; Roberts, 1980). Jin (2013) also demonstrated that those who feel lonely tend to participate less in both initiative and responsive communication activities. Therefore, the current study predicts that the more a user is depressed, the less the user will practice outbound activities, i.e. directly communicating with designated others (RQ1-H2).

Hypothesis 2: Users with more severe depression will engage in less frequent outbound activities (a. likes, b. comments, c. tags) than those with less severe depression.

While most of the prior work on depression investigated the behavior of depressed people, Coyne (1976) proposes an alternative approach of observing a counterpart's response to the depressed. Also, in the case of Facebook, the depressed received fewer likes and comments on their posts than the non-depressed (Park et al., 2015). Coyne (1976) observed that after interacting with depressed individuals, counterparts felt more depressed, anxious, and hostile. In addition to such negative experiences, partners were more likely to reject communicating with those depressed persons in the future (Coyne, 1976). The low enjoyability of interacting with individuals

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with depression and future reluctance to do it again may be due to the frequent usage of negative words by the depressed (De Choudhury et al., 2013; Tsugawa et al., 2015), their deficient or problematic social behaviors (Hokanson et al., 1989; McLaughlin & Vitak, 2012), the contagion of negative mood (Bastiampillai, Allison & Chan, 2013), and reciprocity in social interchange (behaviors eliciting less because the depressed emitted less) (Libet & Lewinsohn, 1973). Thus, the current study expects that the more a user is depressed, the less the user will obtain inbound activities, i.e. directly receive designated interactions from others (RQ1-H3).

Hypothesis 3: Users with more severe depression will be given less frequent inbound activities (a. likes, b. comments, c. tags) than those with less severe depression.

Yet, the speculation that people with a certain mental disorder, e.g. depression, will all act uniformly in a certain way may be overlooking personality factors. The idea seems to be assuming that the depressed are incapable of controlling their emotion and behaviors. However, according to Kokkonen & Pulkkinen (2001)'s observation on longitudinal data, the personality of an individual affects his or her emotion regulation. In particular, neuroticism led to dysregulation of emotion (Kokkonen & Pulkkinen, 2001; Fournier, Chase, Greenberg, Etkin, Almeida, Stiffler, Deckersbach, Weyandt, Cooper, Toups, Carmody, Kurian, Peltier, Adams, McInnis, Oquendo, McGrath, Fava, Weissman, Parsey, Trivedi & Phillips, 2016). Neuroticism is a personality trait associated with vulnerability of emotional distress, and neurotics are inclined to be hot-tempered, worrying, and tense (McCrae, 2002; Roberts, Walton & Viechtbauer, 2006). Other studies showed similar findings with neurotics. Slessareva & Muraven (2004) discovered that neuroticism is negatively correlated with self-control. Also, Larsen & Ketelaar (1991) demonstrated that neurotics display more negative responses than those with stable personality, and such tendency was more prominent in situations where a negative mood was induced. Further, Fournier et al. (2016) observed neural evidence for understanding how personality dysfunction, i.e. neuroticism, is associated with differential responses to treatments for depression; yet, a direct interaction between neuroticism and depression has not been addressed in the study. Hence, the current study anticipates that the effect of depression on communication behaviors will be moderated by the personality trait of neuroticism, and aims to explore the interaction between depression and neuroticism with the following second research question.

Research Question 2. How does neuroticism moderate the effect of depression on each of users' *1. broadcasting activities, 2. outbound activities,* and *3. inbound activities*?

2. Method

Facebook automatically stores all activities of every user in a traceable format as log data. For example, how many likes or comments a user gave to a friend's particular post is all recorded and kept in the system. Hence, researchers gain the opportunity to observe unobtrusive data. Recently, extensive research has been utilizing such unobtrusive data by automatically collecting, i.e. "crawling," and analyzing massive user data (Bachrach, Kosinski, Graepel, Kohli & Stillwell, 2012; Park et al., 2015). In order to take advantage of such unobtrusive data, two procedures were employed; data crawling and survey. First, data on user profiles and activity behaviors on Facebook are crawled through a web application. Second, two surveys are conducted in order to measure depression and neuroticism, respectively. The current research was formally approved by the Institutional Review Board(IRB) in advance.

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2.1. Participants

Participants were limited to Facebook users and were recruited from online channels using the snowballing technique. With a short description of the research, recruiting messages were initially posted on the researchers' Facebook timeline. The message included a link that led participants to the web application, a website where user data is crawled, and the survey is conducted. Further details were provided on the website, with an explanation of the usage of their crawled personal data and survey results. Participants were asked to grant permission to access their data and to participate in the study. A quote asking to share the post was also attached to the message. 393 participants in total agreed to data access and finished both surveys. 45.3% (N=178) were male, while 60.5% (N=238) were in the age between 21 and 30.

2.2. Procedure

To collect participants' Facebook activity behaviors (data crawling) and responses (survey), a web application using Facebook API was created. The application was built with Ruby on Rails in the form of a website. When participants sign in to the application with their Facebook account, permission to collect their profile information and activity data is requested. Once they agree, access tokens of each participant were stored automatically since those are necessary for data collection. Next, participants answered surveys on both depression and neuroticism.

2.2.1. Data crawling

Once a participant grants permission for data collection, the web application collects data from the participant's Facebook user account by using the access tokens of each participant. Specifically, the application accesses information on the user profile and activity data on Facebook through the account. Activity data of the participants for the last 10 weeks were crawled. Thus, participants' activities were done 2-3 months before the surveys on depression and neuroticism were collected.

Though a gap exists between the time of behavior and emotion, it can be inferred that participants had maintained almost the same level of depression for the last few months, considering that depression is known to last for 4-6 months in average (Ahuja, 2006). Also, neuroticism does not easily change since it is a personality dimension, which become increasingly stable in adulthood (Caspi & Roberts, 2001). Hence, the depression and neuroticism scores measured at the current point could be inferred to represent the recent past as well. A number of prior studies on social media and psychological traits were also conducted under the same assumption. De Choudhury et al. (2013) examined the relationship between behavior in the past (Twitter data from 3 months before) and mental state at the present point. Also, other similar research were based on activity data 2 months before (Tsugawa et al., 2015) and 6 months before (Park et al., 2015) the time when psychological states were measured.

2.2.2. Survey

Participants who agreed to data collection are then asked to complete surveys measuring depression and neuroticism. When they complete both surveys, depression scores and neuroticism scores were provided in the last page. Participants could share the results on their Facebook timelines. To promote participation, a link to the web application was always included in the shared posts.

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2.3. Measures

Depression and neuroticism are measured through responses to the survey, and communication behaviors are measured based on the collected activity data.

2.3.1. Depression

The CES-D(Center for Epidemiologic Studies Depression) scale was adopted to measure the degree of depression and to screen depressive disorders. CES-D is a self-report inventory based on counting the number of depressive symptoms of an individual created by the American Psychiatric Association in the Diagnostic and Statistical Manual of Mental Disorders. The scale has been widely used in social science (Radloff, 1977; Roberts, 1980). Also, the questionnaire has been translated into Korean, and the validity of the Korean version has been verified in earlier studies (Cho & Kim, 1993).

The scale consists of 20 items, asking how often the participant experienced each of the symptoms identified in each item, during the past week. Frequency of the occurrence during the past week is measured by checking one of the four options; rarely or none of the time (less than 1 day), some or a little of the time (1-2 days), occasionally or a moderate amount of time (3-4 days), most or all of the time (5-7 days). Responses were weighted from zero to three according to the frequency of occurrence of the symptom. Thus, the score ranged from 0 to 60, with higher scores indicating more severe depression. Four items were reverse scored and the items used are listed in Table 1.

Table 1: CES-D items on depression

Number	Item	Scoring
1.	I was bothered by things that usually don't bother me.	(+)
2.	I did not feel like eating; my appetite was poor.	(+)
3.	I felt that I could not shake off the blues even with help from my family or friends.	(+)
4.	I felt that I was just as good as other people.	(−)
5.	I had trouble keeping my mind on what I was doing.	(+)
6.	I felt depressed.	(+)
7.	I felt that everything I did was an effort.	(+)
8.	I felt hopeful about the future.	(−)
9.	I thought my life had been a failure.	(+)
10.	I felt fearful.	(+)
11.	My sleep was restless.	(+)
12.	I was happy.	(−)
13.	I talked less than usual.	(+)
14.	I felt lonely.	(+)
15.	People were unfriendly.	(+)
16.	I enjoyed life.	(−)
17.	I had crying spells.	(+)
18.	I felt sad.	(+)
19.	I felt that people dislike me.	(+)
20.	I could not get 'going'.	(+)

2.3.2. Neuroticism

Neuroticism is measured by items available in the IPIP(International Personality Item Pool). According to Goldberg (Goldberg, 1999), because a majority of personality inventories (such as

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MMPI and NEO-PI) are often copyrighted by test authors and are mostly utilized on a one-time basis for commercial purposes, items are not updated from the initial version in many cases. Thus, Goldberg (1999) proposed a collaborative personality assessment measure, i.e. IPIP, that could be shared and revised by other researchers in public[1]. In measuring personality based on the Big-Five factors, the comparative performance of the IPIP scale suggested by Goldberg turned out to be more reliable and more predictive than other instruments, including the NEO PI-R, CPI, TCI, HPI, and the 16PF (Goldberg, 1999). Overall, the set of personality measurement items in the IPIP has been refined by many researchers, and the number of items has been increasing continuously (Goldberg, Johnson, Eber, Hogan, Ashton, Cloninger & Gough, 2006).

Nowadays, the IPIP contains a set of over 3,000 items. While various scales within the pool were developed and accumulated by many authors, the current study applies a scale based on NEO PI-R (NEO Personality Inventory-Revised). NEO PI-R is an instrument that measures the Big-Five Factors that underlie a personality (Costa & McCrae, 1992): Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. Both the Big-Five factors and the NEO PI-R scale were originally constructed by Costa & McCrae (1992) in addition to Goldberg's contribution. In their research, Costa & McCrae (1992) correlated their NEO PI-R with other major personality items and demonstrated that essentially all of the scales in existing personality questionnaires are related to the Five factors in NEO PI-R.

IPIP scales that represent NEO PI-R are further generated by identifying items that correlate highly with Costa and McCrae's NEO PI-R. A shorter version with 50-item and a longer version with 100-item scales are included. In this paper, the 20-item scale that indicates Neuroticism is adopted from the 100 items that measure the Big-Five factors ("5 Neo Domain"). The particular 20-item scale has the highest reliability (Cronbach's α=.91) among IPIP scales that measure neuroticism (Goldberg, 2008). In detail, half of the items in the scale are positively-keyed, and the other half are negatively-keyed (Table 2). Scores of each item are measured on a 5-point Likert scale, from 'extremely unlikely = 1' to 'extremely likely = 5.' The negatively-keyed items are all reverse-scored. The score ranged from 20 to 100, and those with higher scores are considered more prone to psychological distress.

2.3.3. Communication behaviors

Among the various activity log data that can be collected in Facebook, current research focuses on interaction behaviors between users. Burke et al. (2011) defines communication behaviors that are generalizable into three categories: broadcasting, directed communication, and passive consumption of social news. While broadcasting includes activities that do not directly target a particular person, directed communication refers to targeted activities that consist of one-to-one exchanges. Passive consumption of social news is the activity of simply reading others' posts. Based on the work of Burke et al. (2011), the current study focuses on the first two categories on Facebook; 'broadcasting' and 'directed communication.' Based on a factor analysis, Jin (2013) also detailed two similar types of activities on Facebook: 'presenting' and 'communicating' activities. Despite the idea that monitoring "other-generated content" may also influence a user's well-being (Chutikulrungsee, Burmeister, Al-Saggaf & Bhattacharya, 2016), passive consumption is excluded from current research since the behavior is not measurable by collecting log data and it does not necessarily require interaction between users.

As listed in Table 3, broadcasting is measured by the frequency of wall posts uploaded on each user's timeline, including status updates, posts with photos or links, and other shared posts.

[1] Available at http://ipip.ori.org

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Table 2: IPIP NEO-Domain items on neuroticism

Number	Item	Scoring
1.	Often feel blue.	(+)
2.	Dislike myself.	(+)
3.	Am often down in the dumps.	(+)
4.	Have frequent mood swings.	(+)
5.	Panic easily.	(+)
6.	Am filled with doubts about things.	(+)
7.	Feel threatened easily.	(+)
8.	Get stressed out easily.	(+)
9.	Fear for the worst.	(+)
10.	Worry about things.	(+)
11.	Seldom feel blue.	(−)
12.	Feel comfortable with myself.	(−)
13.	Rarely get irritated.	(−)
14.	Am not easily bothered by things.	(−)
15.	Am very pleased with myself.	(−)
16.	Am relaxed most of the time.	(−)
17.	Seldom get mad.	(−)
18.	Am not easily frustrated.	(−)
19.	Remain calm under pressure.	(−)
20.	Rarely lose my composure.	(−)

On the other hand, directed communication is defined by the frequency of the three most-used activity types for both outbound and inbound activities: likes, comments, and tags. Outbound activities are those conducted by a user toward particular others, specifically by pressing like or leaving comments on others' posts, writing posts on others' wall, or tagging others. In contrast, inbound activities are those obtained by a user directly from others, including likes or comments received on one's posts, posts left on one's wall, and getting tagged by others.

Table 3: Indicators of communication behaviors

Behavior	Indicator	Description
Broadcasting		
broadcasting	wall posts	uploaded by a user
Directed		
outbound	likes, comments, tags	from a user towards friends
inbound	likes, comments, tags	from friends towards a user

3. Results

3.1. Descriptive Analysis

As shown in Table 4, the mean score of depression is 15.96 (SD=12.63), while the median is 13. The first and third quartiles are 5 and 25, respectively. Though the cutoff score initially suggested by Radloff (1977) to classify the depressed and the non-depressed is 16 (between the range of 0 to 60), the recommended score differs in other research, e.g. 19 in Wada, Tanaka,

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Theriault, Satoh, Mimura, Miyaoka & Aizawa (2007) among Japanese at the workplace. Additionally, previous research demonstrates that the cutoff score of 16 on the CES-D significantly increases the number of individuals classified as depressed in the case of nonclinical samples (Roberts, Lewinsohn & Seeley, 1991; Santor, Zuroff, Ramsay, Cervantes & Palacios, 1995). A cutoff score of 25 was adopted in current study since this paper concerns Korean Facebook users, and for Koreans, it has been suggested that individuals with over 25 on the CES-D are assessed to be depressed (Park & Kim, 2011). In accordance with this benchmark, 25.4% (N=100) of the participants in this research are classified as individuals with depression. The proportion tends to be relatively high, considering that samples from other studies indicate proportions of the depressed between 8.7% and 21.2% in general (Park & Kim, 2011). Also, a large difference is found in the mean depression score between the depressed (M=33.81, N=100) and the non-depressed (M=9.87, N=293); a 23.94 degree difference.

Table 4: Descriptive analysis of depression and neuroticism

Variables	Mean	SD	Q1	Q2(Median)	Q3
depression	15.96	12.63	5	13	25
neuroticism	59.07	15.57	47	60	70

Neuroticism scores of participants imply a relatively moderate level of emotional stability and reaction to stress with a mean score of 59.07 (SD=15.57), and a median score of 60 (Table 4). The first and third quartiles were 47 and 70. In sequence, 20.1% of the participants scored below, 62.8% within (±1SD), and 17.1% above the the mean score[2]. The range of neuroticism scores from the sample of this study seems ordinary in that raw mean scores from previous research fall between 40 and 60 from samples across 36 different cultures (McCrae, 2002) and also from samples over six different age groups (age 20-100) (Terracciano, McCrae, Brant & Costa Jr., 2005).

Table 5: Descriptive analysis of communication behaviors

Variables	Mean	SD	Q1	Q2(Median)	Q3	Total Frequency
Broadcasting						
wall posts	33.52	57.24	3	13	39	13,174
Directed: outbound						
likes_out	387.28	662.71	65	190	438	152,200
comments_out	179.18	256.84	33	100	217	70,417
tags_out	46.7	121.83	0	11	40	18,354
Directed: inbound						
likes_in	167.86	436.86	8	54	147	65,970
comments_in	93.68	217.66	2	32	94	36,816
tags_in	53.08	74.76	10	30	59	20,862

Among the collected 377,793 interaction data points from users, the number of activities on wall posts, likes, comments, and tags amounted 13,174, 218,170, 107,233, and 39,216, respectively (Table 5). Overall, the activity data is not normally distributed. All of the broadcasting

[2]Division points are reported within the text along with the mean and the standard deviation since the data collected in current study shows a positively-skewed distribution rather than a normal distribution.

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and directed-communication behaviors are positively skewed. Specifically, the number of wall posts, representing broadcasting, has a mean of 33.52 (SD=57.24), with a median of 13 (Q_1=3, Q_3=39). In the case of directed communication, the data is classified as either outbound (sent to a friend) or inbound (received from a friend) for analysis. First, the summary of outbound activities is listed as discussed below. For each of the activities, the mean and the median of 1) likes sent to friends is 387.28 (SD=662.71) and 190 (Q_1=65, Q_3=438), 2) comments written to friends is 179.18 (SD=256.84) and 100 (Q_1=33, Q_3=217), and 3) tags mentioning friends is 46.7 (SD=121.83) and 11 (Q_1=0, Q_3=40), respectively. Second, inbound activities have 1) a mean of 167.86 (SD=436.86) and a median of 54 (Q_1=8, Q_3=147) for likes, 2) a mean of 93.68 (SD=217.66) and a median of 32 (Q_1=2, Q_3=94) for comments, and 3) a mean of 53.08 (SD=74.76) and a median of 30 (Q_1=10, Q_3=59) for tags.

Correlation coefficients between each variable and the others took a range of values from −0.12 to 0.91. The lowest dependence of −0.12 existed between neuroticism and the outbound activity of likes, i.e. likes_out. On the other hand, the highest dependence of 0.91 was found between the outbound activity of tags(tags_out) and the inbound activity of comments(comments_in). The correlation between depression and neuroticism was 0.70. Despite the relatively high dependence between depression and neuroticism, correlations between each of the two variables and each of the communication behaviors showed a different pattern. While depression had negative correlations only with likes, both sent to and given from friends, neuroticism showed negative correlations with all of the activities, regardless of the direction.

3.2. Effect of Depression on Communication Behaviors

To examine if behaviors of broadcasting (*H1*) and directed communication (*H2, H3*) vary depending on the level of depression (RQ1), a Poisson regression is conducted for each of the analyses. A Poisson regression is more appropriate than traditional methods, such as analysis of variance(ANOVA) and linear regression model(OLS; ordinary least squares), particularly when the distribution of data is positively skewed and many of the frequency data are zero (Nussbaum, Elsadat & Khago, 2008). To rule out any influence an individual's network size may have on the incidence of communication activities (Park et al., 2015), the number of each participant's friend is controlled. The result shows that the degree of depression has a significant effect on the broadcasting activity (*H1*), with those higher in depression level reporting more frequent broadcasting behaviors (β=0.0095, e^{β}=1.0095, p<0.001), supporting the hypothesis. More specifically, for a 1-point increase in the depression score, the number of broadcasting activities will increase by a factor of 1.0095. For example, if there is a 10-point difference in the depression score between two people, the number of broadcasting activities conducted by the individual with the higher depression score will increase by 9.92% (1.0095^{10}=1.0992), compared to the less depressed person.

In case of directed communication (*H2, H3*), the kind of activity itself appears to be more crucial than the direction. Both likes a user gave to (*H2a*) and received from (*H3a*) friends demonstrate statistically significant negative relationships with the stage of depression ($\beta = -0.0041$, e^{β}=0.9959, p<0.001 and $\beta = -0.0076$, e^{β}=0.9924, p<0.001 respectively), whereas comments a user wrote to (*H2b*; β=0.008, e^{β}=1.008, p<0.001) and received from (*H3b*; β=0.0121, e^{β}=1.0121, p<0.001) manifest significant positive relationships with depression. Similar to comments, results on tags show that depression has positive effects on the activities of a user tagging friends (*H2c*) and a user getting tagged from friends (*H3c*) with statistical significance (β=0.0073, e^{β}=1.0073, p<0.001 and β=0.0059, e^{β}=1.0059, p<0.001 in sequence). For an increase in depression, the number of comments and tags activities will increase while the number of likes

activities will decrease; regardless of the direction. Taken together, H2 and H3 are only partially supported.

To evaluate how neuroticism, a personality factor, moderates the effect of depression on communication behaviors (RQ2), a Poisson regression is used with the following equation [e1]:

$$[e1]\ \log(Y) = (\beta_{dp} + \beta_{dp\cdot neuro} \cdot neuro) \cdot dp + \beta_{neuro} \cdot neuro + \beta_0$$

In e1, *dp* refers to depression scores, *neuro* to neuroticism scores, and Y to communication activities. Coefficients for each of depression, neuroticism, and the interaction between the two are β_{dp}, β_{neuro}, and $\beta_{dp\cdot neuro}$ respectively, where β_0 is a constant. In order to evaluate the interaction effect between depression and neuroticism, both $\beta_{dp\cdot neuro}$ and β_0 are considered as constant. How neuroticism moderates the effect of depression on communication behavior is decided by β_{dp} and $\beta_{dp\cdot neuro}$·neuro. Thus, whether the slope ($\beta_{dp} + \beta_{dp\cdot neuro} \cdot neuro$) is positive or negative determines the direction of the depression effect. When the slope of depression is negative, an increase in the depression score will decrease communication activities. In contrast, when the slope of depression is positive, an increase in depression will also increase communication activities. Neuroticism scores at the turning point of the effect of depression can be computed by setting the slope at zero, i.e. $\beta_{dp} + \beta_{dp\cdot neuro} \cdot neuro = 0$. Significant interactions emerge between depression and neuroticism in every communication behavior (all *p<0.001*) as in Table 6.

Table 6: Interactions of depression and neuroticism

Communication Behaviors	β_{dp}	β_{neuro}	$\beta_{dp\cdot neuro}$	Turning Point of Neuroticism
Broadcasting				
wposts	0.0786^{***}	0.0055^{***}	-0.0010^{***}	79
Directed: outbound				
likes_out	0.0597^{***}	-0.0017^{***}	-0.0008^{***}	75
comments_out	0.0922^{***}	0.0045^{***}	-0.0012^{***}	77
tags_out	0.144^{***}	0.0092^{***}	-0.002^{***}	72
Directed: inbound				
like_in	0.1044^{***}	0.0033^{***}	-0.0016^{***}	65
comments_in	0.013^{***}	0.0096^{***}	-0.0018^{***}	72
tags_in	0.0803^{***}	0.0059^{***}	-0.0011^{***}	73

** p<.05, ** p<.01, *** p<.001*

First, the result of broadcasting activity (RQ2-1) indicates (β_{dp}=0.0786, $\beta_{dp\cdot neuro} = -0.001$) that when a user's neuroticism score is lower than 79, the user's depression score is positively related to the frequency of broadcasting activity. In contrast, when one's neuroticism score is higher than 79, the depression score negatively affects broadcasting activity. In other words, more severely depressed users will perform more broadcasting activities if they are more emotionally stable and less reactive to stress than (the level of) 79. However, the more depressed will do less broadcasting activities if they are more neurotic than 79. Second, results on outbound behaviors (RQ2-2) manifest similar patterns. Depression affects the outbound activity of giving likes in a positive direction if a user's neuroticism is lower than 75, but affects it in a negative direction if higher than 75 (β_{dp}=0.0597, $\beta_{dp\cdot neuro} = -0.0008$). In the case of the outbound activity of writing comments to friends, the turning point of the depression effect (from positive to negative) occurs when one's neuroticism score reaches 77 (β_{dp}=0.0922, $\beta_{dp\cdot neuro} = -0.0012$). Also, an increase in depression induces more frequent rates of the outbound activity of tagging friends until one's

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neuroticism score hits 72. However, once neuroticism exceeds 72, an increase in depression diminishes tagging activity (β_{dp}=0.144, $\beta_{dp\cdot neuro} = -0.002$).

Lastly, results on inbound behaviors (RQ2-3) reveal the turning points of users' neuroticism scores where the direction of the depression effect on communication behaviors changes from positive to negative. Users with higher depression scores receive more likes from friends if their neuroticism level is below 65 (β_{dp}=0.1044, $\beta_{dp\cdot neuro} = -0.0016$). Once, their neuroticism scores go beyond 65, users with higher depression scores receive fewer likes. For the inbound activity of receiving comments, the depression effect switches negative from positive when a user's neuroticism reaches 72 (β_{dp}=0.13, $\beta_{dp\cdot neuro} = -0.0018$). In the case of getting tagged, more depressed users with neuroticism lower than 73 are more frequently tagged, while more depressed users with neuroticism higher than 73 are tagged less often (β_{dp}=0.0803, $\beta_{dp\cdot neuro} = -0.0011$) by friends.

4. Discussion

Findings from current work indicate that more depressed users are inclined to do more broadcasting activities. Also, results for outbound and inbound activities reveal that the kind of activity implemented is more important than the direction of the activity, i.e. whether the user performed the activity towards others or the user has received from others. Those with more severe depression both gave and received fewer likes, wrote and received more comments, and gave and were given more tags. Meanwhile, with the interaction of depression and neurotic personality, depression was positively correlated with all of the activities below certain levels of neuroticism. Yet, once the neuroticism of users passed certain turning points, correlations between depression and the activities all turned negative.

The result of the interaction between depression and neuroticism can be explained by the Simpson's Paradox, which manifests that the effect of an independent variable on a dependent variable changes directions when a lurking explanatory variable is taken into account (Blyth, 1972). Considering that the direction of correlations all changed for each of the communication activities when neuroticism is included in analyses, the personality trait seems to be a lurking variable that needs to be accentuated further in future studies.

Overall, depression does appear to influence online behaviors in social networking. Considering that the more depressed exhibit more frequent self-disclosing behaviors, i.e. broadcasting activities, Facebook may be a place where users satisfy their narcissistic needs (Ryan & Xenos, 2011) as suggested in prior studies. Also, since symptoms of depression include loneliness and less confidence in social skills or competence, it could be speculated that the depressed locate their "real me" on Facebook (or other SNSs). For such reason, they may exhibit more about themselves online than they do face-to-face (McKenna, Green & Gleason, 2002). While the direction of interaction behaviors did not show any statistically significant difference, the type of activities did. This observation may be due to differences in the nature of the activities. The negative relationship between depression and likes can be partially explained by the fact that depressed individuals are often indifferent and feel easily irritated by others: they may not be interested, cannot agree or sympathize with others' life stories. In contrast, though the depressed are less involved in or care less about others, with a small number of intimate people, they may continuously share their thoughts and feelings by using comments or tags. Additionally, many comments and tags can be endlessly added to one's post as a thread, unlike the case of likes, which can only be given once per post. Moreover, comments and tags enable excessive reassurance-seeking, which

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is known to be a prominent behavior of depressed people (Hames, Hagan & Joiner, 2013; Joiner, Metalsky, Katz & Beach, 1999), while likes only allow a single response from the counterpart.

Nevertheless, the result of the interaction between depression and neuroticism implies that negative mental health can be controlled and regulated by one's personality, specifically emotional stability and responsiveness to distress. More specifically, the result may be influenced by neurotics' failure in managing appropriate and normative levels of disclosing behaviors in interpersonal relationships (Chaikin, Derlega, Bayma & Shaw, 1975). Also, it could be that above certain level of neuroticism, people are unwilling or unable to engage in social networking at all, due to their incapability to alleviate symptoms of depression combined with emotional instability.

While the turning-point of neuroticism scores varied from 65 to 79, the highest was 79 for broadcasting activities, i.e. posts uploaded by a user on the user's timeline. Such a result may be partially supported by Ryan & Xenos (2011)'s finding that the more neurotic, the more the users prefer wall posts. On the contrary, the lowest score (65) of the turning-point for likes received by others could be due to the preference of individuals with higher neuroticism score to use SNSs to escape reality (Orchard, Fullwood, Galbraith & Morris, 2014). Combined with symptoms of depression, posts uploaded by users with scores above 65 (though relatively low compared to other turning-points) may not have induced any compassion or conformity from others. Another possible interpretation of the lowest turning-point for likes received by others could be neurotics' tendency to be more anxious and to alienate themselves from others (Anagnostopoulos & Botse, 2016). Individuals with anxiety often disclose visible signs of anxiety, decreasing positive responses from their counterpart in turn (Papsdorf & Alden, 1998).

5. Conclusion

To summarize, the level of depression is significantly correlated with activities on Facebook. Unlike initial expectations of obtaining meaningful disctinction between outbound and inbound activities (direction), the results demonstrate that the type of activity itself (e.g. likes, comments, and tags) is more relevant with regards to depression. Furthermore, personality plays a critical role in social networking behaviors. Until a user's vulnerability to distress and emotional instability (neuroticism level) reaches a certain point, depression was positively related to activity level, regardless of the type, i.e. broadcasting, likes, comments, or tags. Yet, once a user's neuroticism level went beyond that point, correlations between depression and activity levels all turned negative.

Despite interesting findings, current research could be further improved by analyzing the content of posts as well. While only the frequency of communication behaviors are measured in the paper, the amount of activity alone has its limitation in explaining qualitative aspects of social networking behaviors. In order to provide a more comprehensive and meaningful explanation of the relationship between depression, personality, and communication behaviors, analyses on messages to measure both the breadth and depth, e.g. linguistic analysis and content analysis, shall be involved in future studies.

Also, personality traits besides neuroticism, such as extraversion, also should be included in subsequent studies in this line of research. As a moderator, only neuroticism among other personality factors was adopted in this study since neuroticism is the trait regarded to be related to maladaptive emotion regulation (Kokkonen & Pulkkinen, 2001), i.e. depression in this case. Nevertheless, considering that extraversion is also associated with expressing feelings outward and with regulating emotions in general, there is a potential that extraversion and possibly other per-

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sonality traits could be lurking variables as well, impacting the relationship between depression and communication behaviors.

Moreover, despite the findings of prior studies that support the duration of depression as a mental disorder, current research could be further improved and may provide more interesting results by conducting a longitudinal study. In future studies, in order to acquire more accurate and interesting results on the relationship between depression and communication behaviors, measuring depression several times and observing behaviors along at each point within a particular time frame would be necessary.

Nonetheless, the current study not only observed the relationship between mental disorder and social interaction based on actual behavioral data, but also sought a lurking variable that may moderate the effect of mental health on behaviors and discovered significant findings on the interaction between personality and mental disorder.

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Highlights

- More depressed users are inclined to do more broadcasting activities.
- The type of activity is more important than the direction of it.
- Neuroticism moderates the effect of depression on communication behaviors.

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