

## The Effect of Mobile Phone Use on Friendship in School Children : A Panel Study Examining Causality

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### Abstract

We conducted a two-wave panel study with 450 students, ranging from elementary school children to senior high school students, to examine the effect of mobile phone use on the depth and closeness of friendship. The results indicated that mobile phone use had no impact on depth of friendship, but there were significant effects of mobile phone use on closeness of friendship. More specifically, for senior high school students, the closeness of friendship increased as their emotional dependency as well as formality-based emotional bonds became stronger. Junior high school students showed weaker friendships with increased Internet use, stronger sincerity-based emotional bonds, information exchange, and emotional dependency. There were no significant effects for elementary school children. Results also showed reverse influences, such that the status of friendships influenced how a mobile phone was used. Furthermore, the results suggest a cyclic relationship between closeness of friendship, formality-based emotional bonds, and emotional dependency.

**Key words:** mobile phone, friendship, children, panel study, causal relationship

### Introduction

Mobile phones are currently in widespread use and are dramatically improving in Japan. According to statistics from the Telecommunications Carriers Association (TCA), the number of mobile phone subscriptions as of January 2007 was 95,315,200, which was more than landline phone subscriptions. Mobile phone ownership is particularly high among young Japanese individuals. In fact, mobile phone ownership is highest for teenagers, with 95.7% of teenagers owning a mobile phone (Asai, 2005). Indeed, Kamibeppu and Sugiura (2005) reported that e-mail exchange using mobile phones played an important role in the daily lives of young Japanese individuals. In particular, young individuals mainly use mobile phones, more specifically the e-mail function, to communicate with their friends (Kamibeppu and Uemura, 2002), and it is therefore believed that mobile phone use by young individuals has a particularly strong influence on their friendships.

#### Studies on friendship in adolescence

Traditional studies on friendship in adolescence have established that young individuals seek emotional connections with their friends, develop self-understanding or self-awareness through close and mutual interactions with their friends, and finally, use friendship to establish their own identity (e.g., Nishihira, 1973; Atwater, 1992).

However, in contrast to these positive effects of friendship, there also exist negative or weak forms of friendship (e.g., Okonogi, 1984; Sengoku, 1985; Okada, 1995). Strong friendship means having a psychological connection with friends, interacting honestly with them, and trying to have deep friendships built on mutual trust. On the other hand, weak friendship means avoiding deep psychological involvement with friends, remaining distant to avoid getting hurt, and only trying to build superficial friendships.

There have not been consistent findings in studies of friendship characteristics in adolescence, with some studies emphasizing the strengths, and other studies emphasizing the weaknesses of friendship. In response to this inconsistency, Naganuma and Ochiai (1998) identified as many types of friendship interactions in modern adolescents as possible, and then performed second-order factor analysis to identify and classify the characteristics of adolescent friendship. In the current study, 136 questions about friendship were sorted into 16 subordinate scales, which were further divided into two categories identified by Naganuma and Ochiai (1998), deep-superficial and close-distant friendship. In the deep-superficial friendship category, a relationship in which individuals actively and mutually show their inner-self is considered positive, while a relationship in which individuals are defensive and closed-minded with regard to inner bonds is considered negative. In the close-distant friendship category, a relationship in which individuals

are not aware of each other's individuality, attempt to reduce the psychological distance between themselves as much as possible, and trying to stay close to each other is considered positive, while a relationship in which individuals increase psychological distance and stay distant from each other is considered negative. These two aspects of friendship, deep-superficial and close-distant, are independent factors in an orthogonal model, representing depth and psychological distance, respectively (Naganuma and Ochiai, 1998). These two factors have also been studied in the context of mobile phone use, as described in the next section.

### Studies on the relationship between mobile phone use and friendship

The main focus of studies on the relationship between mobile phone use and depth of friendship has been whether mobile phone use weakens or strengthens friendship. In the late 1990s when the young generation started to use mobile phones, many young users wrote and received e-mails on their mobile phones. Based on the concern that these young individuals may have decreased opportunities or motivation to engage in face-to-face communication, which may inhibit social development that occurs via real-world interactions with others (Yamashita, 2001), weakening of interpersonal relationships was often discussed as a negative consequence of mobile phone use. However, no correlations between mobile phone use and weak friendship were observed in experimental studies. In fact, just the opposite was reported: there were significant correlations between mobile phone use and strong friendship (e.g., Nakamura, 1999; Tsuji and Mikami, 2001; Adachi, Takada, Oyama, and Matsumoto, 2003). Here, the term "weak" refers to a friendship that is superficial, and the term "strong" means friendship that is deep. Thus, these two extremes are similar to the concept of depth of friendship (deep-superficial) suggested by Naganuma and Ochiai (1998).

The relationship between mobile phone use and closeness of friendship has also been noted. The spread of mobile phone use allows individuals to casually communicate with their friends anytime and anywhere. As a result, it is believed that young individuals who use mobile phones want to be psychologically "with" someone all the time, and this is achieved by incessantly communicating with friends regardless of the physical distance between them using the mobile e-mail function. This type of interpersonal relationship is called a *fulltime intimate community* (Nakajima, Himeno, and Yoshii, 1999), and refers to a close relationship in which staying connected with friends makes an individual feel safe and comfortable. If, however, recipients of their e-mail messages do not reply, these individuals no longer feel that they are connected, and are likely to feel uneasiness,

mistrust, and loneliness (Kamibeppu and Sugiura, 2002). Tsuji (2006) found that the amount of mobile phone use and fear of loneliness were positively correlated, and it has been suggested that the amount of mobile phone use and fear of loneliness influence each other. In addition, while mobile phone-based e-mail exchange may be voluntary, such exchanges may also occur out of obligation in order to maintain friendship (Kamibeppu and Sugiura, 2002). In this type of friendship, individuals are unlikely to be aware of their own or their friends' individuality, and at the same time, are unlikely to think about maintaining distance between themselves and their friends. In other words, in this type of friendship individuals are quite close to each other.

To summarize, the results of the studies described above found no positive correlation between mobile phone use and the superficiality of friendship, and instead found a positive correlation between mobile phone use and deep friendship. In addition, these studies found evidence for a positive relationship between mobile phone use and closeness of friendship. Note, however, that many of these previous studies examined the relationship between friendship and how much various mobile phone functions were used; there have been almost no studies examining the relationship between friendship and the qualitative aspect of these mobile phone functions, in other words, how they are used (Asai, 2005; Akasaka and Takagi, 2005). One exception is the case study by Asai (2005), in which relationships between the amount of mobile phone use and purpose of use were examined. The results showed that mobile phone use made friendship stronger or weaker depending on what the mobile phones were used for. Specifically, mobile phone use made friendship stronger when individuals communicated to kill time or casually express their feelings to each other, and used these casual interactions to facilitate face-to-face communication. On the other hand, exchanging e-mail messages containing only necessary matters weakened friendship. This may be because individuals feel less need for face-to-face communication when they become aware that they can communicate with each other via e-mail whenever necessary, resulting in less face-to-face communication and thus weakened friendship. Therefore, friendship can become deeper or more superficial depending on how mobile phones are used, and it is necessary to examine in detail how the purpose of communication and amount of mobile phone use affect friendship.

Akasaka and Takagi (2005) categorized the reasons for using mobile phone e-mail functions into the following four types: sincerity-based emotional bond (honest exchange of opinions or feelings), formality-based emotional bond (dishonest exchange intended to maintain friendship), emotional dependency (casual communication to pass time), and information exchange (exchange of

necessary information). They found that mobile phone use was unrelated to whether friendship was weak. Based on their findings, in this study we used the four categories listed above to examine how different purposes for mobile phone communication are related to depth and closeness of friendship.

Many previous studies examining the relationship between friendship and the amount of calling or e-mailing using mobile phones were correlational. However, it is difficult to estimate causal relationships in correlational studies. Furthermore, it may be that there is a cyclical relationship between mobile phone use and friendship, such that they keep influencing each other. Although it is important to examine such relationships, other than a study by Matsuo, Onishi, Ando, and Sakamoto (2005) on mobile phone use and selective friendship, there have not been many studies that use methods that allow estimation of such relationships.

In Japan, mobile phone use is beginning at a younger age, and even elementary school children and junior high school students are likely to carry and use a mobile phone (e. g., Murakami and Maeda, 2006). However, many previous studies looked only at senior high school and undergraduate students who were frequent mobile phone users, and there are no studies that examine participants from different age groups or that examine different factors that influence mobile phone use that may change over the course of development. Therefore, it is necessary to study mobile phone use in younger children in addition to adolescents. Although there have not been any studies comparing the influence of mobile phone use on friendship at different developmental stages, we can make predictions based on Murakami and Maeda (2006), who compared the circumstances of mobile phone use in different age groups. They found that elementary school children tended to use mobile phones to contact their parents; thus, at this age, the influence of mobile phone use on friendship is predicted to be marginal. However, in junior high school, students started using mobile phones to interact with their friends, and senior high school students mainly used mobile phones to communicate with their friends. Therefore, the relationship between mobile phone use and friendship likely gets stronger over the course of development. Specifically, this relationship is expected to be stronger for junior high school students than for elementary school children, and stronger for senior high school students than for junior high school students.

### Objective of this study

The objective of this panel study was to examine the relationship between mobile phone use and depth and closeness of friendship in individuals at various developmental stages, ranging from elementary school to senior high school. In particular, the following two

hypotheses were tested.

Hypothesis 1: Mobile phone use makes friendship deeper. However, since previous studies found that exchange of e-mails containing only necessary matters was associated with weak friendship, we predict that friendship will become superficial if a mobile phone is simply used to exchange information.

Hypothesis 2: Mobile phone use will lead to closer friendships.

Note that since previous studies found that mobile phones were used differently during different developmental stages, we expect that the relationships described in Hypotheses 1 and 2 will also vary across development. For this reason, we compared data from three developmental stages: elementary school, junior high school, and senior high school. We also examined causal relationships in the opposite direction than our hypotheses, in which friendship may influence mobile phone use, and also examined whether there were any cyclical relationships between mobile phone use and friendship.

## Method

### Analysis method and goodness of fit of models

We conducted a panel study in two waves and conducted structural equation analysis using the cross-lagged effects model (Figure 1). This model allows examination of relationships between two variables measured at the same time, and examination of two hypothetical influential factors. Since this study was conducted with elementary school children, junior high school students, and senior high school students so that we could make comparisons between different populations, we conducted simultaneous multiple group analysis.

For example, as illustrated in Figure 1, we can conclude that amount of mobile phone use influences friendship if the amount of mobile phone use by elementary school children measured at the time of the first survey has a significant effect on friendship measured at the time of the second survey. Conversely, we can conclude that friendship influences mobile phone use if friendship measured in the first survey has a significant effect on the amount of mobile phone use measured in the second survey.

In simultaneous multiple group analysis, equivalent constraints were used because the same model was examined and compared in multiple groups. In this analysis, we used the 10 analysis models shown in Table 1. In Model 1, all five paths shown in Figure 1 (paths a through e) were assumed to be the same in all three participant groups. In Model 10, there were no constraints and it was assumed that all five paths were different in all three participant groups.

Goodness of fit of these models was assessed with  $\chi^2$ , Normed Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Akaike Information Criterion (AIC). In general, a smaller  $\chi^2$  value means that the subject model is a better fit for the particular dataset. This model is discarded if the probability of  $\chi^2$  is 0.5 or lower. Note, however, that  $\chi^2$  largely depends on sample size, where for smaller sample sizes the probability of the subject model being discarded is lower. For this reason, decisions must be made taking sample size into account. A particular model is considered to fit the data well when the AIC value is low, both the NFI and CFI values are 0.9 or higher, and the RMSEA value is 0.05 or lower (Toyota, 1998).

**Study period and participants**

In this study, a questionnaire was distributed over the Internet to students ranging from fifth graders to third year high school students from across Japan. The first wave was conducted in November 2002, and the second in January 2006. Study information and a request to complete the questionnaire were sent to individuals registered with InfoPLANT (currently Yahoo! Japan Value Insight), who were within the target age range, as well as their parents. There were 900 respondents for the first survey (43.3% male and 56.7% female; 300 elementary school children, 300 junior high school

students, and 300 senior high school students) and 450 for the second survey (42.4% male and 57.6% female; 150 elementary school children, 150 junior high school students, and 150 senior high school students). Note that questionnaire collection terminated when 150 responses were collected from elementary school children, junior high school students, and senior high school students. The collection period for the second survey was intentionally shorter since we believed this would be highly beneficial to the study. More specifically, if the period of questionnaire collection was longer, the number of participants in each group would increase, however, this would create a situation where the study period was different for each sample. This issue was circumvented by limiting the collection period to approximately two weeks. Although this prevented variation in the study period, there may be another issue of sample bias because the participants who responded quickly could have unique characteristics, such as a strong interest in mobile phones. To determine if there was a sampling bias, we compared data obtained from the 450 participants who only responded to the first survey with data from the 450 participants who responded to both the first and second surveys using *t*-tests. Results indicated that there were no significant differences in any of the variables of interest. We therefore conclude that there were no problems related to sampling bias. Note, however, that Schmidt (1997) and Webster and Compeau (1997) suggest that study samples are biased in web-based surveys, so it may be possible that the participants in this study had higher than average IT literacy. This issue will be considered further in the results.

**Questionnaire**

The same questionnaire was used for the first and second surveys.

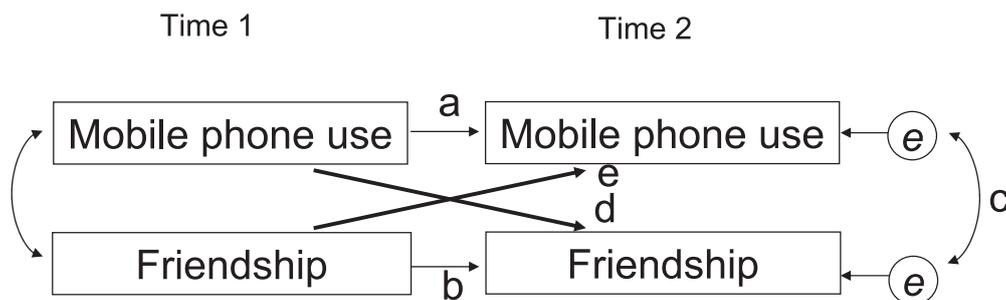
*Questions about mobile phones*

- (1) Mobile phone ownership ratio

The participants selected one of the following responses: 1 = I own a mobile phone, 2 = I do not own a mobile phone but I want to own one, or 3 = I do not own a mobile phone and I do not want one either.

**Table 1.** Equivalent constraints of analysis method

Model	Equivalent constraints	DF
Model 1	a, b, c, d, e	10
Model 2	a, b, c, d	8
Model 3	a, b, c, e	8
Model 4	a, b, c	6
Model 5	a, b, d	6
Model 6	a, b, e	6
Model 7	a, b	4
Model 8	a	2
Model 9	b	2
Model 10	no constraints	0



**Figure 1.** Cross-lagged effects model

(2) Amount of mobile phone use

The participants used 6-point and 9-point scales to indicate the amount of calling, e-mailing, and Internet use per day. Participants used a 6-point scale to indicate the amount of calling (1 = 0 seconds, 2 = 1 second to less than 5 minutes, 3 = 5 minutes to less than 10 minutes, 4 = 10 minutes to less than 30 minutes, 5 = 30 minutes to less than 60 minutes, and 6 = 60 minutes or longer), a 9-point scale to indicate the amount of e-mailing (1 = 0 messages, 2 = 1 to 4 messages, 3 = 5 to 9 messages, 4 = 10 to 14 messages, 5 = 15 to 19 messages, 6 = 20 to 29 messages, 7 = 30 to 39 messages, 8 = 40 to 49 messages, and 9 = 50 messages or more), and a 6-point scale to indicate the amount of Internet use (1 = 0 seconds, 2 = 1 second to less than 1 minute, 3 = 1 minute to less than 5 minutes, 4 = 5 minutes to less than 10 minutes, 5 = 10 minutes to less than 30 minutes, and 6 = 30 minutes or longer).

(3) Purpose of e-mailing

To identify the purpose of e-mailing, a total of 10 questions about the content of mobile phone e-mail messages developed by Akasaka and Takagi (2005) were used. Participants used a 4-point scale (1 = strongly disagree; 4 = strongly agree) for two questions about sincerity-based emotional bonds, three questions about formality-based emotional bonds, three questions about emotional dependency, and two questions about information exchange.

*Questions about friendship*

We selected some of the subordinate scales from the Friend Interaction Pattern Scale developed by Naganuma and Ochiai (1998) to measure depth and closeness of friendship. A total of 36 questions about depth and 13 questions about closeness of friendship were used. For each statement, the participants responded using a 4-point scale (1 = Strongly disagree; 4 = Strongly agree).

**Results**

**Mobile phone ownership and amount of use**

Among all the participants, 569 (63.2%) individuals owned a mobile phone. Among those who did not own a mobile phone, 275 (30.6%) indicated that they did not own a mobile phone but they wanted to own one, and 56 (6.2%)

indicated that they did not own a mobile phone and they did not want one either. In terms of stage of development, 29.7% of elementary school children, 65.3% of junior high school students, and 94.7% of senior high school students owned a mobile phone. According to a survey on mobile phone use in children (N = 2129) conducted by the Mitsubishi Research Institute (2006), 21.1% of fourth through sixth graders, 49.5% of junior high school students, and 94.2% of senior high school students owned a mobile phone; according to a survey by the Survey Research Center (2006), 33.3% of fifth and sixth graders, 62.5% of junior high school students, and 95.3% of senior high school students owned a mobile phone. The percentage of ownership obtained in this study is in-between those found in the two previous surveys. As described above, samples recruited on the internet for web-based surveys may be biased. However, because ownership in our participants falls within the range of ownership measured in the two previous surveys, it seems unlikely that the participants in our study are different from the general population. Therefore, we conclude that the results of this study are not biased.

Table 2 shows the medians, means, and standard deviations for the reported amount of calling, e-mailing, and Internet use per day. As shown in the table, the mean amount of time spent calling, e-mailing, and using the Internet increased as participants got older. There were no significant differences in these values between the first and second surveys.

Inter-variable correlation coefficients and test-retest reliability were calculated for each variable (amount of calling, amount of mailing, amount of Internet use, sincerity-based emotional bond, formality-based emotional bond, information exchange, and emotional dependency) obtained in the first and second surveys for all three participant groups (Tables 3 through 6).

Next, we calculated scale scores related to the purpose of e-mailing for the 450 participants who responded to both the first and second surveys. Note that one question in the emotional dependency category was excluded from the following item analysis. The inter-question correlations for items meant to measure the same variable on the first and second surveys were as follows:

**Table 2.** Medians and means for each survey question about the amount of mobile phone use. Standard deviations are shown in brackets. Responses were on a 6-point scale for amount of calling and Internet use, and on a 9-point scale for amount of e-mailing.

	Total		Elementary school		Junior high school		Senior high school	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Calling	2 2.16 (1.33)	2 2.12 (1.26)	1 1.41 (0.80)	1 1.47 (0.86)	2 2.09 (1.30)	2 2.05 (1.22)	3 2.99 (1.31)	2 2.84 (1.25)
Mailing	2 2.76 (2.15)	2 2.89 (2.29)	1 1.35 (0.83)	1 1.39 (0.89)	2 3.03 (2.46)	2 3.23 (2.58)	4 3.91 (1.93)	4 4.05 (2.14)
Internet	1 2.40 (1.82)	1 2.39 (1.75)	1 1.16 (0.59)	1 1.20 (0.69)	1 2.27 (1.76)	1 2.29 (1.67)	4 3.77 (1.75)	4 3.69 (1.69)

**Table 3.** Correlation matrix for all variables for all participants. Rows refer to values obtained in the first survey and columns show values obtained in the second survey. Test-retest reliability coefficients are shown in brackets.

	Calling	Mailing	Internet	Sincerity-based emotional bond	Formality-based emotional bond	Information exchange	Emotional dependency	Depth	Closeness
Calling	(.72**)	.60 **	.53 **	.53 **	.44 **	.46 **	.51 **	.08	-.07
Mailing	.58 **	(.87**)	.61 **	.50 **	.51 **	.30 **	.61 **	.07	-.02
Internet	.54 **	.62 **	(.84**)	.72 **	.71 **	.58 **	.78 **	.03	.02
Sincerity-based emotional bond	.50 **	.57 **	.77 **	(.72**)	.63 **	.69 **	.82 **	.19 **	-.01
Formality-based emotional bond	.42 **	.59 **	.72 **	.69 **	(.71**)	.63 **	.74 **	-.16 **	.08
Information exchange	.38 **	.34 **	.61 **	.70 **	.60 **	(.69**)	.52 **	-.07	-.07
Emotional dependency	.49 **	.69 **	.80 **	.81 **	.77 **	.52 **	(.78**)	.12 **	.11 *
Depth	.04	.07	.03	.15 **	-.14 **	-.04	.06	(.78**)	-.11 *
Closeness	-.02	.07	.07	.02	.16 **	-.04	.15 **	-.12 *	(.55**)

Note. \* $p < .05$ , \*\* $p < .01$   $n = 450$

**Table 4.** Correlation matrix for all variables in elementary school children

	Calling	Mailing	Internet	Sincerity-based emotional bond	Formality-based emotional bond	Information exchange	Emotional dependency	Depth	Closeness
Calling	(.66**)	.74 **	.42 **	.44 **	.38 **	.36 **	.45 **	-.03	-.01
Mailing	.69 **	(.79**)	.65 **	.53 **	.64 **	.41 **	.69 **	-.12	.07
Internet	.35 **	.65 **	(.53**)	.82 **	.85 **	.57 **	.92 **	-.02	.13
Sincerity-based emotional bond	.36 **	.65 **	.92 **	(.54**)	.78 **	.77 **	.91 **	.02	.10
Formality-based emotional bond	.33 **	.75 **	.75 **	.79 **	(.54**)	.77 **	.88 **	-.12	.14
Information exchange	.35 **	.64 **	.66 **	.82 **	.85 **	(.54**)	.66 **	-.09	.07
Emotional dependency	.35 **	.71 **	.90 **	.83 **	.87 **	.69 **	(.69**)	-.05	.17 *
Depth	-.13	-.10	-.03	-.07	-.14	-.15	-.07	(.69**)	-.08
Closeness	.09	.21 *	.11	.08	.21 *	.15	.18 *	-.06	(.44**)

Note. \* $p < .05$ , \*\* $p < .01$   $n = 150$

**Table 5.** Correlation matrix for all variables in junior high school students

	Calling	Mailing	Internet	Sincerity-based emotional bond	Formality-based emotional bond	Information exchange	Emotional dependency	Depth	Closeness
Calling	(.67**)	.48 **	.52 **	.56 **	.35 **	.47 **	.50 **	.33 **	-.09
Mailing	.53 **	(.85**)	.58 **	.43 **	.39 **	.26 **	.52 **	.18 *	.01
Internet	.55 **	.53 **	(.77**)	.71 **	.73 **	.61 **	.80 **	.12	-.09
Sincerity-based emotional bond	.45 **	.51 **	.79 **	(.68**)	.61 **	.74 **	.82 **	.34 **	-.07
Formality-based emotional bond	.33 **	.52 **	.71 **	.71 **	(.60**)	.55 **	.76 **	-.06	.06
Information exchange	.40 **	.26 **	.68 **	.80 **	.59 **	(.59**)	.55 **	.13	-.14
Emotional dependency	.46 **	.63 **	.80 **	.83 **	.76 **	.55 **	(.73**)	.19 *	.03
Depth	.24 **	.21 *	.10	.21 **	-.07	.11	.16 *	(.78**)	-.22 **
Closeness	-.07	.04	.05	.00	.12	-.15	.16 *	-.18 *	(.61**)

Note. \* $p < .05$ , \*\* $p < .01$   $n = 150$

**Table 6.** Correlation matrix for all variables in senior high school students

	Calling	Mailing	Internet	Sincerity-based emotional bond	Formality-based emotional bond	Information exchange	Emotional dependency	Depth	Closeness
Calling	(.61**)	.47 **	.23 **	.15	.11	.11	.18 *	-.03	-.03
Mailing	.33 **	(.80**)	.31 **	.14	.23 **	-.18 *	.38 **	.10	-.02
Internet	.17 *	.41 **	(.77**)	.38 **	.33 **	.16 *	.51 **	.05	.22 **
Sincerity-based emotional bond	.15	.20 *	.46 **	(.49**)	.16 *	.31 **	.60 **	.32 **	.09
Formality-based emotional bond	.03	.27 **	.41 **	.29 **	(.55**)	.30 **	.44 **	-.31 **	.22 **
Information exchange	-.05	-.09	.22 **	.33 **	.24 **	(.55**)	.04	-.19 *	.01
Emotional dependency	.13	.49 **	.58 **	.57 **	.52 **	.06	(.65**)	.26 **	.31 **
Depth	-.02	.04	.04	.32 **	-.25 **	-.09	.09	(.83**)	-.05
Closeness	-.11	-.04	.04	-.07	.23 **	-.08	.10	-.07	(.58**)

Note. \* $p < .05$ , \*\* $p < .01$   $n = 150$

For sincerity-based emotional bonds, the correlations between Questions 8 and 10 were .60 and .66 ( $p < .01$ ); for formality-based emotional bonds, the correlations were .37 and .41 ( $p < .01$ ) between Questions 5 and 7, .33 and .30 ( $p < .01$ ) between Questions 5 and 9, and .23 and .40 ( $p < .01$ ) between Questions 7 and 9; for emotional dependency, the correlations between Questions 1 and 4 were .38 and .56; for information exchange, the correlations between Questions 2 and 3 were .45 and .48 ( $p < .01$ ) (see Appendix 1).

In the same manner, scale scores for depth and closeness of friendship were calculated. Note that six questions were excluded from the following item analysis. Cronbach's alpha obtained for the first and second surveys for each scale were .91 and .91 for depth (30 questions) and .86 and .85 for closeness (13 questions) (see Appendix 2).

### Selection of an analysis model

As shown in Table 1, analysis models 1 to 10 were compared based on goodness of fit indices. Comparison was carried out for 14 patterns of variable combinations obtained from seven types of mobile phone use (amount of calling, amount of e-mailing, amount of Internet use, sincerity-based emotional bond, formality-based emotional bond, emotional dependency, and information exchange) x 2 characteristics of friendship (depth and closeness).

When comparing models, two types of comparison methods were used. In the first method, all paths for all three participant groups were made equivalent, and then constraints were gradually removed in the manner shown in Table 1. In the second method, among the three participant groups, the path for one group was made independent, and the paths for the remaining two groups were made equivalent. Then, the constraints were gradually removed. Note that the amount of calling, e-mailing, and Internet use for those who did not own a

mobile phone were translated into 0 seconds of calling, 0 seconds of Internet use, and 0 e-mail messages, respectively, and "strongly disagree" was selected as the response for questions regarding the purpose of e-mailing. Examination of AIC values for each model for all 14 combinations indicated that Model 10, where all paths were different for all three participant groups, had the lowest AIC value. Therefore, Model 10 was used in the remainder of the study. Since this model was a saturated model, the  $\chi^2$  value was 0. RMSEA was not obtained, NFI = 1.00, and CFI = 1.00.

### Estimating the effect of mobile phone use on friendship

To examine the effect of mobile phone use on depth and closeness of friendship, path coefficient values for each participant group in Model 10 were examined (Tables 7 and 8). For depth of friendship, examination of the standard partial regression coefficients did not indicate any significant effects in any of the participant groups (Table 7). As for closeness of friendship, there were no significant effects in elementary school children, while closeness of friendship decreased for junior high school students as the amount of internet use, sincerity-based emotional bonds, information exchange, and emotional dependency increased. For senior high school students, closeness of friendship increased as formality-based emotional bonds and emotional dependency increased (Table 8).

### Estimating the effect of friendship on mobile phone use

Next, causal relationships in the opposite direction were examined (Tables 7 and 8). For depth of friendship, examination of the standard partial regression coefficients did not indicate any significant effects in elementary school children. For junior high school students, deeper friendship resulted in more phone calls. For senior high school students, deeper friendship resulted in increased

emotional dependency and decreased formality-based emotional bonds and information exchange (Table 7).

As for closeness of friendship, there were no significant effects in elementary school children. For junior high school students, increased closeness resulted in increased e-mailing, and for senior high school students, increased closeness resulted in increased formality-based emotional

bonds and emotional dependency (Table 8). Furthermore, a cyclic relationship was observed in senior high school students, such that formality-based emotional bonds and emotional dependency influenced closeness of friendship, and closeness of friendship influenced formality-based emotional bonds and emotional dependency (Table 8).

**Table 7.** Effect of mobile-phone use on the depth of friendship. For each item, the first line shows a standardized path coefficient for which there was a significant effect of mobile phone use on friendship, and the second line shows a standardized path coefficient for which there was a significant effect of friendship on mobile phone use. Positive values indicate positive effects, and negative values indicate negative effects.

		School type		
		Elementary school	Junior high school	Senior high school
Calling	(Calling → Depth)			
	(Depth → Calling)		.17 **	
Mailing	(Mailing → Depth)			
	(Depth → Mailing)			
Internet	(Internet → Depth)			
	(Depth → Internet)			
Sincerity-based emotional bond	(Sincerity-based emotional bond → Depth)			
	(Depth → Sincerity-based emotional bond)			
Formality-based emotional bond	(Formality-based emotional bond → Depth)			
	(Depth → Formality-based emotional bond)			-.16 *
Information exchange	(Information exchange → Depth)			
	(Depth → Information exchange)			-.19 **
Emotional dependency	(Emotional dependency → Depth)			
	(Depth → Emotional dependency)			.13 *

Note. \* $p < .05$ , \*\* $p < .01$

**Table 8.** Effect of mobile phone use on the closeness of friendship

		School type		
		Elementary school	Junior high school	Senior high school
Calling	(Calling → Closeness)			
	(Closeness → Calling)			
Mailing	(Mailing → Closeness)			
	(Closeness → Mailing)		.09 *	
Internet	(Internet → Closeness)			
	(Closeness → Internet)		-.13 *	
Sincerity-based emotional bond	(Sincerity-based emotional bond → Closeness)			
	(Closeness → Sincerity-based emotional bond)		-.16 **	
Formality-based emotional bond	(Formality-based emotional bond → Closeness)			.20 **
	(Closeness → Formality-based emotional bond)			.18 **
Information exchange	(Information exchange → Closeness)			
	(Closeness → Information exchange)		-.17 **	
Emotional dependency	(Emotional dependency → Closeness)			
	(Closeness → Emotional dependency)		-.14 *	.20 **

Note \* $p < .05$ , \*\* $p < .01$

## Discussion

In this study, two hypotheses were tested. Overall findings and conclusions are first provided regarding the hypotheses in general, and then the results for each participant group are discussed in detail separately.

### Examination of the hypotheses

The first hypothesis was that mobile phone use would make friendship deeper. However, since previous studies found that exchange of e-mails that only contained necessary matters was associated with friendship being weak, we hypothesized that friendship would become superficial if a mobile phone was simply used to exchange information. However, we found no significant effects in any of the participant groups. Therefore, this hypothesis was not supported, and the effect of mobile phone use on depth of friendship was generally negligible.

The second hypothesis was that mobile phone use would increase closeness of friendship. The results indicated that, for junior high school students, closeness of friendship decreased as the amount of Internet use, sincerity-based emotional bonds, information exchange, and emotional dependency increased. For senior high school students, closeness of friendship increased as formality-based emotional bonds and emotional dependency increased. There were no other significant effects. Therefore, the results suggest that mobile phone use not only increased closeness of friendship, but also had different effects on junior high school students and senior high school students.

The following sections describe the findings and conclusions regarding the effects of mobile phone use on depth and closeness of friendship separately for elementary school students, junior high school students, and senior high school students. Note that the effects on senior high school students are discussed first, followed by junior high school students and elementary school children, based on the number of significant results.

### Effect of mobile phone use on friendship in senior high school students

The results of this study showed that, for senior high school students, closeness of friendship increased as formality-based emotional bonds and emotional dependency increased. Formality-based emotional bonds are generated by hiding true feelings and pretending to agree with others in order to maintain friendship. It seems reasonable that frequently engaging in such behavior would increase closeness, because these individuals are trying to behave in a way that their friends like. This behavior may also help maintain relationships because these individuals are blindly agreeing with their friends. It is also reasonable that closeness increased with increased emotional dependency,

where individuals feel lonely when they do not receive messages from their friends, because these individuals are casually and frequently exchanging their feelings.

In addition, the results suggested that, for senior high school students, there were causal relationships in the opposite direction. In particular, there was a cyclical relationship in which formality-based emotional bonds and emotional dependency increased closeness, and at the same time, closeness increased formality-based emotional bonds and emotional dependency. This is consistent with Naganuma and Ochiai (1998), who noted that psychological distance between friends was smallest in senior high school students. Therefore, in this age range, it seems that individuals have a strong sense of closeness and are careful not to make themselves disliked by others when interacting with them (Naganuma and Ochiai, 1998). Because of these friendship characteristics, closeness may increase formality-based emotional bonds, where individuals communicate with each other while hiding their true feelings, and emotional dependency, where individuals casually express and communicate their feelings, resulting in the establishment of the abovementioned cyclical relationship.

### Effect of mobile phone use on friendship in junior high school students

The results of this study indicated that, for junior high school students, closeness decreased as the amount of Internet use, sincerity-based emotional bonds, information exchange, and emotional dependency increased. One possible reason why increased Internet use decreased closeness is that the Internet does not have communication-oriented functions, such as calls or e-mail, and is designed for personal entertainment, such as viewing websites and downloading ringtones. Frequent Internet use therefore increases opportunities for individuals to enjoy the Internet alone, instead of opportunities to become closer to friends. As a result, closeness to friends may actually decrease with increased Internet use. Reasons for Internet use were not examined in this study, so future studies are necessary to clarify the types of Internet use that may lead to a decrease in closeness.

The results also suggested that, for junior high school students, sincerity-based emotional bonds, information exchange, and emotional dependency decreased closeness. Sincerity-based emotional bonds are generated through exchanging e-mails with friends that contain true feelings, and a deeper relationship can be established by expressing individuality to each other even though this may sometimes lead to conflicts or fights. Closeness, on the other hand, refers to a state in which individuals have an attached relationship, and are not aware of their own or the other person's individuality. It is therefore suspected that increased sincerity-based emotional bonds

resulted in decreased closeness because it is difficult to realize sincerity-based emotional bonds if individuals have a closely attached relationship. Information exchange also seemed to decrease closeness, likely because this type of communication only occurs when it is necessary. Furthermore, in contrast to senior high school students, emotional dependency in junior high school students led to a decrease in closeness. Emotional dependency is generally thought to increase closeness, but junior high school students exhibited the opposite trend. One hypothesis is that, compared to senior high school students, the concept of closeness is not firmly established in junior high school students (Naganuma and Ochiai, 1998); therefore, their desire for closeness is not strong to start with, and so this desire is satisfied when they use a mobile phone to exchange e-mails with friends that contain emotionally dependent content. Consequently, if emotional dependency through mobile phone e-mail compensates for closeness, increased emotional dependency may result in decreased closeness.

Overall, the results from junior high school students conflict with our hypotheses as well as the results for senior high school students, suggesting that mobile phone use has different effects on different age groups. These differences require further study.

#### Effect of use of a mobile phone on friendship for elementary school children

No significant effects were found for elementary school children. The percentage of children who own mobile phones is lower for elementary school children than for junior or senior high school students, and elementary school children use mobile phones mainly to communicate with their parents, while junior and senior high school students use them to communicate with their friends (Murakami and Maeda, 2006). Therefore, it is likely that mobile phone use only had a marginal effect on elementary school children in this study because they do not use mobile phones often. Note, however, that individuals now own a mobile phone at an increasingly younger age, and as mobile phone use spreads among young individuals, mobile phone use may have stronger effects on elementary school children. Therefore, continued examination of the effect of mobile phone use on younger individuals, such as elementary school children and junior high school students, is necessary.

#### Suggested future studies

In this study we examined the effect of mobile phone use on friendships in mobile phone users, and the results suggest topics that are worthy of future research. First, our study suggested that, for junior high school students, increased Internet use resulted in decreased closeness, but it is necessary to examine which Internet activities specifically influence friendship. Second, this study

described the effect of mobile phone use on depth and closeness of friendship, but the detailed mechanisms of how and why these effects were observed have not been clarified. For example, increased Internet use may decrease the number of opportunities for face-to-face communication, resulting in decreased closeness of friendship. Therefore, clarification of the mechanisms underlying our results is necessary, taking differences between developmental stages into account. Finally, results of this study show influences that occur over a two month interval, demonstrating that even short-term use of a mobile phone affects friendship. Examination of the effects of long-term mobile phone use are necessary in the future.

Although further research is necessary, as described above, we believe that this study is important because it successfully estimated causal relationships where mobile phone use influenced depth and closeness of friendship. Furthermore, this study illustrated differences in influences at different developmental stages.

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#### Appendix I. Questions about mailing

	Item
Sincerity-based emotional bond	
	8 I always reply honestly to e-mail from my friends.
	10 I always communicate my true feelings in e-mail.
Formality-based emotional bond	
	5 I sometimes lie in e-mail.
	7 I do not have to show my true feelings in e-mail.
	9 I sometimes say in my e-mail that I agree with my friends when I actually do not.
Information exchange	
	1 When exchanging e-mail messages, I try not to use pictograms or words that are not related to information to be communicated.
	4 I do not write long e-mail messages; I write only what needs to be communicated.
Emotional dependency	
	2 I think I will feel lonely if I do not receive any e-mail messages from my friends for a whole day.
	3 When little things happen, I sometimes talk about these events to my friends through e-mail.

**Appendix 2.** Questions about friendship

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	Item
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Depth	
2	I am always who I am when I interact with my friends.
10	I can honestly express my feelings to my friends.
27	I hide my true-self from my friends.(R)
47	I try not to show my friends who I really am.(R)
48	I have friends that I can talk about anything with.
3	My friends will listen to my problems.
11	My friends and I help each other when we have problems.
19	My friends help me when I have problems.
35	I have a few friends that we can talk about anything with each other.
4	I have a few friends who will never betray me.
12	Whatever happens, I can trust my friends.
20	My friends and I understand each other even though we aren't together all the time.
28	My friends are reliable.
36	My friends and I understand each other even though we do not spend much time together, and this is what friends are about.
13	I would like to be honest with my friends even if we may shock each other.
21	I would like my friends and myself to always show our true-selves to each other even though that may hurt each other a little.
37	I do not want to be hurt by being honest with my friends.(R)
29	I do not want to be honest with my friends if that hurts me.(R)
46	I do not mind being hurt by saying my honest opinions.
14	I do not want to rely on my friends.(R)
22	I cannot rely on my friends in the way I really want to.(R)
38	I can rely on my friends.
15	I try not to be too involved with my friends.(R)
23	My friendship is on a day-to-day basis.(R)
31	In many cases my friendship lasts only while I am with them.(R)
39	I feel more comfortable being alone than being with my friends.(R)
43	I have no problem living by myself without having any friends.(R)
25	I select friends depending on purposes. (R)
33	I try to select friends who are the best suited for occasions.(R)
41	I change which friends I spend time with from one day to another.(R)
Closeness	
9	I worry if I hurt my friends.
1	I am careful not to make my friends dislike me.
18	I maintain friendship while worrying about being disliked by them.
26	I try not to do anything that annoys or upsets my friends.
34	I try to make myself agreeable to all of my friends.
42	I am always conscious about the possibility of being disliked by my friends.
45	I try to blend in.
16	Shared secrets make friendship deeper.
24	I need to be with my friends all the time to make friendship work.
32	I am happy to share secrets with my friends.
40	My friends and I are connected through shared secrets.
44	My friends and I will not be able to understand each other unless we spend time together all the time.
49	Friends must spend all their time together in order to understand each other.

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*Note.* (R) is a reverse item.

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