

# Towards Understanding Relational Orientation: Attachment Theory and Facebook Activities

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## ABSTRACT

Knowing individuals' relational orientation is imperative for effective offline, as well as online, interactions and collaborations. We use attachment theory to examine the link between Facebook users' relational orientation (in terms of attachment styles: anxiety and avoidance) and their relational activities. Our research examines whether and how the two key relational processes identified in offline social relationships (self-expression and responsiveness) are manifested on online social networks and related to attachment styles. We describe our dataset of 640 Facebook users, their attachment scale survey results, and their 525,334 posts. We define four features that map onto relational activities on Facebook: status updates and status updates with emotional words (self-expression); comments and likes (responsiveness). We find significant relationships between the users' attachment styles and their self-expression and responsiveness activities on Facebook. A key takeaway of our research is that without relying on self-reported surveys, a computational analysis of a Facebook user's self-expressing and responding activities alone can reveal the user's underlying relational orientation (i.e., attachment style).

## Author Keywords

Relational orientation; interpersonal relationship; personality; attachment theory; social network behavior

## ACM Classification Keywords

H.5.3. Information Interfaces and Presentation [Information Interfaces]: Group and Organization Interfaces—Web-based interaction, Computer-supported cooperative work; J.4. Social and Behavioral Sciences: Psychology

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## INTRODUCTION

The ever-increasing ubiquity of online social media is transforming the way we connect and interact with others. We work, learn, entertain, and engage in business activities with a wide variety of people, some of whom we have little or no interactions in an offline setting. For example, we collaborate with previously unfamiliar people on an open-source project; we take massive open online courses (MOOCs) and discuss lectures together; we join online communities around interests and hobbies; we crowdsource tasks requiring large-scale human intelligence; and the list goes on.

Unlike connections based on offline interactions, most of the online-only connections face challenges in understanding one another in terms of relational orientation, that is, how an individual views and behaves toward partners in interpersonal communication. There are individual differences in such relational orientations, and those differences contribute to concrete behavioral differences in emotional expressiveness, confirmation of affection, physical proximity, and many other communicative traits. In face-to-face interactions, most people can quickly grasp the relational orientation of the partner to tune their interactional behaviors and avoid misunderstandings. With a lack of non-verbal cues, as well as shared context, this is much harder to do in an online setting, and thus, a computational technology can be a solution to analyze and present the relational orientation of the online interactional partners. Such technology has the potential to help manage the large number of online connections. For example, we may be able to recruit people with certain relational orientation rather than randomly selecting people from the crowd to carry on socially intensive tasks such as online emotional support [39]. In remote collaboration, we may strategize for effective interaction depending on the relational orientation of interactional partners.

Individuals' relational orientations have received much attention in offline relationship research [36, 44] to understand how they react to social relationships and communicate with others. Such an understanding is complex and delicate; many factors are collectively considered such as personality, reputation, education, culture, family, social position, etc. It has been a main theme of exploration in diverse disciplines of humanities and social sciences. However, most of the efforts try

to understand a person through background information, observation, and interviews, which basically requires significant amounts of time and human efforts.

In this paper, we explore the possibility to develop a computational method to help understand the relational orientation of people. To this end, we utilize already obtainable and rich data on the Internet such as online social network service (SNS) data. While there have been many attempts to analyze personal characteristics based on SNS data, most of them focus on understanding the users' personality traits [4] based on personality analyses (e.g., the Big Five or the MBTI). The relational orientation, a key aspect affecting the interpersonal behaviors of people, remains underexplored in the online social setting.

As an initial step, we propose a new model of interpersonal behaviors of SNS users. We build the model based on *attachment theory* which is one of the leading theories of interpersonal relationships in developmental and social psychology [35, 43, 44]. Attachment refers to an individual's psychological ties to specific relationship partners [24, 35]. Individuals' attachment style explains their relational cognition, emotion, motivation, and behavior across an entire life span and in multiple relational settings [7, 35, 43], such as infant-mother attachment [1], adult romantic attachment [24], and work colleague attachment [31]. The attachment style is conceptualized by two continuous dimensions: *attachment anxiety* and *attachment avoidance* [10]. These anxiety and avoidance dimensions of attachment shape individuals' mental model of self (i.e., their belief or expectation about their own worthiness) and model of others (i.e., their belief or expectation about others' benevolence or trustworthiness). These models of self and others serve as mediating mechanisms for interpersonal behavior [5, 7].

To build and test the model, we target Facebook users and examine the link between users' attachment styles and their Facebook activities. Our investigation focuses on answering the following questions:

- Is Facebook users' attachment style related to their Facebook activities? Can we predict Facebook users' relational orientations by looking at their Facebook activities?
- Do people behave similarly or differently in offline and online interactions? Are attachment theory-based predictions replicated in online relationships?

To analyze relational activities on Facebook in terms of attachment style, we use two key relational processes identified by previous research on attachment theory: self-expression and responsiveness [43]. We select and classify Facebook activities into two sets of features to represent self-expression and responsiveness. While self-expression is related to the Facebook activities that a user initiated, e.g., status updates and emotional expression, responsiveness is associated with passive or active responses to others' posts (those initiated by others), e.g., liking and commenting. Through regression analysis, we examine the link between the features and the two continuous dimensions of attachment anxiety and avoidance. We collect the data via a Facebook application we de-

veloped, called KnowYourself, which obtains users' consent for a survey of attachment style and their Facebook activities. In total, we analyzed 640 Facebook users and their 525,334 posts. We find a significant link between the users' attachment styles and their self-expression and responsiveness activities on Facebook.

Our main contributions are as follows:

- We integrate attachment theory, a leading theory of interpersonal relationships, with Facebook activities and identify four features that represent relational processes online.
- We show that attachment theory-based predictions, which have long been examined in offline social interaction, are applicable to online social interactions, even though the relational environments are different.
- We present how Facebook activities can be used to predict users' relational orientations (attachment anxiety and avoidance).

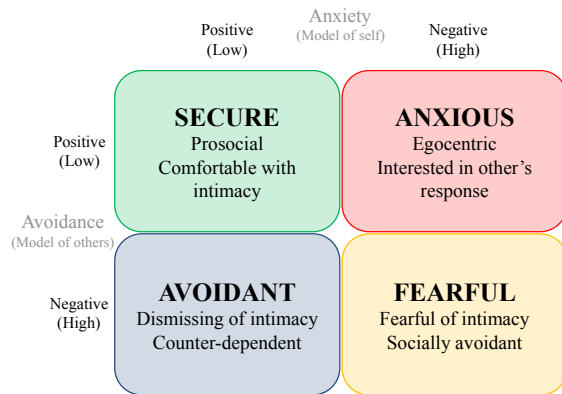
The rest of this paper is organized as follows. We first describe attachment theory, the details of our data, and the features we propose to link attachment styles and Facebook activities. Next, we present the regression results analyzing attachment anxiety and avoidance as continuous values. Then we classify users' attachment styles based on the proposed features. We conclude by discussing ideas for future research.

## ATTACHMENT THEORY AND RESEARCH

The recent increase in popularity of SNS for interpersonal communication has opened new opportunities to observe and analyze naturally occurring interpersonal behavioral patterns at an unprecedented scale. Attachment theory is one of the leading theories of interpersonal relationships [35, 43, 44] with which we can explain SNS users' behaviors. The theory states that an individual's relational qualities with respect to a specific relationship partner affect a large variety of cognitive and psychological processes [8], such as styles of loving [12], interpersonal communication [3], interpersonal distance [28], and cognitive processes [6].

### Attachment Dimensions: Anxiety and Avoidance

The anxiety dimension of attachment refers to the degree of concern over others' evaluation, and the avoidance dimension reflects the degree of comfort with closeness and intimacy. Combining the two dimensions, people can be roughly categorized into four attachment types. People high on the anxiety dimension and low on the avoidance dimension are *anxiously* attached. They have a negative model of self, viewing themselves negatively, and are highly concerned about others' approval, but they have a positive model of others, generally liking others and desiring to build close relationships. Anxiously attached people attempt to increase closeness with others. People low on anxiety dimension and high on avoidance dimension are *avoidantly* attached. They have a positive model of self, thinking highly of themselves, but a negative model of others, mistrusting them. Thus, avoidantly attached people attempt to increase distance from others and dismiss intimacy. Those high on both dimensions are *fearfully* attached. Their models of self and other are both negative. They think negatively about themselves and believe that



**Figure 1. Four attachment types based on the two dimensions, anxiety and avoidance.**

others are unresponsive or rejecting. In contrast, people low on both dimensions are *securely* attached. Their models of self and other are positive. They think positively about themselves and believe that others are benevolent and trustworthy [35].

Figure 1 shows the four attachment types. Although people can be categorized into the four types based on their levels of anxiety and avoidance, the attachment literature views anxiety and avoidance as two continuous dimensions, allowing each survey participant to be placed anywhere along the two axes.

Self-report survey is the typical method of measuring individuals' attachment [10]. The Experiences in Close Relationships-Revised (ECR-R) is a well-constructed survey for measuring individuals' attachment through two subscales of 18 items: anxiety and avoidance [21, 45, 19]. It has 36 items such as "I prefer not to show my significant other how I feel deep down," "I feel comfortable opening up to my significant other," and "I often worry that my significant other will not want to stay with me." In this survey, participants are asked to indicate their relationship qualities with respect to their significant other (e.g., spouse, romantic partner, family, or friends). The survey results generate two scores of anxiety and avoidance for each participant. An individual can be high or low on either or both dimensions.

### Attachment Theory and SNS Behavior

Previous studies examined the relationship between attachment styles of individuals and their technology-mediated behaviors. Jin and Pena studied mobile phone usage by college students in romantic relationships and its association with relational uncertainty, love and commitment, and attachment styles [27]. Their results regarding attachment styles have shown that the higher the avoidance scores were, the smaller voice call frequency and the shorter call time. Drouin and Landgraff focused on texting and sexting behaviors and their association with attachment styles of college students in romantic relationships [17]. Weisskirch and Delevi studied the association between the use of technology such as text message, instant message, and email in relationship dissolution

and attachment style [50]. Gentzler et al. focused on the college students' use of technology-mediated communication with parents and examined its links to loneliness, attachment, and relationship quality [22]. Unlike these studies, we focus on studying the association between attachment styles of Facebook (a popular SNS) users and their activities on Facebook. In addition, our study is based on a computational analysis with a large amount of data generated from Facebook activities of users, quite different from the studies based on self-report surveys about technology use.

Similar to our study, several studies have explored SNS behaviors and their relationship with attachment style. Oldmeadow et al. examined data collected with a self-report questionnaire that measures attachment style, social skills, and Facebook use and experience [41]. They found that individuals with high anxiety showed more frequent Facebook use, while ones with high avoidance showed less Facebook use. Andangsari et al. conducted a similar study for Indonesian young adults [2]. Their study also showed that people with high anxiety would be more active in using Facebook. Jenkins-Guarnieri et al. investigated how attachment style, personality traits, and self-esteem were related to perceptions of Facebook use and interpersonal competency [26]. These studies were also based on self-report surveys about Facebook use, e.g., the frequency of log in, the frequency of status updates, time spent on Facebook, whereas we collected a large amount of actual Facebook data from users and investigated detailed activities including status updates, photo uploads, comments to others, and likes received, associated with individuals' attachment style. In this research, we examine whether we can link specific Facebook activities to attachment styles, much in the same way that attachment researchers have predicted relational behavior in offline social interactions. We map offline relational processes identified in prior research to user behavior on Facebook.

Prior research on attachment and relationship-building in social psychology categorizes two key processes involved in real-life (as opposed to online) relationship-building: self-expression and responsiveness [43]. These are purposeful behaviors intended to increase or decrease intimacy. Although Facebook has a different relational context in that many of the interactions are through text, images, and clicks, compared to face-to-face interactions in the offline setting, Facebook users may have a similar underlying motivation, that of building and strengthening friendships. Thus, we borrow the same classification of relational processes (self-expression and responsiveness) to analyze the relational activities on Facebook. Specifically, in our research, self-expression includes Facebook activities that are clearly initiated by self: status updates and emotional expression. Responsiveness includes commenting or pushing a like button to posts generated by others. We propose that the models of self and others associated with attachment styles will affect Facebook users' self-expression and responsiveness. More specifically, attachment anxiety is related to negative model of the self (viewing the self negatively) and positive model of others (viewing others positively). In contrast, attachment avoidance is associated with positive model of the self (viewing the self positively)

and negative model of others (viewing others negatively) [5, 10]. We propose that the model of the self influences Facebook users' self-expression activities, whereas the model of others affects their responsiveness activities.

## DATA AND PROPOSED FEATURES

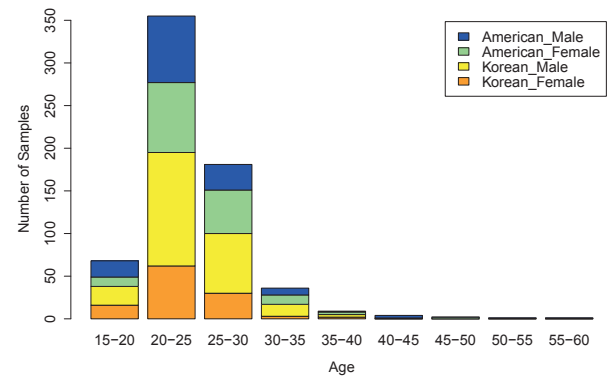
This section describes how we collected Facebook users' attachment styles and detailed Facebook activity data and transformed specific Facebook actions to key relational features that are used to link with attachment styles.

### Participants

We collected data from two different cultures: the United States and the Republic of Korea. These two countries are quite disparate in language and culture, but both have a big number of Facebook users. Using data from two countries ensures that our findings are indeed driven by the relationship between Facebook activities and attachment styles, not particularly biased by a specific cultural setting in which the social network service is operating. Initially, 1,060 Facebook users were recruited for the study. Participants in the United States ( $N = 497$ , 54% female) were recruited through Amazon Mechanical Turk (MTurk). MTurk users with more than three consecutive months of Facebook usage were allowed to participate. They were rewarded with \$0.50 each. Since MTurk was not available in Korea, Korean participants ( $N = 563$ , 31% female) were recruited through an advertisement on Facebook groups and online communities of universities in Korea. After the completion of the study, 50 of them were randomly selected and rewarded with gift certificates worth about \$3.50. Note that different recruiting and rewarding methods for American and Korean participants might motivate people to participate in the study differently. The collected Facebook activities of the participants, however, were not affected by the different recruiting methods because they were done before the users' participation. Moreover, we ruled out untrustworthy participants to ensure the quality of the collected data as explained below.

The recruitment and data collection were performed during the period between September 6, 2012 and March 29, 2013. For data collection, we developed an application on Facebook, *KnowYourself*. It asked for participants' permission for us to access their Facebook data. When the user granted permission, the app showed the attachment survey questionnaire and gathered answers from the user. Facebook data were automatically collected and anonymized while the user took the survey. Note that we explicitly announced on the front page of the survey that user data would be collected. We also informed them that the data would be used only for academic research and automatically anonymized. In addition, we allowed the participants to drop out of the survey at any time. The number of participants who dropped out was 138.

We ruled out participants who gave untrustworthy answers to survey questionnaires or had too few Facebook activities. First, we designed and added dummy questions that were the same as the original questions with slightly different wording, so that we could check for the similarity of the answers. We also measured the time taken by each user in completing the



**Figure 2. Summary of collected data. Most samples are concentrated in the range of 20 to 30 years old.**

survey to filter out those who completed the survey within 30 seconds. As for the Facebook data, we excluded participants who had less than six months of Facebook usage prior to the beginning of recruitment. We also examined the amount of Facebook usage and excluded those who had fewer than five photo uploads or 10 status updates. In total, 282 participants were ruled out (inconsistent answers to questions: 28, survey completed in less than 30 seconds: 100, less than 6 months: 42, not enough Facebook activities: 112).

The final dataset for analysis is 640 users, 42% female. The cultural and gender makeup of the users is: 136 U.S. men, 159 U.S. women, 236 Korean men, and 109 Korean women. Figure 2 summarizes the detailed statistics of the participants.

### Data

Attachment style survey data were collected with the shortened version of ECR-R which is an attachment scale questionnaire widely used in the attachment literature. 7-scale responses (ranging from "Not at all" to "Very much") are used for rating each question. We were cautious that participants might correctly guess the purpose of our research (i.e., the link between their significant-other relationship with their Facebook behavior). To ameliorate this concern, we shortened the number of items on the attachment questionnaire by randomly selecting four items of attachment avoidance and four items of attachment anxiety from the original version of ECR-R Form (See the Appendix for shortened version of ECR-R). We also tested the reliability of shortened version of ECR-R by Cronbach's Alpha (avoidance:  $\alpha = 0.685$ , anxiety:  $\alpha = 0.848$ ). To the extent that both anxiety and avoidance items were randomly selected, the anxiety's high reliability signals that the avoidance's relatively low reliability was not driven by our random selection of the items. Instead, it appears associated with SNS context, in which there would be more anxious users (seeking social interaction) than avoidant users (shunning it).

Attachment avoidance and attachment anxiety are measured by four relevant questions, respectively: questions 1, 2, 3, 7 for attachment avoidance and questions 4, 5, 6, 8 for attachment anxiety. Each of attachment scores is obtained by taking an average of the answers to the relevant questions. Note that

scores about questions 2 and 7 are given reverse-coded. Since the score 4 is the middle score (cut-off value), each attachment dimension is defined as *Low* if the score is lower than 4; otherwise, it is defined as *High*. Participants responded to the attachment questionnaire while thinking about their broad significant other (including spouse, romantic partner, family, or friend). We expect the general attachment styles to influence Facebook friend relationships.

The ECR-R Form was originally developed in English and there is no official Korean version. Thus, for our Korean participants, we translated the original English version into Korean using the back-translation procedure [11]. Back-translation is usually accepted as a valid procedure for cross-cultural research. Following [11], one bilingual research assistant, who is fluent in English and Korean, translated the original English version into Korean. Then, another English-Korean bilingual research assistant back-translated the Korean version into English. Then one of the authors of this research confirmed the equivalence of the original English version and the back-translated English version. Any discrepancy was resolved by discussion.

We collected the participants' Facebook data that can be accessed via user data permissions and extended permissions of Facebook. This includes the users' basic profile, status updates, photos, shared posts, tagged posts, comments/likes received, comments/likes to other posts, liked pages and friend lists. The basic profile includes only a public profile such as ID, name, gender, age range, and locale. Other data include ones shown to public as well as ones to friends only. The time durations of Facebook use by participants were different from each other. Thus, among the collected data, we used data updated during the six-month period prior to the beginning of recruitment and data collection (from March 6, 2012 to September 6, 2012) to control the effects of the variability in the period of Facebook use. A total of 525,334 posts were collected.

For our analysis, we used 10 features from the collected data: the number of status updates, photos, shared posts, tagged posts, comments received, likes received, comments to other posts, likes to other posts, liked pages, and friends. Besides, we incorporated two additional features derived from the collected Facebook data. There are previous studies showing that attachment style affects people's emotional disclosure [36], as well as their responding characteristics to others' behavior [5]. There are several ways to examine such emotional disclosures and responding characteristics. As one way for examining them from our collected dataset, we added two features, i.e., the number of status updates containing emotional keywords and the average time taken to respond to other's comments on user's posts (we calculated the time difference between other's first comment on a user's post and user's comment on the post after others have commented).

### **Proposed Features for Self-Expression**

We propose that the two attachment dimensions will be related to how individuals disclose themselves on Facebook. There are at least two motivations underlying self-expression.

First, self-expression is a strategic action aimed at achieving one's social goals [37]. It is an individual's desire to enhance a relationship that promotes self-expression [43]. In detail, observers infer expressers' feeling or traits from the self-expressed materials and get useful information for relationship-building. Thus, self-expression initiates a potential relationship: Unless an individual self-discloses, a relational process does not follow [43]. Second, an anticipated response is an important determinant of self-expression. People expecting others to respond supportively disclose themselves more than those expecting a discouraging or no response [13, 43].

We predict that due to these motivations, the users' activity to express themselves on Facebook will be positively associated with attachment anxiety, but negatively related to attachment avoidance. As briefed, the social goal of anxiously attached people is to enhance close relationships [35], and they have a positive model of others, anticipating responsive and encouraging others. These motivations should lead people with high anxiety to self-disclose frequently on Facebook. In contrast, the goal of avoidantly attached people is to increase their distance from others and maintain self-sufficiency [35]. Their negative model of others should lead them to expect an unfriendly or no reactions from others. Thus, people who have high avoidance are less likely to self-express on Facebook. In support of our prediction, prior research has demonstrated that attachment avoidance is related to less self-expression in offline social interaction [34].

We consider the status update to be the typical and the most direct way of self-expression because Facebook users express their current activity and/or thought via the status update. Although there is an option for a user to limit the disclosure of the status updates from only him/herself all the way to everyone, the main purpose of the status update is for the user to disclose him/herself to others.

*H1. Status updates will be positively associated with attachment anxiety.*

*H2. Status updates will be negatively associated with attachment avoidance.*

Emotion also plays an important role in self-disclosure [42], and it is closely related to attachment [7]. Thus, as a self-disclosure medium, emotional expression on Facebook likely varies by attachment dimensions. Specifically, people with high anxiety draw others' attention by expressing negative emotion, such as anger, hostility, or contempt [16, 40]. Desiring to build a relationship and expecting others to respond to their emotions, people who have high anxiety are likely to engage in frequent emotional expression on Facebook. In contrast, attachment avoidance is generally characterized by the lack of emotional expression. People with high avoidance defensively inhibit painful memories of past rejection and separation and thus prevent those emotions from becoming conscious [33]. Because they are likely to expect others to be unresponsive or unfriendly to their emotional disclosure, emotional expression will be negatively associated to attachment avoidance.

Anger (9)	Fear (9)	Sadness (31)	Disgust (16)	Joy (27)
angry	afraid	alone	ashamed	amazing
frustrated	helpless	bad	awful	awesome
jealous	naked	broken	bored	beautiful
mad	scared	confused	disgusting	best
mean	stressed	crappy	gross	fine
upset	trapped	depressed	pathetic	happier
pissed	vulnerable	drained	wasted	loved

**Table 1. Sample emotional keywords of five primary emotions defined in “We Feel Fine.”**

While emotional expression can be shown in a range of ways, we take a simple keyword-based approach to capture the emotional expression. Facebook users might reveal their emotion via photos that they take. Another user might share photos or postings that he/she sympathizes with. Also, status updates written by users might have different degrees of emotional expression. Analyzing such diverse channels could provide a more comprehensive view to understand emotional expression, but it is highly difficult. In the current study, we considered the proportion of status updates containing emotion keywords as a key feature to measure emotional expression. To identify emotion keywords in postings, we used the list of emotion words in the We Feel Fine project [29], which were collected from Web blog posts and manually placed into emotion categories. We focused on the five emotions: anger, fear, sadness, disgust, and happiness, as they were identified as the primary emotions in social psychology [18]. Table 1 contains the list of keywords for those five primary emotions. To analyze Korean postings, each English keyword is manually translated to relevant Korean word(s) based on the English-Korean dictionary. We also considered applying LIWC, a computerized text analysis tool that can calculate the degree of positive and negative emotion words used in text. However, the limitation of applying LIWC for our study is that LIWC does not support Korean. Moreover, keywords from We Feel Fine are based on blog posts, which tend to be more similar to Facebook posts than the general lexicon used in LIWC. For both English and Korean, we simply counted the number of status updates containing the emotion keywords. Note that we also examined the use of emoticons as a part of emotional expression. We counted the number of status updates containing emoticons from the Wikipedia list<sup>1</sup> as of September 2012. However, the absolute number of emoticon uses was very small (*Median* = 0, *Mean* = 0.2, *Std.Dev.* = 0.63, across 640 Facebook users), so we did not include it for our analysis.

*H3. Status updates containing emotional keywords will be positively associated with attachment anxiety.*

*H4. Status updates containing emotional keywords will be negatively associated with attachment avoidance.*

### Proposed Features for Responsiveness

We propose that attachment dimensions will be related to how Facebook users respond to others. We predict that responsiveness will be significantly associated with attachment anxiety.

Relational process is reciprocal: Person A’s response generates Person B’s response. That is, showing responsiveness is a strategic way to elicit more responses and thus build a relationship [43]. People with high anxiety are likely to fulfill their desire to build close relationships by showing responses actively. Research in the caregiving literature has documented that individuals who have high anxiety tend to be over-involved and impulsive in caring for others, because they need greater interdependence [13, 20]. The responsiveness of people who have high anxiety may be motivated by a desire to meet strategic goals (e.g., closeness) and an impulsive desire to avoid negative consequences (e.g., rejection) [20] that can result from their not responding. Thus, we think that people who have high anxiety are likely to respond to others more actively.

People with high avoidance show inconsistent relational behaviors. On one hand, they are disinterested or unresponsive in social relationships. Because their primary goal is to maintain self-sufficiency, they are uninvolved in relationship-building [35]). Individuals who do not want to build a relationship are unlikely to reciprocate [43]. Also, people who have high avoidance are egoistically oriented and lack a sense of interdependence [13, 20, 36]. Thus, they may show less responsiveness. On the other hand, other research suggests that because all human beings have the fundamental need to belong [6], high-avoidance individuals value relationships at a preconscious level [33]. Thus they might show responsiveness on Facebook as a defensive means to counteract the indifference and rejection they perceive in past relationships. We expect these conflicting motivations to nullify the link between responsiveness on Facebook and attachment avoidance.

Facebook users can show their responses to others by adding comments or pushing a “like” button to others’ posts. We considered comments to other posts as a relatively active response compared to likes; commenting implies that the user saw the posts and engaged in them actively. In contrast, likes to other posts can be considered as a response that may be shown by people who do not want to express their opinions or thoughts.

*H5. Comments to other posts will be positively associated with attachment anxiety (and will not be associated with attachment avoidance).*

*H6: Likes to other posts will be negatively associated with attachment anxiety (and will not be associated with attachment avoidance).*

### REGRESSION ANALYSIS

We selected four Facebook features that are closely related to attachment dimensions in terms of self-expression and responsiveness. We further consider other Facebook features that also might prove significant to the attachment dimensions. For this, we tested our hypotheses by hierarchical regression for each attachment dimension with all Facebook features. We considered 12 variables, shown in Table 2, including the 10 Facebook features and two derived ones.

<sup>1</sup>[http://en.wikipedia.org/wiki/List\\_of\\_emoticons](http://en.wikipedia.org/wiki/List_of_emoticons)

Attachment dimensions	Median	Mean	Std. Dev.
Attachment anxiety	4	3.87	1.56
Attachment avoidance	3.25	3.29	1.23
Facebook features	Median	Mean	Std. Dev.
<b>Self-expression</b>			
Status updates	4	42.16	90.62
Status updates with emotional words	1	14.12	35.98
<b>Responsiveness</b>			
Comments to others	56	87.03	128.73
Likes to others	30	174.89	254.80
<b>Other Facebook features</b>			
Number of friends	278	339.3	273.51
Comments received	218	235.18	173.99
Likes received	187	240.05	222.48
Photos	35	97.39	133.72
Liked pages	5.61	5.49	1.96
Tagging	2	2.66	1.84
Sharing	2	2.82	2.24
Response time (hour)	52.48	55.34	36.51

Number of observations: 640

**Table 2. Descriptive statistics for participants' activities across six months. All behavioral variables except number of Liked pages follow heavy-tailed distributions and have variances larger than their means.**

All Facebook features (independent variables) except the number of Liked pages follow heavy-tailed distributions, and their variances were larger than their means (see Table 2). To control for skew, all dependent variables except Liked pages were standardized after log-transformation (i.e., log-transformed with base 2 after adding 1, and then converted to z-scores). The number of Liked pages was standardized without log-transformation. Attachment dimensions (dependent variables) are also standardized.

Additionally, we entered three demographics-related control variables in regression analysis. Our U.S. samples were MTukers, whereas the Korean samples were mostly college students. Due to the difference in demographics, we controlled for age and gender ( $1 = male, 2 = female$ ). We also controlled for culture ( $1 = United States, 2 = Korea$ ). The attachment literature has documented mixed results on the relationship between culture and attachment. On one hand, prior research demonstrated culturally universal effects of attachment [1, 23, 48]. On the other hand, there is evidence that attachment effect varies by culture [14, 38, 49]. Because there is no evidence on *a priori* effect of culture interacting with SNS users' attachment styles, we entered culture as a control variable, rather than hypothesizing how culture moderates the link between Facebook activities and attachment styles.

To examine the relationships between attachment dimensions and Facebook features, we applied hierarchical regression with the first model including control variables (3 variables) and the second model including all Facebook features (12 variables). Table 3 and Table 4 show the result of regression analysis for attachment anxiety and that for attachment avoidance, respectively.

In Table 3, in the control variables, the age and culture show a significant relationship with attachment anxiety (age:  $\beta = -0.13, p = 0.02$ , culture:  $\beta = -0.16, p = 0.02$ ). The status updates and the emotional statuses, representing self-

Predictor	$\beta$ for Anxiety	
	Model 1	Model 2
<b>Controls</b>		
Age	-0.16**	-0.13*
Gender	0.05	0.03
Culture	-0.21**	-0.16*
<b>Self-expression</b>		
Status updates		0.18*
Status updates with emotional words		-0.12*
<b>Responsiveness</b>		
Comments		0.07
Likes		-0.18***
<b>Other Facebook features</b>		
Number of friends		-0.07
Comments received		0.08
Likes received		-0.04
Photos		0.16*
Liked pages		0.04
Tagging		-0.17*
Sharing		-0.17*
Response time (hour)		-0.06*
F-statistic	9.587	4.458
(df)	(3, 360)	(15, 348)
Adjusted $R^2$	0.07	0.13
F change	-	3.015***

significance codes: \*\*\*\* 0.001 \*\*\* 0.01 \*\* 0.05

Gender ( $1 = male, 2 = female$ ), Culture ( $1 = United States, 2 = Korea$ )

Number of observations: 640

**Table 3. The results of hierarchical regression for attachment anxiety.**

expression, show a significant relationship with attachment anxiety (status updates:  $\beta = 0.18, p = 0.02$ , emotional statuses:  $\beta = -0.12, p = 0.03$ ). However, for attachment responsiveness, the number of comments does not show a significant relationship with attachment anxiety, while the number of likes does (comments:  $\beta = 0.07, p = 0.70$ , likes:  $\beta = -0.18, p < 0.001$ ). As for other features, the number of photos is associated with a significant increase in attachment anxiety ( $\beta = 0.16, p = 0.05$ ), while the number of tagged posts and the number of shared posts are associated with a significant decrease in attachment anxiety (tagging:  $\beta = -0.17, p = 0.04$ , sharing:  $\beta = -0.17, p = 0.03$ ).

As for attachment avoidance (see Table 4), in the control variables, the culture shows a significant relationship with attachment avoidance ( $\beta = -0.26, p < 0.001$ ). The status updates and emotional statuses are associated with a significant decrease in attachment avoidance (status updates:  $\beta = -0.09, p = 0.01$ , emotional statuses:  $\beta = -0.10, p = 0.002$ ). The number of friends and the response time are associated with a significant decrease in the attachment avoidance (number of friends:  $\beta = -0.17, p = 0.006$ , response time:  $\beta = -0.14, p = 0.009$ ), while the number of liked pages is associated with significant increase ( $\beta = 0.13, p = 0.05$ ).

As for self-expression, the number of status updates is associated with a significant increase in attachment anxiety, while the number of those containing emotional keywords is associated with a significant decrease in attachment anxiety. On the other hand, in Table 4, status updates and those with emotional keywords are associated with a significant decrease in attachment avoidance. Thus, *H1, H2, and H4* – which were developed based on offline interaction research that used at-

Predictor	$\beta$ for Avoidance	
	Model 1	Model 2
<b>Controls</b>		
Age	0.03	-0.02
Gender	-0.02	0.01
Culture	-0.36**	-0.26***
<b>Self-expression</b>		
Status updates		-0.09*
Status updates with emotional words		-0.09**
<b>Responsiveness</b>		
Comments		-0.07
Likes		0.08
<b>Other Facebook features</b>		
Number of friends		-0.17**
Comments received		-0.01
Likes received		-0.14
Photos		0.11
Liked pages		0.13*
Tagging		-0.03
Sharing		-0.05
Response time (hour)		-0.14**
F-statistic	4.285	3.894
(df)	(3, 360)	(15, 348)
Adjusted $R^2$	0.03	0.11
F change	-	3.700***

significance codes: \*\*\* 0.001 \*\* 0.01 \* 0.05  
Gender (1 = male, 2 = female), Culture (1 = United States, 2 = Korea)  
Number of observations: 640

**Table 4. The results of hierarchical regression for attachment avoidance.**

tachment theory – are supported in online interaction as well, however, *H3* is not supported.

*H1, H2, and H4 are supported.*

*H3 is not supported.*

As for responsiveness, the number of comments does not have a significant relationship with attachment anxiety, while the number of likes is associated with a significant decrease (Table 3). However, in Table 4, comments and likes are not significantly associated with attachment avoidance. Thus, *H5* is not confirmed and *H6* is confirmed. Like self-expression activities, Facebook features related to responsiveness, not comments but likes, followed offline interpersonal behavior predicted by the attachment theory.

*H5 is not supported.*

*H6 is supported.*

In summary, the regression results showed that the attachment theory usefully predicts both offline and online relational behaviors. Self-expression activities on Facebook can predict both attachment anxiety and attachment avoidance. In contrast, responsiveness activities on Facebook (the number of likes) can predict attachment anxiety only.

It is not appropriate to directly characterize individual attachment types from the above regression analysis. However, it would be somewhat meaningful to compare different attachment styles. For example, anxious and fearful types are both high in anxiety; however, the former would potentially show more self-expression since it is lower in avoidance. Similarly,

Anxiety	Avoidance
Tagging	<b>Likes</b>
Photos	<b>Status updates</b>
<b>Likes</b>	<b>Emotional statuses</b>
Response time	Photos
<b>Status updates</b>	Like received
<b>Emotional statuses</b>	Comments received
<b>Comments</b>	<b>Comments</b>
Likes received	Tagging
Comments received	Response time
Liked pages	Liked pages
Number of friends	Number of friends
Sharing	Sharing

**Table 5. Features sorted by information gain. Selected four features (bold-faced) are relatively highly ranked.**

comparing the secure and anxious types both with low avoidance, the latter would show more self-expression via status update; however, less with emotional words, and would probably respond more with comments but less with likes. As for avoidant and fearful types, the fearful would be more active in status update, but less with emotional terms, and would respond more with comments and less with likes.

#### ATTACHMENT CLASSIFICATION

In this section, we present a classification experiment of attachment styles into two classes, high and low, for each of the two attachment dimensions. We show that using Facebook features with the Support Vector Machine (SVM) [15] can automatically classify attachment styles with accuracy much better than a baseline.

We start by computing information gain<sup>2</sup> to measure the degree of the discriminatory power of each Facebook feature. Table 5 shows the features sorted by the information gain metric. The bold-faced ones are the four selected features in the previous sections, and they are relatively highly ranked.

Among other features, *tagging* (i.e., the number of events a user is tagged in) and *response time* (i.e., the time spent on responding to others' posts) have high information gain for attachment anxiety, but relatively low information gain for attachment avoidance, which implies that they may not be effective when classifying for both attachment anxiety and attachment avoidance. Similarly, *like received* and *comment received* have high information gain for attachment avoidance, indicating that received Facebook activities are good indicators in classifying the level of attachment avoidance, but not for attachment anxiety.

<sup>2</sup>Information gain is defined as  $H(X) - H(X|Y)$ , where  $H(X)$  is the entropy of a random variable  $X$ , i.e.,  $H(X) = -\sum_i^n P(X=x_i) \log P(X=x_i)$ , given that  $P(X=x_i)$  is the probability of  $X=x_i$ , and  $H(X|Y)$  is the conditional entropy of  $X$  given another random variable  $Y$ , i.e.,  $H(X|Y) = \sum_i^n P(Y=y_i) H(X|Y=y_i)$ .

In the context of this paper, it is used as a metric to measure the impact of a feature from a set of features (i.e. independent variables) in classifying the class of each attachment dimension (i.e. dependent variable). It does not make any prior assumption on the nature of relationship between the variables (e.g., monotonic relationship, linearity in the relationship).



	ALL	Selected-4	Random-4	Base Line
Anxiety	87.44%	83.26%	64.26%	58%
Avoidance	89.46%	84.65%	65.64%	52%

**Table 6. The results of classification accuracy. They imply that the four selected features are representative features for binary classification of each attachment dimension.**

Class (# of participants)	Precision	Recall	F-measure
High Anxiety (368)	0.796	0.954	0.868
Low Anxiety (272)	0.915	0.668	0.772

**Table 7. The performance results of binary classification for attachment anxiety.**

We then perform and compare binary classification using all of the features (labeled as *All* in Table 6), the four selected features (labeled as *Selected-4*), and four random features (labeled as *Random-4*). We evaluate the classification accuracy using 10-fold cross-validation with SVM. For *Random-4*, we take the average of 20 repeated evaluations. Table 6 presents the classification accuracy of attachment anxiety and attachment avoidance.

### Binary Classification

The accuracy of *All*, i.e., with all available features, is the highest that we can get. The accuracy of *Selected-4* is almost identical to that of *All* and higher than that of *Random-4*. The baselines of anxiety and avoidance are 58% and 52%, respectively (the case of every participant is classified as one class).

The difference between *All* and *Selected-4* is larger for avoidance than for anxiety classification. We conjecture that this is consistent with the results in Table 6, in which responsiveness-related features, i.e., comments and likes, do not show a significant relationship with avoidance.

Table 7 shows the classification performance with the four selected features on attachment anxiety. Since the number of people with low anxiety is smaller than the number with high anxiety, the recall of low anxiety is small and the baseline is 58% (the case of every user is classified as high anxiety). We think this is natural since previous work states that people with high attachment anxiety and low attachment avoidance tend to use SNS more [41].

Table 8 shows the classification performance with the four selected features on attachment avoidance. The baseline is 52% (the number of people who have low avoidance is larger than the number of people who have high avoidance), which shows more people in low avoidance use Facebook.

### Multi Class Classification

Binary classification can be used to determine users' attachment level of each attachment dimension. For more practi-

Class (# of participants)	Precision	Recall	F-measure
High Avoidance (308)	0.904	0.761	0.827
Low Avoidance (332)	0.807	0.925	0.862

**Table 8. The performance results of binary classification for attachment avoidance.**

Class (# of participants)	Precision	Recall	F-measure
Secure (156)	0.838	0.790	0.813
Anxious (177)	0.710	0.921	0.802
Avoidant (116)	1	0.444	0.615
Fearful (191)	0.757	0.839	0.796

**Table 9. The performance results of multiclass classification.**

cal use, we further examined multi-class classification for the four types of attachment styles.

Table 9 shows the classification performance of multi-class classification. The baseline is 29.8% (the case of every user is classified as fearful). Overall accuracy was 77.83%. Since the number of the avoidant type is much smaller than the other types, the F-measure shows the lowest performance (0.615) even when the precision shows 1.

### DISCUSSIONS

This research examined the relationship between Facebook users' online behavioral patterns and their relational orientation based on the attachment theory. Our results show that Facebook users' attachment style is significantly related to their self-expression and responsiveness activities on Facebook. There may be many reasons for Facebook users liking, commenting, and posting, etc. Our research shows that one reason, their relational orientation, can be inferred by looking at their self-expressing/responding activities on Facebook. Our research demonstrates that the attachment theory is useful in predicting not only offline but also online social interaction. Our findings will be informative for both social scientists who study the implications of attachment style and social media practitioners who could use this information to design customized social media.

Our research opens multiple new inquiries of social computing research. For example, there are many issues in online behavioral analysis, such as the inter-attachment activities. The communication between two anxious users may be different from the communication between an anxious user and an avoidant user. Analyzing such inter-attachment activities and their implications would be an interesting future study issue. Another issue is to incorporate the analysis of the topic of the users' posts. People of different attachment styles might have different topics in their posts. For instance, avoidant users may usually talk about a non-relational, task-oriented topic to decrease intimacy, whereas anxious users may often post about their emotional feelings to increase intimacy. Thus, looking into the topics would also be helpful to analyzing the user's attachment style.

Future research might examine whether our findings are generalizable to other types of social media or specific to Facebook. Twitter is another social media form seen as a combination of both social networking and microblogging [30]. However, there exist multiple differences between Facebook and Twitter. For example, Facebook allows reciprocal interaction between users: Facebook users post comments on each other's pages and form virtual groups based on common interests. In contrast, Twitter is less reciprocal: Twitter is a platform where people usually argue or debate on vari-

ous topics, e.g., political debate [46] and its message is targeted for general audience [9]. Moreover, Facebook is used more by people who are gregarious in their nature, whereas Twitter is preferred by those who seek cognition or utilitarian values [25]. Due to the less relational characteristic of Twitter usage, Twitter might not reflect the users' attachment styles. Facebook may be a more appropriate social media to examine interpersonal online relationship. The characteristic of Facebook, which does not support anonymity, seems to make Facebook activities possible to reflect the same attachment styles of offline research. Further study might extend our Facebook-based analysis to other social network services.

The current research analyzed Facebook features only from the perspective of the user him/herself, i.e., how the user expresses and responds to others. However, SNS user behavior involves essentially dynamic and reciprocal interaction, such that Person A's expression influences Person B's responses, which then affects Person A's response to Person B. It is an important topic to explore this feedback process and extend our understanding of SNS user behavior. For example, how will others respond to status updates and emotional communication expressed by users who have high anxiety? Will others' reactions to users who have high anxiety differ from the anxious users' responses to others? These questions await future research.

Because culture's effect on attachment has generated mixed results [1, 14, 23, 38, 48, 49], we entered culture as a control variable and did not systematically compare the impact of culture on Facebook activities/attachment across the U.S. and Korean samples. Moreover, attachment research has demonstrated that intra-cultural attachment variance is much bigger than inter-cultural attachment variance [47, 32]. An important follow-up would be to investigate more thoroughly how culture moderates the relationship between Facebook users' attachment styles and online behavior. While this paper addressed an initial study on the coherence of users' relational orientations in online and offline interactions, we are planning the following important steps including user studies and pilot application design across cultures.

Our model included three demographic-related control variables. However, it is likely that many other variables could also potentially contribute to the attachment styles, and the current model is limited to that extent.

## CONCLUSION

Social interaction in a popular online social network, Facebook, reflects people's relational orientation. There are several models to figure out human personality, such as the Big Five or MBTI. These models focus on individual personal traits, although an online social network is a relational context and major activities in online social network involve interpersonal communication. Therefore, our study focused on attachment theory, a leading theory of interpersonal relationships. We crawled users' Facebook data and surveyed attachment styles using a Facebook application, KnowYourself. We summarized behavioral differences of two attachment dimensions (anxiety and avoidance) and four attachment types

and identified four features that significantly affect each attachment dimension, by exploring the two key relational processes (self-expression and responsiveness) on Facebook. We used regression analysis and found relationships between two attachment dimensions (anxiety and avoidance) and Facebook activities. The results present classifications for attachment dimensions that can successfully determine users' attachment style.

## APPENDIX

### Attachment Style Questionnaires

To shorten the survey's length, we randomly selected four items of attachment avoidance ( $\alpha = 0.685$ ) and four items of attachment anxiety ( $\alpha = 0.848$ ) from the ECR-R [21, 45, 19]. This questionnaire uses a 7-point scale ranging from "Not at all" to "Very much."

1. *I prefer not to show my significant other how I feel deep down.*
2. *I feel comfortable sharing my private thoughts and feelings with my significant other.*
3. *I find it difficult to allow myself to depend on my significant other.*
4. *I often worry that my significant other will not want to stay with me.*
5. *I worry a lot about my relationships with significant other.*
6. *I often wish that my significant other's feelings for me were as strong as my feelings for him or her.*
7. *I feel comfortable opening up to my significant other.*
8. *I worry that my significant other won't care about me as much as I care about him or her.*

Attachment avoidance and attachment anxiety are measured by taking an average of relevant questions as follows.

- Avoidance: 1, 2 (*reverse-coded*), 3, 7 (*reverse-coded*)
- Anxiety: 4, 5, 6, 8

## ACKNOWLEDGMENTS

The authors thank the anonymous reviewers for their valuable comments and our shepherd, Professor Susan Fussell, for her support and insightful comments to improve the quality of our paper. This work was partly supported by National Research Foundation of Korea (NRF) grant (No. 2011-0018120) and by Next-Generation Information Computing Development Program through NRF (No. 2010-0020729), both funded by the Korea government (MSIP).

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