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**A Socio-Ecological Context Moderates the Association  
between Communication Skills and Friendship  
Satisfaction: Possible Role of Relational Mobility**

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# **A Socio-Ecological Context Moderates the Association between Communication Skills and Friendship Satisfaction: Possible Role of Relational Mobility**

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Good communication skills facilitate successful interpersonal relationships. However, the specific communication skills (encoding and decoding) required for establishing friendships can vary depending on aspects of the social context. We conducted a two-wave longitudinal study in Japan to investigate the adaptive value of communication skills in different socio-ecological contexts (i.e., different stages of university life). New college students are immersed in a high-level relational mobility environment, where they have a greater range of options for forming new relationships and leaving old ones. Conversely, students beyond their second-year experience less relational mobility. Cross-lagged analyses indicated a positive association between decoding skill and friendship satisfaction 3 months later for senior students, who are likely to be in an environment characterised by low relational mobility. However, for first-year students in a high relational mobility environment, the association was negative, supporting our hypothesis. Conversely, encoding skill did not demonstrate an association with satisfaction 3 months later. However, it was positively associated with satisfaction at each time point. Another cross-lagged analysis revealed that satisfying relationships help improve encoding skills. We further explore the socio-ecological aspects related to the adaptive value of communication skills.

Keywords: Communication skills; Decoding; Friendship; Relational mobility; Social ecology

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## Introduction

Communication involves the sending and receiving of messages (Shannon, 1948). Brunswik's lens model proposes that communication behaviours act as mediators between senders and receivers. Hence, not all communicators possess equal competence in sending and accurately receiving messages (Brunswik, 1956; Laukka et al., 2016). Some individuals have a broader range of behaviours and utilise them more effectively to convey their intended messages. Likewise, certain receivers focus more on implications within senders' messages. In this paper, we explore the interactive effects of individual differences in these skills and contextual characteristics. As socio-ecological contexts alter how social relationships are formed and maintained (e.g., Kito et al., 2017), they may also constrain the skills necessary for successful communication.

### *Communication Skills*

'Communication skills' refers to an individual's ability to adapt and respond effectively in the context of communication (Burgoon et al., 1995; Feldman et al., 1991; Riggio, 1986; Riggio et al., 2003)<sup>1</sup>. As communication skills are critical in various aspects of social life, researchers from various fields have become interested in understanding individual differences in effective communication skills. For instance, clinical psychologists have identified impaired social skills in certain disorders like depression (Segrin, 2000), while developmental psychologists have examined skill deficits in children, particularly those with autism spectrum disorders (Bellini et al., 2007). Additionally, researchers in personality and social psychology have explored the fundamental dimensions of skills and their associations with individual and social factors, including extraversion (Riggio et al., 2003), self-esteem (Riggio et al., 1990), and gender (Hall & Bernieri, 2001; Hall et al., 2016).

Despite the broad range of studies across disciplines, the level of communication skills is linked to successful formation and maintenance of interpersonal relationships. Previous studies have shown that greater communication skills are associated with improved impression formation (Riggio & Friedman, 1986), perceived social support (Riggio et al., 1993; Segrin et al., 2016), satisfaction with college life including social and academic aspects (Riggio et al., 1993), decreased loneliness (Riggio & Kwong,

2009), and enhanced psychological well-being through positive interpersonal relationships (Segrin & Taylor, 2007).

While communication skills have often been considered a single generalised skill (Riggio et al., 1993; Segrin et al., 2016; Segrin & Taylor, 2007), Riggio (1986) proposed that communication skills consist of three basic components: expressivity, sensitivity, and control. These components correspond to encoding (sending information), decoding (receiving information), and emotion and behaviour regulation, respectively. Studies have highlighted the importance of distinguishing these components, as they contribute differently to interpersonal relationships.

For instance, good expressivity or encoding skills have been associated with reduced loneliness (DiTommaso et al., 2003; Riggio & Kwong, 2009; Riggio et al., 1990; but see Miczo et al., 2001). A cross-lagged longitudinal study also demonstrated a robust connection between improved encoding skills and decreased loneliness (Segrin, 1993). Conversely, findings regarding sensitivity or decoding skills have been mixed. Some researchers have found that higher sensitivity is related to satisfactory interactions (Hodgins & Zuckerman, 1990), better relationship quality (Hall et al., 2009), and lower loneliness (Zakahi & Goss, 1995). However, other studies have shown that good decoding skills are not significantly associated with loneliness (DiTommaso et al., 2003; Miczo et al., 2001) or have even indicated that they are linked to increased loneliness, depression, and anxiety (Riggio & Kwong, 2009). This suggests that high sensitivity may lead to overreacting to others' emotional and verbal messages. To address the complex and conflicting findings concerning the associations between communication skills, particularly decoding and successful interpersonal relationships, researchers may find considering the potential moderating effects of contextual factors beneficial. In this study, we explored the role of a socio-ecological factor that could alter the adaptive functions of different communication skills.

### ***Socio-Ecological Contexts and Communication Skills***

Relational mobility is a well-known socio-ecological factor that reflects extent to, which a society or social context provides individuals with opportunities to choose relational partners based on personal preferences (Yuki & Schug, 2012). High relational mobility environments (e.g., the USA) offer abundant opportunities for individuals to meet strangers and form relationships (Yuki & Schug, 2012). In contrast, low relational

mobility environments, like Japan, are characterised by stable and exclusive relationships that are not easily replaceable (Yuki & Schug, 2012). Notably, relational mobility varies across countries (e.g., Thomson et al., 2018).

Additionally and important to this study, relational mobility is not consistent within each country but can vary across social contexts. In Japan, Sato and Yuki (2014) conducted a survey approximately 1 month after the start of a school year (early May) and found that relational mobility among new college students was higher than among second-year students at the same university. This difference can be attributed to new college students having more opportunities to meet and form new friendships versus second-year students, whose relationships are more stable and exclusive (Sato & Yuki, 2014). Owing to the low level of relational mobility in Japan (Thomson et al., 2018; Yuki et al., 2013), first-year students (FYSs) at this time of year are expected to experience a unique state of relational mobility that decreases as they establish most of their relationships by the end of the semester.

High relational mobility has been associated with various psychological and behavioural tendencies that facilitate the formation of new relationships, such as a high level of trust in strangers (Thomson et al., 2018) and low privacy concerns on social networking sites (Thomson et al., 2015). Conversely, low relational mobility has been linked to psychological tendencies aimed at avoiding negative reputations, such as rejection sensitivity (Sato et al., 2014) and norm compliance based on the fear of negative evaluation (Iwatani et al., 2016). Considering these findings, the question arises as to, which communication skills best promote successful social relationships in different relational mobility contexts.

Some studies have explored this question by demonstrating that prevalent communication styles differ across socio-ecological contexts. Hall (1976) introduced the concept of low-context versus high-context cultures, suggesting that some Western cultures (e.g., North America) rely heavily on verbally explicit messages (low-context communication). Conversely, some East Asian cultures (e.g., Japan) place greater emphasis on contextual and nonverbal cues (high-context communication; see also Ishii et al., 2003). As relational mobility typically varies between Western cultures (high) and East Asian cultures (low) (Thomson et al., 2018), Hall's (1976) observation leads to the hypothesis that encoding skills are more crucial in relationally mobile contexts than in stable contexts. Conversely, decoding skills are more important in relationally stable

contexts than in mobile contexts. The following sections describe the rationale behind how relational mobility relates to different communication styles and skills.

### *High Relational Mobility, Low-Context Communication, and Encoding Skills*

In environments with high relational mobility, people are more likely to encounter strangers. As strangers typically do not share past experiences, assuming that they possess similar knowledge is somewhat impractical. In such situations, clear and precise communication becomes essential for mutual understanding. Therefore, a relationally mobile environment encourages individuals to employ explicit verbal expressions (i.e., low-context communication). These situations require strong encoding skills.

Apart from the necessity of encoding skills for low-context communication, they also serve a purpose in building successful interpersonal relationships in relationally mobile environments. Two potential reasons exist for this. First, encoding skills may help individuals avoid mismatches. In high relational mobility contexts, individuals should pursue desirable relationship partners instead of staying in existing relationships. However, finding individuals with similar preferences can be challenging as different people have different desires (e.g., one person may seek friends who love music, while another may prefer hiking enthusiasts). Hence, individuals are motivated to utilise active self-expression (Takemura & Suzuki, 2017) and explicit communication to increase the likelihood of a good match. While straightforward self-expression carries the risk of leaving negative impressions owing to differing tastes, this issue is less problematic in high-mobility environments. With more opportunities for relationship formation, the potential cost of being negatively perceived by someone is lower compared to low-mobility environments (e.g., Sato et al., 2014). As a result, individuals in high relational mobility contexts tend to be more active in pursuing favourable matches. Correspondingly, friends in high relational mobility environments tend to be more similar than in low-relational mobility contexts (Schug et al., 2009). Encoding skills, specifically the competence to express intentions and desires clearly, play a significant role in fulfilling this need.

Second, good encoding skills are crucial for attracting others, especially in high-relational-mobility environments. Such environments are competitive. Notably, relational mobility is a socio-ecological factor rather than a personal trait, indicating that a high degree of it denotes that *everyone* in the same social context have numerous

opportunities to meet new people (e.g., Takemura, 2014; Yuki et al., 2013). Consequently, individuals must compete to form desirable relationships. Failing to attract others can result in not being selected as a friend (Yuki & Schug, 2020, for a review) and encoding skills are necessary to effectively present oneself in this market-like environment.

Alternatively, encoding skills are of lesser importance or may even be detrimental when relational mobility is low. For example, in Japan, direct expression can lead to increased loneliness (Watanabe, 2008). Instead, people refrain from asserting their opinions in long-term relationships when anticipating conflict (Yoshitake, 1991). In low-relational-mobility environments, clear self-expression (e.g., expressing needs or goals) does not appear to reduce the risk of miscommunication. Conversely, it increases the likelihood of conflict. The Japanese, for instance, maintain their interdependent relationships not by sharing opinions and overcoming conflicts but by avoiding conflicts and subsequent rejection (Hashimoto & Yamagishi, 2013, 2016). People hesitate to express themselves to avoid being ostracised from their existing relationships (e.g., Hashimoto & Yamagishi, 2013, 2016; Sato et al., 2014). Ostracism poses a serious threat in low-mobility contexts owing to the scarcity of opportunities to form new relationships.

#### *Low Relational Mobility, High-Context Communication, and Decoding Skills*

In environments characterised by low relational mobility, individuals share a significant amount of accumulated knowledge. As a result, there is less need for explicit communication and reliance on high-context communication is more common. In such an environment, one's decoding skills are critical. Individuals benefit from strong decoding skills, which involve the ability to understand messages and the sender's intentions (Hall & Bernieri, 2001; Hall et al., 2016) and to infer meaning from less explicit cues. These skills enable individuals to adaptively navigate social life. Essentially, decoding skills help individuals understand what their relationship partners want from them and adjust their behaviour accordingly, even when the partners' expressions are unclear and implicit. Without sufficient decoding skills, individuals may fail to respond appropriately, leading to negative evaluations from their partners. Furthermore, they may develop a reputation as someone who does not share the accumulated knowledge, which poses a threat to their societal life because of an increased risk of rejection.

Conversely, in high-relational-mobility environments, the importance of decoding skills is expected to be relatively lower, as individuals rely more on explicit expressions, which constitute low-context communication. When messages are clearly verbalised in the environment, the risk of misunderstanding the sender's intention is correspondingly reduced, thereby requiring a relatively lower level of decoding skills. Furthermore, using an excess of decoding skills in such an environment can result in heightened sensitivity and overreacting to others' emotional and verbal messages (Riggio & Kwong, 2009). Additionally, dedicating more time to decoding and meeting the needs of diverse individuals in an environment characterised by high relational mobility may cause individuals to overlook opportunities to assert their own needs, desires, or even their 'market value'. Hence, in a high-mobility society, decoding skills alone are less likely to contribute to increasing the chances of forming compatible relationships or attracting others.

Notably, control skills pertain to the regulation of emotions and behaviours, and extensive studies exist on emotion regulation, which is sometimes discussed in the context of relational mobility (e.g., Schunk et al., 2023). However, attempting to address the similarities and differences between control skills and various components of emotion regulation (e.g., rumination, reappraisal, suppression) to formulate a hypothesis about control skills would have overly complicated this study. Additionally, our primary focus in this study was to contrast the roles of encoding and decoding skills in high- and low-relational-mobility environments. Therefore, we treated control skill as a control variable among the explanatory variables in this study, rather than subjecting it to hypothesis testing.

### ***The Present Study***

This study aims to investigate whether the association between communication skills (particularly decoding and encoding) and friendship satisfaction is moderated by the socio-ecological context. We chose to focus on friendship as it serves as a significant determinant of college life adjustment (Buote et al., 2007) and overall well-being throughout the lifespan (Chopik, 2017). Friendship satisfaction serves as a general measure of the perceived value derived from a friendship and is indicative of the quality of the friendship (Arroyo & Segrin, 2011).



Typically, scholars have relied on cross-cultural comparisons (e.g., between Japan and the United States; Yuki et al., 2007) to examine the effects of socio-ecological contexts. However, this approach comes with several limitations, such as failing to account for differences in languages, economies, or education systems. By comparing two or more social contexts within the same society, we can adopt a 'just minimal difference' paradigm (Uskul et al., 2008), which enables us to keep potentially confounding factors as constant as possible.

Considering this, we treated school grade as a contextual variable in this study, assuming that it represents different degrees of relational mobility. One group consisted of first-year students (FYSs) who had recently enrolled in a Japanese university, entering an environment characterised by high relational mobility and numerous opportunities to form new friendships. In addition, to the numerous opportunities for making new friends, first-year students (FYSs) should be motivated to do so to enhance their college life adjustment, which is expected to better elucidate the role of encoding skills (Buote et al., 2007). The other group consisted of senior students (SSs), including sophomores, juniors, and seniors, who were in a context characterised by low relational mobility because of their established social relationships during their years at the university (see Sato & Yuki, 2014, for a description of this research strategy). By comparing these two groups of Japanese students, we were able to investigate the moderating role of the socio-ecological context on the significance of encoding and decoding skills for achieving a successful social life.

Notably, the hypothesised mechanisms through which socio-ecological contexts moderate the association between encoding/decoding skills and friendship satisfaction operate at the context level. Essentially, as the hypothesised processes involve interpersonal dynamics, the importance of encoding/decoding skills is determined not only by the opportunities an individual has but also by those available to others within the shared context. For example, suppose there is only one person who has numerous opportunities for forming new relationships. Conversely, others in the same environment do not (or at least do not perceive so). In this situation, many people are expected to engage in high-context rather than low-context communication. Hence, the individual in question needs good decoding skills to facilitate meaningful communication with them. Additionally, in such an environment, the individual does not need to endeavour to 'sell' themselves as competition for relationship partners is not prevalent, which reduces the necessity of possessing high encoding skills. Therefore,

individual-level differences in perceived relational mobility within the same context may not exhibit the hypothesised moderating effect.

Nevertheless, for the purpose of comparison, we incorporated students' self-reported perceived relational mobility scores in addition to the binary context-level variable of relational mobility (i.e., grade: FYS versus SS). By measuring perceived relational mobility on an individual basis, we can compare the extent to which relational mobility at the context level versus the individual level moderates the association between communication skills and friendship satisfaction. Similarly, we also explored a self-relevant measure of relational mobility: the number of new acquaintances individuals had recently encountered (Schug et al., 2010). This individual-level measure, referred to as personal relational mobility, shares the theoretical foundation of relational mobility but differs in focus. It shifts attention to the self and provides a personal history of the opportunities individuals have actually had to form new relationships. In contrast, the relational mobility scale (Yuki & Schug, 2012) directs attention to the socio-ecological environment and gauges the general perception of the availability of new relationships within the local society. As previously mentioned, individual-level differences in the amount of opportunity to form new relationships within the same context may not exhibit the hypothesised moderating effect. We believe that including this measure along with the other collectively contributes to the empirical testing of whether context-level variance or individual-level variance moderates the association between communication skills and friendship satisfaction.

To conduct our study, we implemented a two-wave survey at the beginning (T1) and the end (T2) of the semester and performed a cross-lagged analysis to examine the association between communication skills and friendship satisfaction. In our analysis, we included the respondent variable measured at T1 as an explanatory variable addressing within-person variances. While a cross-lagged analysis with two-wave data cannot establish causation (Ployhart & MacKenzie, 2014), it offers a more robust analysis compared to simple cross-sectional studies.

First, we hypothesised that the socio-ecological context, measured by grade (Sato & Yuki, 2016), would be related to differences in the level of perceived relational mobility and the number of new acquaintances:

H1a: FYSs will have a higher level of perceived relational mobility compared to SSs.

H1b: FYs will have a greater number of new acquaintances compared to SSs. Subsequently, we conducted cross-lagged analyses using the binary context-level variable (grade) to test the following hypothesis

H2: Among FYs, encoding skills at T1 will be more positively associated with friendship satisfaction at T2.

H3: Decoding skills at T1 will be more positively associated with friendship satisfaction at T2 among SSs than FYs.

Regarding the individual-level relational mobility variables (i.e., perceived relational mobility, number of new acquaintances), we explored whether they moderate the association between encoding/decoding skills at T1 and friendship satisfaction at T2. Although we assume that the moderating role occurs at the context level (i.e., grade), these explorations are expected to reveal the varying roles played by different levels of relational mobility.

Furthermore, while we assumed that communication skills would be associated with satisfaction in interpersonal relationships, as suggested in the literature, it is important for scholars to consider the possibility of the reverse direction of association: satisfying relationships may also enhance communication skills (Connell & Prinz, 2002). To gain a better understanding of the directionality of the association, we also examined the potential link between satisfaction at T1 and self-perception of communication skills at T2. For these purposes, we proposed and investigated the following hypotheses.

## **Methods**

### ***Participants and Procedure***

We conducted a two-wave survey with undergraduate students from two Japanese universities. Data were collected in early April (T1) and mid-July (T2) 2016. Participation was voluntary and the students received no compensation for their involvement. The study procedures were approved by the ethics committee of *Name Withheld University*.

The same paper-and-pencil questionnaire was administered at both time points. Although 406 and 334 students completed the questionnaire at T1 and T2, respectively, there was a considerable attrition rate among those who completed both surveys during the semester. This may be because of the voluntary nature of participation and the

timing of the first survey (T1) coinciding with a period when students could change their coursework. The final sample for subsequent cross-lagged analysis consisted of 175 students who completed both questionnaires (97 female, 77 male, 1 unknown).<sup>2</sup>

Notably, the current sample size remained comparable to a previous study that demonstrated the relationship between greater decoding skill and higher levels of loneliness, depression, and anxiety ( $N = 178$ ; Riggio & Kwang, 2009). Among the 175 students ( $M_{\text{age}} = 18.90$ ,  $SD_{\text{age}} = 1.24$ ), 95 were FYs and 80 were SSs (49 sophomores, 23 juniors, 8 seniors).<sup>3</sup> The findings of the cross-sectional analysis with the complete sample at T1 and T2 can be found in the Supplementary Results (Table S1, S2).

## ***Questionnaire***

### *Relational Mobility*

We employed Yuki et al.'s (2007) relational mobility scale, which consists of 12 items designed to measure participants' perceptions of their surrounding situations. Respondents rate items such as 'They [i.e., individuals in my immediate society] can choose who they interact with' and 'It is easy for them to meet new individuals' on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*).

### *Number of New Acquaintances*

To assess the number of new acquaintances, participants were asked to indicate the number of new people they had met in the past month (Schug et al., 2010). We used the reported number for subsequent analysis.

### *Communication Skills*

We employed Encode–Decode 2 (ENDE 2; Horike, 1994), a widely used communication skills scale in Japan based on Riggio (1986). The scale measures three factors of communication skills: encoding (e.g., 'Telling others exactly how I feel'), decoding (e.g., 'Reading feelings from others' gestures') and control (e.g., 'Getting along with individuals by controlling my feelings'). There were five items for each factor. The questionnaire asked participants to reflect on their relationships with others at school and select the number that corresponds to their thoughts on the provided

statements, using a 5-point Likert scale ranging from 1 (*I cannot*) to 5 (*I can*). As this scale measured participants' self-perceptions, we will refer to the variable as *perceived communication skill* hereafter.

### *Friendship Satisfaction*

The friendship satisfaction subscale from Uchida's (1990) life-feeling scale was utilised. Specifically, this included three items that exhibited a relatively high loading to the original factor: 'I feel like there's no one who really understands me' (reversed), 'I feel very much in touch with my friends,' and 'I am well accepted by my friends at school.' We added two items directly assessing satisfaction: 'I'm satisfied with my friendships at school' and 'Recently, I find myself lonely at school' (reversed). Participants rated their responses on a 5-point Likert scale ranging from 1 (*very rarely*) to 5 (*very often*).

### *Analytical Approach*

Initially, we conducted a measurement invariance test (Ployhart & MacKenzie 2014) to assess whether our data met the prerequisite for unbiased cross-temporal analysis. Specifically, the focus was on friendship satisfaction and encoding and decoding skills as they were treated as the respondent variables in the cross-lagged analysis. To achieve this, we performed a confirmatory factor analysis with several constraints using the 'cfa' function in the *lavaan* package to examine if each factor retained an invariant structure. Notably, the possibility of correlation between each item across the two time points was considered (see Figure 1). Constraints were applied incrementally to the parameters in the model. In the configural model, no constraints were added to factor loadings, item intercepts, and residual variances, allowing them to vary freely across waves. In the weak model, we constrained factor loadings to be equal across waves. The strong model introduced additional constraints to make the item intercepts equivalent across waves. Finally, the strict model constrained the residual error of each factor to be equal across waves.

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Figure 1 here  
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Subsequently, we examined whether perceived relational mobility (H1a) and

number of new acquaintances (H1b) differed between FYSs and SSs. Grade (FYS, SS) served as the between-subjects factor, while time (T1, T2) was the within-subjects factor. The associations between perceived communication skills and friendship satisfaction were then examined through a cross-lagged analysis of perceived communication skills at T1 and friendship satisfaction at T2. H2 focuses on encoding skills, while H3 addresses decoding skills. Binary grade (FYS, SS) was utilised as a socio-ecological context variable to test H2 and H3. Furthermore, the role of perceived relational mobility and the number of new acquaintances measured at the individual level were explored separately for comparison in distinct models.

In addition, to these cross-lagged analyses, the reverse direction was investigated—specifically, whether friendship satisfaction at T1 is related to perceived communication skills at T2. Considering notable gender differences in communication skills reported by previous researchers (Hall & Bernieri, 2001; Hall et al., 2016), participants' self-reported gender was included as a control variable, except when examining H2 and H3.

## Results

Table 1 summarises the descriptive statistics, Cronbach's alpha reliability coefficients, and bivariate correlations at each time point (T1 and T2). Notably, neither encoding and decoding skills nor friendship satisfaction showed significant differences between T1 and T2 ( $ts[174] < 1.40$ ,  $ps > .164$ ).

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Table 1 here  
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To assess whether our data meet the prerequisites for unbiased cross-temporal analysis, we conducted the measurement invariance test. The results do not appear to be greatly supportive of the measurement invariance, particularly regarding encoding skills. However, they do not seem to be entirely rejective of it either (see Table 2).

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Table 2 here  
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### ***Relational Mobility***

To examine whether different grades correspond to varying levels of relational mobility as a socio-ecological variable, we performed a 2 (grade: FYS, SS)  $\times$  2 (time: T1, T2) mixed analysis of variance for perceived relational mobility scores and the number of new acquaintances. Grade served as the between-subjects factor and time as the within-subjects factor. As hypothesised, the main effect of grade was significant for perceived relational mobility ( $M_{\text{FYS}} = 4.122$ ,  $SD_{\text{FYS}} = 0.499$  vs.  $M_{\text{SS}} = 3.804$ ,  $SD_{\text{SS}} = 0.566$ ),  $F(1, 172) = 15.79$ ,  $p < .001$ ,  $\eta_p^2 = .084$  (Figure 2). Additionally, the main effect of time was also significant,  $F(1, 172) = 7.91$ ,  $p = .006$ ,  $\eta_p^2 = .044$  (see also Table 1). However, the interaction effect for grade and time was non-significant,  $F(1, 172) = 0.25$ ,  $p = .620$ ,  $\eta_p^2 = .001$ . For a more extensive 4  $\times$  2 ANOVA using grade as non-binary (freshmen, sophomores, juniors, seniors; between-subjects) and time (T1, T2; within-subjects), please refer to Supplementary Results (Table S3).

Similarly, the 2  $\times$  2 ANOVA using binary grade (FYS, SS; between-subjects) and time (T1, T2; within-subjects) for the number of new acquaintances revealed significant main effects of grade ( $M_{\text{FYS}} = 15.31$ ,  $SD_{\text{FYS}} = 13.04$  vs.  $M_{\text{SS}} = 7.79$ ,  $SD_{\text{SS}} = 8.50$ ,  $F(1, 173) = 19.58$ ,  $p < .001$ ,  $\eta_p^2 = .102$  (Figure 2) and time,  $F(1, 173) = 26.77$ ,  $p < .001$ ,  $\eta_p^2 = .134$  (see also Table 1). However, the interaction effect for grade and time was non-significant,  $F(1, 173) = 4.52$ ,  $p = .035$ ,  $\eta_p^2 = .026$ . For a more detailed analysis, see Supplementary Results (Table S3) for a further 4 (non-binary grade)  $\times$  2 (time) ANOVA.

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Figure 2 here  
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### ***Cross-Lagged Analysis***

To investigate whether socio-ecological contexts moderate the association of perceived communication skills (i.e., decoding and encoding) with friendship satisfaction, a cross-lagged analysis was conducted with friendship satisfaction at T2 as the respondent variable. Explanatory variables included self-reported gender, encoding and decoding skills, and friendship satisfaction, all measured at T1. Additionally, two-way interaction effects with binary grade were included for hypothesis testing (see Table 3). Moreover,

for comparison, cross-lagged analyses were also performed using perceived relational mobility or the number of new acquaintances as explanatory variables.

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Table 3 here

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We found no significant interaction effect between perceived encoding skill and relational mobility (binary grade, perceived relational mobility, or number of new acquaintances) on satisfaction, which does not support H2. Conversely, as predicted by H3, there was a significant interaction effect between perceived decoding skill and grade ( $p = .003$ , see Table 3). Among SSs, self-perceived decoding skill showed a significant and positive association with satisfaction ( $b = .275$ ,  $SE = .130$ ,  $p = .036$ ), while among FYs, it showed a significant and negative association with satisfaction ( $b = -.225$ ,  $SE = .106$ ,  $p = .035$ ) (Figure 3). The perceived relational mobility and number of new acquaintances, measured at the individual level, had no significant main and interaction effects.

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Figure 3 here

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To explore the possibility that friendship satisfaction at T1 being associated with self-perception of communication skills at T2, we conducted another cross-lagged analysis (Table 4). The results revealed that satisfaction at T1 was significantly and positively associated with perceived encoding skill at T2. However, satisfaction at T1 did not show a significant association with perceived decoding skill at T2. These patterns generally remained consistent even after including relational mobility (see also Tables S5 and S6 in Supplementary Results).

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Table 4 here

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## Discussion

In this study, our aim was to investigate whether the socio-ecological context moderates the association between communication skills and friendship satisfaction. Through a two-wave survey, we observed that first-year students (FYs) reported higher relational



mobility and had more new acquaintances compared to senior students (SSs), which supports H1a and H1b, consistent with previous literature (Sato & Yuki, 2014; Thomson et al., 2018; Yuki et al., 2013). Additionally, relational mobility and the number of new acquaintances decreased from T1 to T2 as students established most of their new relationships.<sup>4</sup>

The results of the cross-lagged analysis did not show any significant interaction effect between perceived encoding skill at T1 and grade on satisfaction at T2, contradicting H2 and previous studies (e.g., Segrin, 1993). Surprisingly, there was no significant main or interaction effect for perceived encoding skill. This finding may be attributed to the tendency of Japanese individuals to avoid conflicts and subsequent rejection by not asserting themselves (Hashimoto & Yamagishi, 2013, 2016). However, the cross-sectional analysis results (Table 1), supporting previous literature (DiTommaso et al., 2003; Riggio & Kwong, 2009; Riggio et al., 1990), revealed that higher encoding skill was associated with greater friendship satisfaction at both T1 and T2. Thus, the non-significant results in the cross-lagged analysis may stem from the lack of invariance of the encoding skills measure across the two time points, making it unsuitable for longitudinal analysis (Ployhart & MacKenzie, 2014). Alternatively, in the association between encoding skill and friendship satisfaction, satisfaction may precede encoding skill rather than the other way around. Importantly, the additional cross-lagged analysis demonstrated that satisfaction at T1 significantly related to perceived encoding skill at T2, indicating that individuals who had satisfying relationships at T1 learned to express themselves more effectively by T2 (Table 4).

Regarding the moderating role of socio-ecological contexts, it was expected that individuals in high relational mobility environments would benefit from higher encoding skills as they increase the likelihood of positive matches (Takemura & Suzuki, 2017). However, this was not supported by our study. None of the relational mobility variables at the context- and individual-level (i.e., binary grade, perceived relational mobility, number of new acquaintances) showed significant interaction effects with perceived encoding skill on friendship satisfaction. One possible reason is that freshmen (FYs) in their high relational mobility environment may not be accustomed to finding and building new relationships through clear self-expression. Just a few weeks before T1, the freshmen were in high school—an environment in, which relationships were predetermined and inflexible. Their unfamiliarity with being expressive would weaken the relationship between their encoding skills and friendship satisfaction.

Meanwhile, the association between perceived decoding skill at T1 and satisfaction at T2 was moderated by binary grade, supporting H3. The results indicated that higher decoding skills were associated with greater friendship satisfaction when relational mobility was low (e.g., SSs). However, the association was reversed when relational mobility was high (e.g., FYSs). In environments with low relational mobility, minimising the risk of being ostracised from existing relationships is more important as opportunities to create new relationships are limited (e.g., Sato et al., 2014). Individuals with high decoding skills who can understand their relationship partners' intentions would be able to effectively manage such risks and establish satisfactory relationships.

However, in high relational mobility environments, greater decoding skills inhibit the development of satisfying interpersonal relationships. Previous studies have shown that sensitive individuals can be overly sensitive and overreact to others' emotional and verbal messages (Riggio & Kwong, 2009). In situations where many individuals come and go without time to become deeply involved, attempting to understand messages from unfamiliar others requires special effort. Intensely exerting decoding skills may be too demanding and less effective in establishing desirable friendships in high relational mobility situations. Another possible explanation is that individuals with high decoding skills may lose opportunities to establish their own market value in a relationally mobile environment where people frequently move around and meet and part ways while attempting to decode and meet the needs of different individuals. Although further investigation is needed, our results provide a possible explanation for the mixed evidence on the relationship between decoding skill and well-being in previous studies (DiTommaso et al., 2003; Hall et al., 2009; Hodgins & Zuckerman, 1990; Miczo et al., 2001; Riggio & Kwong, 2009; Zakahi & Goss, 1995): Decoding skills should benefit individuals in socio-ecological contexts of low relational mobility but could be unhelpful or harmful in situations where relational mobility is high.

Notably, we found a moderating role at the context level, rather than the individual level, which aligns with our hypothesis. Specifically, decoding skills were expected to be crucial for individuals in low-mobility contexts as they interact with others who are unwilling to express themselves clearly. The limited opportunities to form new relationships contribute to their ambiguous expressions. This hypothesis suggests that the behaviour of *others* in the same context moderates the significance of communication skills. This emphasises the importance of theorising context-level

processes, which do not simply extend linearly from individual-level processes (e.g., Schelling, 1978). Indeed, perceived relational mobility and the number of new acquaintances, measured at the individual level, did not serve as significant moderators, possibly owing to the discrepancy between theorising and measurement.<sup>5</sup> If the hypothesised processes involve interpersonal dynamics such as competition (e.g., Takemura, 2014) and communication, an individual's personal perception may not greatly determine the outcome, as others' perceptions and behaviours also matter. Takemura (2014) found similar results to this study, indicating that *context-level* relational mobility was associated with the adaptive value of a high need for uniqueness in a high relational mobility society. Conversely, individual-level relational mobility did not show the same pattern. The present findings provide evidence that social contextual factors and personal factors (e.g., communication skill, an internal factor) are intertwined and related to later friendship satisfaction. Essentially, the adaptive value of communication skills depends on socioecology.

Considering that friendship significantly pertains to college life adjustment (Buote et al., 2007) and well-being throughout life (Chopik, 2017), the current findings have practical implications, particularly for intervention studies aimed at improving communication skills. Many researchers have investigated skill training programmes in various domains. Some have examined theoretical models of social skill training (e.g., Ladd & Mize, 1983), while others have focused on the effectiveness of skill training programmes in different contexts, such as schools (Cooker & Cherchia, 1976) and medical settings (Boissy et al., 2016). However, based on our literature review, no researchers have specifically addressed relational mobility within individuals' contexts. Through this study, we have demonstrated that the adaptive value of each communication skill, especially decoding, depends on the level of relational mobility present in a particular context. If skill training aims to enhance well-being, it should include skills that align with the relevant level of relational mobility.

### ***Limitations and Future Work***

One important limitation is embedded in the quasi-experimental design, which makes concluding that relational mobility *is* the moderator of the association between communication skills and friendship satisfaction impossible. Unlike cross-cultural comparisons that inevitably involve several confounding factors, our approach (i.e., comparing two similar groups within a single country) aimed to control for as many

potential confounding factors as possible. However, some confounding factors have not been completely ruled out. For example, college students' class year could have been confounded with specific coursework and grade-related experiences. As our participants were from two Japanese universities with different course works, any single effect is unlikely to have fully confounded with binary grades. However, it is unreasonable to deny the possibility of unforeseen confounding factors. Therefore, the current findings cannot be directly attributed to the role of relational mobility, even though our binary grade variable represented the different levels of relational mobility.

Nevertheless, we would like to emphasise the importance of accumulating context-level data and findings across studies, not necessarily within a single study. Studying context-level phenomena is challenging. On one hand, collecting context-level data (group data) is often more costly than individual-level data. It requires a large budget and manpower, making the accumulation of context-level findings in a balanced manner difficult not only from developed societies but also from developing societies, as a global research community. On the other hand, relatively low-cost approaches such as two-context comparisons often face concerns about confounding factors. To overcome this challenge, it is important to accumulate findings from multiple studies and papers. Even if individual studies (and papers) involve two-group comparisons, the possible interpretations can be narrowed down by considering multiple studies with different types of two-group comparisons (e.g., rural versus urban in the same region, a company with high mobility versus a similar company with low mobility) together probably through a meta-analysis. This approach helps us collectively address the difficulties in examining hypotheses on context-level phenomena.

Yet another limitation is that we did not examine possible mediating processes; thus, the question of how perceived decoding skill produces satisfaction or dissatisfaction remains unclear. One possible mediator may be the lower number of interpersonal conflicts experienced by individuals with strong decoding skills. When relational mobility is low, maintaining existing relationships and avoiding ostracism are important as opportunities to create new relationships are limited. Individuals with high decoding skills can understand their relationship partners' requirements and, therefore, prevent conflicts, thereby establishing satisfying relationships.

Decoding fatigue, caused by overreacting to the communication of others (Riggio & Kwong, 2009), could potentially act as another mediator. In a setting characterised by high relational mobility, where individuals with diverse personal needs

and preferences come and go, decoding all their communications would require a significant investment of cognitive and emotional resources from individuals committed to relational sensitivity. This investment may hinder the quality of their relationships. Further research should directly test these potential mediators.

In this study, we relied on self-reports of communication skills, which may not always accurately reflect an individual's actual ability. For instance, individuals with low communication skills may consider themselves good communicators. Hence, obtaining ratings of individuals' communication skills from those around them would provide informative insights (e.g., Arroyo & Segrin, 2011; Wilson et al., 2015). Additionally, studies on communication skills have primarily focused on face-to-face communication. Shifting attention to online communication and the skills required for this modern form of interaction is necessary. Although our procedures did not explicitly instruct participants to assume either face-to-face or online communication, given that the study was conducted before the outbreak of the novel coronavirus pandemic, participants are likely to have assumed face-to-face communication owing to their primarily campus-based school lives involving predominantly face-to-face interactions. Conversely, during the pandemic, online communication through electronic meeting platforms (e.g., Zoom) and social networking services (e.g., Facebook and Instagram) became essential aspects of daily life.

While encoding skill did not demonstrate a clear impact on friendship satisfaction in this study, online communication could amplify the importance of this skill owing to the potentially higher relational mobility in online interactions compared to face-to-face interactions (e.g., individuals can communicate with others worldwide without the need for physical travel). Applying the framework of socio-ecological contexts or relational mobility to online communication could yield valuable insights for investigators studying the role of communication skills in this context.

Furthermore, researchers should examine whether the findings of this study can be generalised to a broader cultural context (e.g., Kitayama et al., 2022). In this study, decoding skills were deemed critical in the low-relational-mobility context (i.e., Japan) because of the higher reliance on high-context communication. However, in other non-Asian interdependent cultural contexts where factors such as self-assertion or greater extent of emotional expressions dominate (e.g., Arab, Latin America; Kitayama et al., 2022), individuals may rely more on explicit expressions (i.e., low-context communication) even in a low-relational-mobility society. If this is the case, decoding

skills may not be as necessary. As the relationship between different types of interdependence (Kitayama et al., 2022) and relational mobility is not yet well understood, further investigation is needed to confirm the value of communication skills in a wide variety of cultural and socio-ecological contexts.

## Footnotes

<sup>1</sup>Communication skills have been referred to by various terms such as *social skills*, *social competence*, or *communicative competence* in diverse research fields. Despite the differences in terminology, these concepts share a common core. In this study, we use the term ‘communication skills’ to encompass the range of skills that generally indicate competence in communication.

<sup>2</sup>To investigate the potential impact of attrition, we compared the main variables (i.e. three control skills and friendship satisfaction) measured at T1 between participants who completed both surveys and those who completed only the first survey. The results of the attrition analysis indicated no significant differences in the encode skill:  $t(383.16) = 0.27$ ,  $p = .785$ , the decode skill:  $t(371.18) = 0.21$ ,  $p = .833$ , the control skill:  $t(365.58) = 0.51$ ,  $p = .613$ ; or friendship satisfaction:  $t(359.39) = 0.63$ ,  $p = .532$ . These findings suggest that attrition occurred randomly and did not have a systematic impact on the main analysis.

<sup>3</sup>We calculated the statistical power for the multiple regression that utilised binary grade as a variable using the ‘pwr.f2.test’ function from the *pwr* package of R, which offered a power of .955 under the medium effect size of multiple regression ( $f^2 = 0.15$ , Cohen, 1992), with 11 predictors, a sample size of 175 and a significance level of 0.05.

<sup>4</sup>When examining each grade more specifically, we observed that relational mobility among seniors was as high as among freshmen (see also Table S3 in Supplementary Results). This somewhat surprising result seems to be related to the unique tendency in Japanese job hunting, where most future graduates begin job hunting together in the spring, at the end of their third year of university. As they visit numerous companies and meet many people, including other future graduates, during this period, their relational mobility may become higher than usual.

<sup>5</sup>We also conducted multilevel modelling, considering both perceived relational mobility and the number of new acquaintances at the individual and context levels. The context-level variables were calculated as the means for each grade (freshman, sophomore, junior, and senior). For the multilevel modelling, we utilised the ‘lmer’ function from the *lmerTest* package. The model includes a random intercept of grade. The model included a random intercept of grade. The results revealed a significant interaction effect between perceived

decoding skill and each of the context-level variables (see Table S4 in Supplementary Results). As the direction of the interaction effects was consistent with the binary grade, these findings collectively suggest that a context-level factor moderates the relationship. However, having only four groups (i.e.,  $N = 4$  at the context level) was insufficient for multilevel modelling (Maas & Hox, 2005)

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### **Declaration of interest statement**

The authors declare that there are no conflicts of interest.

### **Data availability statement**

Data reported in the study and code analysis are accessible at the Open Science Framework website (*Anonymous for the review*).

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Table 1. Descriptive statistics, reliability coefficients, and bivariate correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12
Time 1												
1. RM												
2. NNA	.105											
3. EN	.211**	.032										
4. DE	.093	-.049	.442**									
5. CN	.085	.007	-.190*	.159*								
6. FS	.250**	-.020	.273**	.237**	-.066							
Time 2												
7. RM	.656**	.164	.225**	.121	.032	.278**						
8. NNA	-.013	.406**	.036	-.073	.009	.057	-.013					
9. EN	.313**	.045	.622**	.253**	-.168*	.304**	.306**	-.030				
10. DE	.203**	-.046	.262**	.507**	.149	.171*	.097	-.041	.336**			
11. CN	.227**	.080	-.096	.089	.613**	-.003	.254**	.058	-.136	.205**		
12. FS	.276**	-.050	.256**	.146	-.125	.602**	.290**	-.044	.415**	.220**	.076	
<i>M</i>	4.031	14.963	3.297	3.419	3.423	3.425	3.923	8.789	3.358	3.420	3.313	3.490
<i>SD</i>	0.593	13.470	0.653	0.636	0.653	0.773	0.609	14.626	0.673	0.582	0.645	0.736
Cronbach's $\alpha$	.819	n/a	.637	.742	.611	.779	.838	n/a	.707	.720	.636	.750

*Note.*  $N = 175$ . RM: Relational mobility, NNA: Number of new acquaintances (single item), EN: Encoding skill, DE: Decoding skill, CN: Control skill, FS: Friendship satisfaction. \* $p < .05$ . \*\* $p < .01$ .

Table 2. Summary of the model-fitting measures of the confirmatory factor analysis

	Satisfaction		Encode		Decode	
	CFI	RMSEA	CFI	RMSEA	CFI	RMSEA
Configural	.936	.088	.891	.100	.980	.043
Weak	.927	.088	.887	.096	.953	.061
Strong	.929	.082	.863	.099	.947	.061
Strict	.926	.079	.864	.093	.952	.055



Table 3. Association between perceived communication skills and friendship satisfaction in cross-lagged analysis

	Satisfaction					
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	3.504**	0.079	3.452**	0.061	3.448**	0.061
Gender	0.040	0.094	0.057	0.091	0.097	0.094
Satisfaction	0.636**	0.091	0.516**	0.062	0.552**	0.062
Encode	0.137	0.112	0.066	0.085	0.118	0.084
Decode	-0.225*	0.106	0.031	0.085	-0.017	0.084
Control	-0.070	0.100	-0.154	0.078	-0.093	0.074
Grade	-0.077	0.091				
Grade × Satisfaction	-0.157	0.123				
Grade × Encode	-0.188	0.166				
Grade × Decode	0.501*	0.168				
Grade × Control	-0.050	0.146				
Relational mobility			0.197*	0.090		
Relational mobility × Satisfaction			-0.055	0.094		
Relational mobility × Encode			0.138	0.149		
Relational mobility × Decode			-0.008	0.148		
Relational mobility × Control			0.229	0.102		
Num. new acquaintances					-0.004	0.003
Num. new acquaintances × Satisfaction					0.011*	0.005
Num. new acquaintances × Encode					-0.002	0.005
Num. new acquaintances × Decode					-0.002	0.007
Num. new acquaintances × Control					-0.008	0.006

$R^2$	0.413	0.411	0.398
Adjusted $R^2$	0.376	0.375	0.361
$F$ Statistic	11.440**	11.370**	10.790*

*Note.* Explanatory variables were measured at T1; the respondent variable was measured at T2. Gender (0 = female, 1 = male) and Grade (0 = FYS, 1 = SS) are a binary dummy code. Relational mobility and Num. new acquaintances were centred. Weights in Table 3 are not standardised. \* $p < .05$ . \*\* $p < .01$ .

Table 4. Summary of cross-lagged analysis of perceived communication skills

	Encode		Decode	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	3.297**	0.053	3.415**	0.052
Gender	0.136	0.081	0.008	0.078
Satisfaction	0.133*	0.054	0.039	0.052
Encode	0.622**	0.072	0.059	0.070
Decode	-0.039	0.073	0.413**	0.071
Control	-0.043	0.064	0.082	0.063
<i>R</i> <sup>2</sup>	0.417		0.265	
Adjusted <i>R</i> <sup>2</sup>	0.400		0.243	
<i>F</i> Statistic	24.070**		12.12**	

*Note.* Explanatory variables were measured at T1; the respondent variable was measured at T2. Gender is a binary dummy code (0 = female, 1 = male). Weights in Table 4 are not standardised. \**p* < .05. \*\**p* < .01. A full table with the variables of relational mobility is in the Supplementary Results.

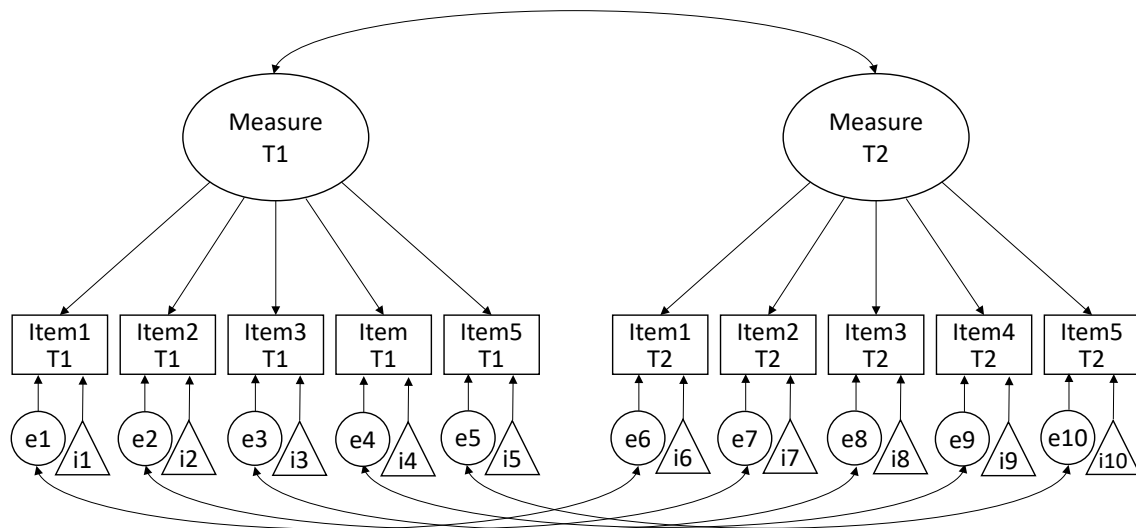


Figure 1. Confirmatory factor analysis for the measurement at T1 and T2 (i.e., friendship satisfaction and communication skills). Ovals represent the latent variables. Rectangles labelled represent the measured items. Their corresponding factor loadings are shown as arrows to the latent variables. Triangles represent the item intercepts; circles represent the residuals. Double-headed arrows represent covariances.

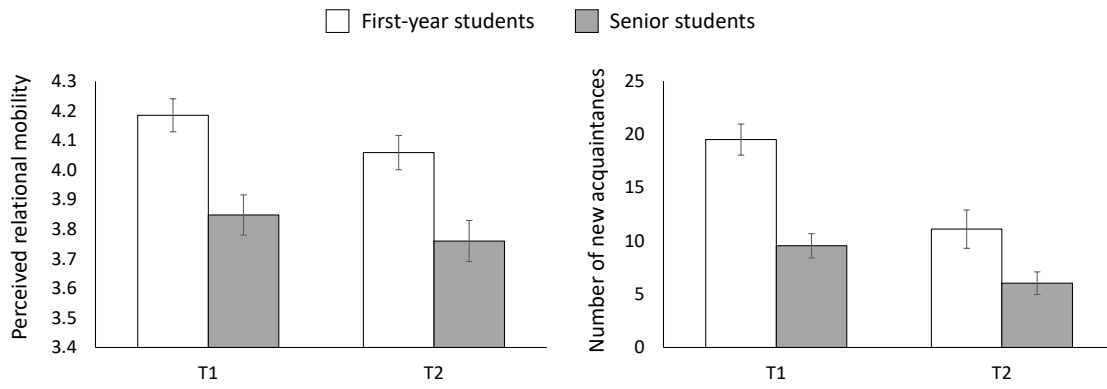


Figure 2. Main effect of grade and time on the perceived relational mobility (left) and number of new acquaintances (right). T1 and T2 represent the beginning and end of the semester, respectively.

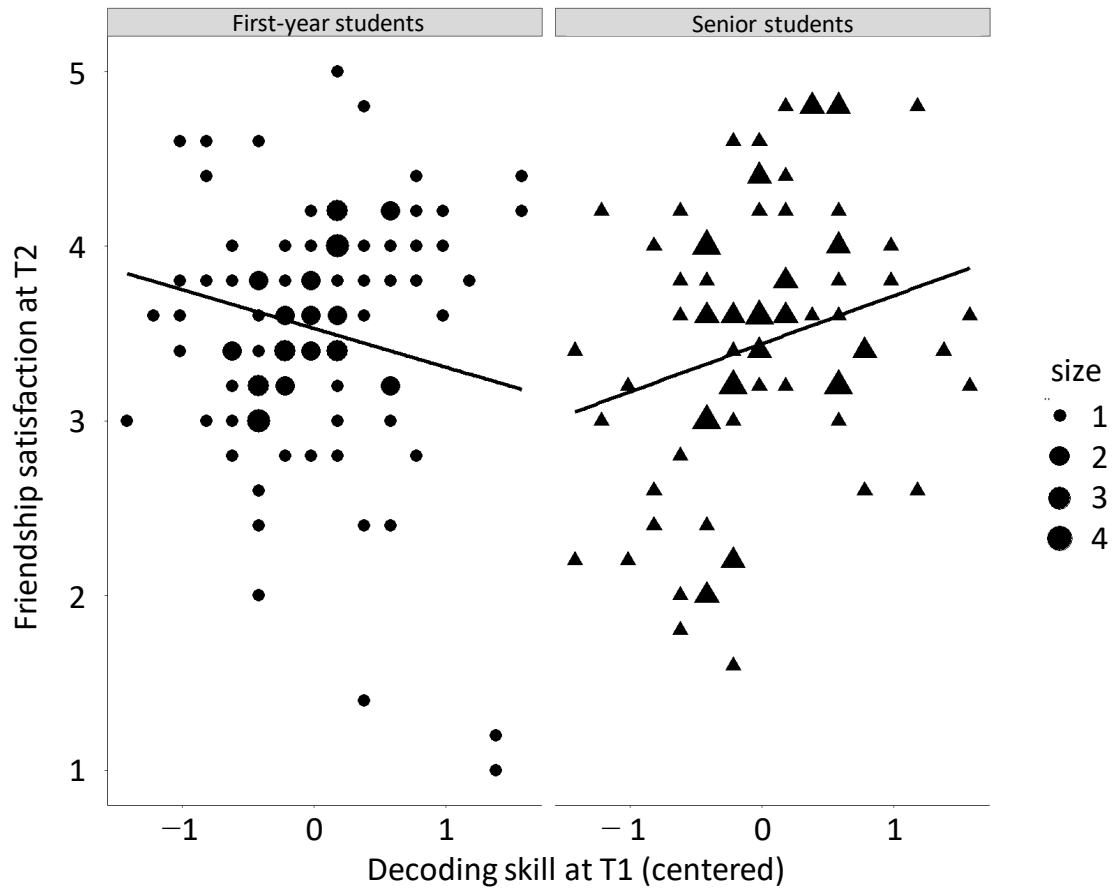


Figure 3. Interaction effect of the perceived decoding skill at T1 and grade on friendship satisfaction at T2. Circle/triangle size represents the number of individuals.

# A Socio-Ecological Context Moderates the Association between Communication Skills and Friendship Satisfaction: A Possible Role of Relational Mobility

## Supplementary results

The same paper-and-pencil questionnaire was administered at both time points, in which 406 and 334 students completed the questionnaire at T1 and T2, respectively. The descriptive statistics and bivariate correlations at each time point (T1 and T2) are summarized in Tables S1 and S2. Note that 394 (202 female, 190 male, 1 other, 1 unknown,  $M_{age} = 19.01$ ,  $SD_{age} = 1.29$ ) and 314 (157 female, 156 male, 1 unknown,  $M_{age} = 19.22$ ,  $SD_{age} = 1.38$ ) students were analysed, respectively, after removing the participants who did not complete the questionnaire.

**Table S1. Descriptive statistic and bivariate correlation at T1**

Variable	1	2	3	4	5	6
Time 1						
1. RM						
2. NNA	.188**					
3. EN	.218**	.160**				
4. DE	.090**	.105*	.358**			
5. CN	-.009	-.005	-.268**	.173*		
6. FS	.216**	.065	.349**	.215**	-.009	
<i>M</i>	4.031	13.669	3.316	3.411	3.390	3.456
<i>SD</i>	0.552	12.831	0.711	0.641	0.649	0.750

*Note.*  $N = 394$ . RM: Relational mobility, NNA: Number of new acquaintances (single item), EN: Encoding skill, DE: Decoding skill, CN: Control skill, FS: Friendship satisfaction. \*  $p < .05$ . \*\*  $p < .01$ .

**Table S2. Descriptive statistic and bivariate correlation at T2**

Variable	1	2	3	4	5	6
Time 1						
1. RM						
2. NNA	.085					
3. EN	.214**	.053				
4. DE	.146*	.067	.319**			
5. CN	.161**	-.027	-.184**	.222**		
6. FS	.227**	.081	.383**	.205**	.048	
<i>M</i>	3.898	8.003	3.330	3.375	3.313	3.506
<i>SD</i>	0.557	13.011	0.678	0.623	0.604	0.709

Note.  $N = 314$ . RM: Relational mobility, NNA: Number of new acquaintances (single item), EN: Encoding skill, DE: Decoding skill, CN: Control skill, FS: Friendship satisfaction. \*  $p < .05$ . \*\*  $p < .01$ .

### ***Relational mobility***

The perceived relational mobility and number of new acquaintances among freshmen, sophomores, juniors, and seniors at T1 and T2 ( $N = 175$ ) are reported in Table S3.

Regarding the perceived relational mobility, a  $4 \times 2$  ANOVA using grade as non-binary (freshmen, sophomores, juniors, seniors; between-subjects) and time (T1, T2; within-subjects) revealed a significant main effect of grade,  $F(3, 170) = 7.24, p < .001, \eta_p^2 = .113$ . Holm's multiple comparison identified that freshmen (FYSSs) reported higher perceived relational mobility than sophomores ( $t[170] = 3.81, \text{adjusted } p = .001$ ) and juniors ( $t[170] = 3.24, \text{adjusted } p = .007$ ). However, the difference between freshmen and seniors ( $t[170] = 0.48, \text{adjusted } p = 1.00$ ) as well as other differences were not significant ( $ts[170] < 2.26, \text{adjusted } ps > .099$ ). Similar to the findings from the  $2 \times 2$  mixed-design ANOVA above, the main effect of time was significant,  $F(1, 170) = 4.40, p = .037, \eta_p^2 = .025$ , whereas the interaction effect for grade and time was non-significant,  $F(3, 170) = 0.36, p = .784, \eta_p^2 = .006$ .



For the number of new acquaintances, a  $4 \times 2$  mixed-design ANOVA revealed a significant main effect of grade,  $F(3, 171) = 6.61, p < .001, \eta_p^2 = .104$ . Holm's multiple comparison identified that freshmen reported more new acquaintances than sophomores ( $t[171] = 4.09$ , adjusted  $p < .001$ ). However, neither the differences between freshmen and juniors ( $t[171] = 2.38$ , adjusted  $p = .092$ ) and seniors ( $t[171] = 1.86$ , adjusted  $p = 0.261$ ) nor other differences reached significance ( $ts[171] < 0.66$ , adjusted  $ps = 1.00$ ). The main effect of time was significant,  $F(3, 171) = 7.56, p = .007, \eta_p^2 = .042$ , but the interaction effect for grade and time was non-significant,  $F(3, 171) = 1.49, p = .219, \eta_p^2 = .026$ . Overall, freshmen had both higher perceived relational mobility and more new acquaintances than sophomores, and seniors had similar values for both measures with freshmen. Additionally, both perceived relational mobility scores and new acquaintance number were higher at Time 1 than at Time 2.

**Table S3. Perceived relational mobility and number of new acquaintances in each grade at T1 and T2**

	<i>n</i>	Relational Mobility		Number of New Acquaintances	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Time 1					
Freshmen	95	4.185	0.542	19.521	14.240
Sophomores	49	3.816	0.531	8.980	9.942
Juniors	23	3.747	0.611	10.870	10.868
Seniors	8	4.323	0.828	9.250	10.647
Time 2					
Freshmen	95	4.059	0.567	11.105	17.554
Sophomores	49	3.725	0.573	5.449	9.124
Juniors	23	3.714	0.626	7.304	11.289
Seniors	8	4.104	0.843	6.000	6.676

### ***Cross-lagged multi-level analysis***

In this study, the context-level variable was grade (FYS, SS). As the binary variable cannot rule out confounding factors, such as specific coursework and grade-related experiences, we created other context-level variables, using the self-reported measures. That is, the perceived relational mobility and number of new acquaintances at the *context*-level were calculated by the means for each grade (freshman, sophomore, junior, and senior). Then, we performed multilevel modeling that included perceived relational mobility or number of new acquaintances at the individual AND context levels (Table S3). We employed the “lmer” function from the *lmerTest* package in R. The model includes a random intercept of grade.<sup>1</sup>

The results identified significant negative interaction effects of perceived decoding skill and context-level perceived relational mobility ( $b = -1.421, p = .001$ ) and of perceived decoding skill and context-level number of new acquaintances ( $b = -0.044, p = .017$ ), both of which illustrated varying associations between perceived decoding skill and friendship satisfaction depending on environmental relational mobility.

Note that the multilevel model is expected to be somewhat better than a binary variable as it allows less potential for other confounding factors, however, having only four groups (grades) at the context level is not ideal (Maas & Hox, 2005). Thus, the results should not be conclusive by themselves. Rather, they are supposed to be considered collective evidence with the binary-grade variable because both of which indicated the same direction of the results; namely, a context-level factor has a moderating role. The results of another cross-lagged analysis that examined whether friendship satisfaction at T1 was associated with self-perception of communication skills at T2 were reported in Tables S5 and S6.

**Table S4. Association between perceived communication skills and friendship satisfaction in cross-lagged multi-level analysis**

	Satisfaction			
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	3.459**	0.076	3.442**	0.092
Gender	0.048	0.093	0.069	0.097
Satisfaction	0.503**	0.063	0.553**	0.064
Encode	0.031	0.085	0.075	0.089
Decode	0.077	0.085	0.016	0.084
Control	-0.172*	0.078	-0.103	0.074
Relational mobility (Ind.)	0.226*	0.094		
Relational mobility (Ctx.)	0.159	0.316		
Relational mobility (Ind.) × Satisfaction	-0.099	0.109		
Relational mobility (Ind.) × Encode	0.116	0.159		
Relational mobility (Ind.) × Decode	0.089	0.152		
Relational mobility (Ind.) × Control	0.200	0.115		
Relational mobility (Ctx.) × Satisfaction	0.257	0.337		
Relational mobility (Ctx.) × Encode	0.632	0.430		
Relational mobility (Ctx.) × Decode	-1.421**	0.439		
Relational mobility (Ctx.) × Control	0.369	0.424		
Num. acquaintances (Ind.)			-0.004	0.004
Num. acquaintances (Ctx.)			0.011	0.017
Num. acquaintances (Ind.) × Satisfaction			0.008	0.006
Num. acquaintances (Ind.) × Encode			-0.004	0.006
Num. acquaintances (Ind.) × Decode			0.003	0.007
Num. acquaintances (Ind.) × Control			-0.008	0.006
Num. acquaintances (Ctx.) × Satisfaction			0.004	0.014
Num. acquaintances (Ctx.) × Encode			0.022	0.019
Num. acquaintances (Ctx.) × Decode			-0.044*	0.018
Num. acquaintances (Ctx.) × Control			0.009	0.016
<hr/>				
$R^2$				
Adjusted $R^2$				
$F$ Statistic				
Conditional $R^2$	0.434		0.417	
Marginal $R^2$	0.424		0.396	

*Note.* Explanatory variables were measured at T1; the respondent variable was measured at T2. Gender (0 = female, 1 = male) is a binary dummy code. Relational mobility (Ctx.) and Num. acquaintances (Ctx.) are the means for each grade (freshman, sophomore, junior, and senior). Explanatory variables except for Grade were centered. In the model using perceived relational mobility, the random effects appeared to be small, such that Conditional  $R^2$  was not computed. Weights in Table S4 are not standardized. \*  $p < .05$ . \*\*  $p < .01$ .

**Table S5. Association between friendship satisfaction and encoding skill**

	Encoding skill					
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	3.341**	0.071	3.343**	0.054	3.328**	0.063
Gender	0.113	0.084	0.085	0.082	0.098	0.087
Satisfaction	0.186*	0.082	0.073	0.056	0.165**	0.058
Encode	0.512**	0.082	0.546**	0.075	0.569**	0.080
Decode	-0.031	0.106	0.001	0.075	-0.020	0.076
Control	-0.146	0.095	-0.059	0.069	-0.067	0.066
Grade	-0.073	0.090				
Grade × Satisfaction	0.180	0.111				
Grade × Encode	-0.039	0.150				
Grade × Decode	0.501*	0.151				
Grade × Control	0.201	0.131				
Relational mobility (Ind.)			0.219*	0.083		
Relational mobility (Ctx.)			-0.107	0.216		
Relational mobility (Ind.) × Satisfaction			-0.014	0.096		
Relational mobility (Ind.) × Encode			-0.120	0.140		
Relational mobility (Ind.) × Decode			0.259	0.134		
Relational mobility (Ind.) × Control			-0.006	0.101		
Relational mobility (Ctx.) × Satisfaction			0.029	0.297		
Relational mobility (Ctx.) × Encode			-0.628	0.379		
Relational mobility (Ctx.) × Decode			-0.547	0.388		
Relational mobility (Ctx.) × Control			-0.213	0.373		
Num. new acquaintances (Ind.)					0.001	0.003

Num. new acquaintances (Ctx.)			0.004	0.004
Num. new acquaintances (Ind.) × Satisfaction			0.001	0.005
Num. new acquaintances (Ind.) × Encode			0.003	0.005
Num. new acquaintances (Ind.) × Decode			−0.001	0.007
Num. new acquaintances (Ind.) × Control			0.010	0.006
Num. new acquaintances (Ctx.) × Satisfaction			−0.027	0.013
Num. new acquaintances (Ctx.) × Encode			−0.003	0.017
Num. new acquaintances (Ctx.) × Decode			−0.026	0.016
Num. new acquaintances (Ctx.) × Control			0.009	0.014
<hr/>				
$R^2$	0.431			
Adjusted $R^2$	0.396			
$F$ Statistic	12.330**			
Conditional $R^2$		n/a	0.429	
Marginal $R^2$		0.465	0.424	

*Note.* Explanatory variables were measured at T1; the respondent variable was measured at T2. Gender (0 = female, 1 = male) and Grade (0 = FYS, 1 = SS) are a binary dummy code. Relational mobility (Ctx.) and Num. new acquaintances (Ctx.) are the means for each grade (freshman, sophomore, junior, and senior). The analysis using these context-level variables is multilevel modeling with a random effect of grade. Explanatory variables except for Grade were centered. In the model using perceived relational mobility, the random effects appeared to be small, such that Conditional  $R^2$  was not computed. Weights in Table S5 are not standardized. \* $p < .05$ . \*\* $p < .01$ .

**Table S6. Association between friendship satisfaction and decoding skill**

	Decoding skill					
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Intercept	3.479**	0.069	3.347**	0.100	3.362**	0.144
Gender	-0.003	0.082	-0.003	0.080	0.019	0.083
Satisfaction	0.113	0.080	0.026	0.054	0.025	0.055
Encode	-0.006	0.103	0.010	0.073	0.066	0.076
Decode	0.399**	0.093	0.428**	0.073	0.433**	0.072
Control	0.105	0.087	0.030	0.067	0.061	0.063
Grade	-0.122	0.080				
Grade × Satisfaction	-0.125	0.107				
Grade × Encode	0.080	0.145				
Grade × Decode	0.029	0.146				
Grade × Control	-0.079	0.128				
Relational mobility (Ind.)			0.176*	0.080		
Relational mobility (Ctx.)			-0.096	0.422		
Relational mobility (Ind.) × Satisfaction			0.105	0.094		
Relational mobility (Ind.) × Encode			0.127	0.137		
Relational mobility (Ind.) × Decode			-0.160	0.131		
Relational mobility (Ind.) × Control			0.103	0.099		
Relational mobility (Ctx.) × Satisfaction			0.141	0.289		
Relational mobility (Ctx.) × Encode			-0.303	0.371		
Relational mobility (Ctx.) × Decode			-0.193	0.377		
Relational mobility (Ctx.) × Control			0.349	0.365		
Num. new acquaintances (Ind.)					-0.003	0.003
Num. new acquaintances (Ctx.)					0.023	0.028

Num. new acquaintances (Ind.) × Satisfaction		0.011*	0.005
Num. new acquaintances (Ind.) × Encode		−0.0005	0.005
Num. new acquaintances (Ind.) × Decode		−0.0004	0.006
Num. new acquaintances (Ind.) × Control		−0.0001	0.005
Num. new acquaintances (Ctx.) × Satisfaction		−0.0004	0.012
Num. new acquaintances (Ctx.) × Encode		−0.005	0.016
Num. new acquaintances (Ctx.) × Decode		−0.004	0.015
Num. new acquaintances (Ctx.) × Control		0.004	0.014
<hr/>			
$R^2$	0.284		
Adjusted $R^2$	0.240		
$F$ Statistic	6.467**		
Conditional $R^2$		0.364	0.407
Marginal $R^2$		0.298	0.287

*Note.* Explanatory variables were measured at T1; the respondent variable was measured at T2. Gender (0 = female, 1 = male) and Grade (0 = FYs, 1 = SS) are a binary dummy code. Relational mobility (Ctx.) and Num. new acquaintances (Ctx.) are the means for each grade (freshman, sophomore, junior, and senior). Weights in Table S6 are not standardized. \* $p < .05$ . \*\* $p < .01$ .

## **Footnote**

<sup>1</sup>We also tried another model that includes a random slope of friendship satisfaction and communication skills, both of which were measured at T1. However, this model was eventually not accepted because, in the model selection using AIC, it was found to be a worse fit (higher AIC value) than the model that included a random intercept only.

## **References**

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*(3), 86–92. <https://doi.org/10.1027/1614-2241.1.3.86>