

Communication modality matters: Co-rumination via in-person versus digital modalities has different prospective associations with depression and friendship quality

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Abstract

Introduction: Co-rumination is an interpersonal emotion regulation strategy in which negative feelings and problems are discussed perseveratively with another person. Although co-rumination is salient in adolescence, research to date has focused on co-rumination occurring *in person* and has not kept pace with the surge in digital communication that begins in adolescence. This study examined the degree, associations among, and consequences (i.e., depressive symptoms, and friendship quality) of adolescents' co-rumination via in-person, text, social media, and phone modalities.

Methods: Adolescents ($n = 109$; 51 girls, 57 boys, 1 nonbinary; $M_{\text{age}} = 12.83$ years) residing in Canada, completed self-report questionnaires on co-rumination, depressive symptoms, and friendship quality for up to 2 years.

Results: Adolescents engaged in co-rumination across all modalities, particularly in-person. Findings indicated a negative association between in-person co-rumination at baseline and in-person co-rumination over time. Whereas less text co-rumination was associated with increased depressive symptoms over time, greater phone co-rumination was associated with increased depressive symptoms over time. Although greater in-person co-rumination was positively associated with friendship quality concurrently, it was negatively associated with friendship quality prospectively.

Conclusions: Taken together, co-rumination outcomes may vary depending on communication modality. Implications for adolescents' mental and social wellbeing are discussed.

KEYWORDS

adolescence, co-rumination, depression, digital communication, emotion regulation, friendship quality

1 | INTRODUCTION

The ability to regulate emotions that arise from environmental changes and stressors is crucial for mental health (Gross & Muñoz, 1995). Adolescents often manage their emotions by turning to a friend, but not all communications with friends are helpful. Co-rumination is a style of communication that involves the perseverative discussion of one's feelings and problems (Dixon-Gordon et al., 2015; Rose, 2002). Although co-rumination has received increased attention in the literature (e.g., Hankin et al., 2010; Rnic et al., 2022; Spendelov et al., 2017; Stone et al., 2011), research has not kept pace with the surge in digital technology use that often begins in adolescence (Anderson & Jiang, 2018; Lenhart, 2015). Indeed, digital technology has profoundly expanded the breadth of modalities in which adolescents communicate (Katz, 2008). The present study sought to examine co-rumination in light of adolescents' digital technology use by investigating co-rumination through both in-person and digital technology (i.e., text, phone, social media). Specifically, we examined (1) the degree to which

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adolescents co-ruminated in-person and via digital technology, (2) the association of co-rumination in one communication modality with the trajectory of co-rumination in that same modality and other modalities over time, and (3) the consequences of in-person and digital co-rumination on depressive symptoms and friendship quality.

1.1 | Co-rumination in adolescence

The transition from childhood to adolescence is a stressful developmental period associated with increased novelty and environmental demands (Benner, 2011; Ganeson & Ehrich, 2009; Isakson & Jarvis, 1999). Indeed, developmentally normative experiences such as gaining greater autonomy from caregivers and changes in the educational curriculum tend to augment stress and strain adolescents' emotional wellbeing (e.g., Erikson, 1968; Ganeson & Ehrich, 2009; Steinberg & Silverberg, 1986).

Research shows that adolescents often regulate emotional responses to stress by turning to their friends (Rueger et al., 2016). Some of these conversations are typified by co-rumination, which involves perseverating, dwelling on, and rehashing feelings and problems with another person (Rose, 2002). Interestingly, co-rumination has both adverse and beneficial effects. On the one hand, co-rumination is associated with greater internalizing symptoms (Rose et al., 2014). For example, researchers have documented that co-rumination is associated cross-sectionally and longitudinally with increased depressive symptoms in adolescents (see Spindel et al., 2017). On the other hand, co-rumination has interpersonal benefits. Rose et al. (2014), for example, found that co-rumination, particularly self-disclosing one's problems to another person, was associated with higher friendship quality (see also Boren, 2014; Calmes & Roberts, 2008; Guassi Moreira et al., 2016). Hence, co-rumination is associated with diminished mental health yet beneficial interpersonal outcomes. However, the majority of this research has focused on co-rumination cross-sectionally that takes place via in-person interactions and limited research to date has examined co-rumination via multiple communication modalities and its prospective outcomes.

1.2 | Digital technology use in adolescence

The emergence of digital technology has expanded the modalities in which people communicate (Katz, 2008). Adolescents tend to use digital technology more than any other age group. Indeed, 95% percent of adolescents possess or have access to a cell phone, and 92% report being online daily (Anderson & Jiang, 2018; Lenhart, 2015; Ofcom, 2019). Approximately 90% of teens text and, among those who text, individuals send and receive about 30 texts daily (Anderson & Jiang, 2018; Lenhart, 2015). Adolescents also report making or receiving approximately five calls per day (Lenhart et al., 2010). Similarly, social media use is pervasive among youth, and most adolescents report regularly using platforms such as Facebook, Youtube, Instagram, and Snapchat (Anderson & Jiang, 2018). Despite the fact that adolescents engage in co-rumination across both in-person and digital modalities (i.e., text, phone, social media; Battaglini et al., 2021), there is limited research investigating co-rumination through digital technology. This paucity of research precludes the field from developing a greater understanding of the long-term prospective outcomes of co-rumination via text, phone, and social media modalities.

The few studies that have investigated outcomes of co-rumination through digital technology in adolescents focus on relatively short-term follow-up periods and show mixed findings. Frison et al. (2019), for example, found that co-rumination during Facebook interactions was not associated with depressive symptoms 6-months later. In addition, Van Zalk and Tillfors (2017) documented that co-rumination occurring online had beneficial outcomes for youth with social anxiety; specifically, online co-rumination with friends diminished the association between social anxiety and depressive symptoms 8 months later. Finally, using a twice-daily diary design, Battaglini et al. (2021) found that co-rumination via text and phone was associated with greater positive affect and/or relationship closeness at the following assessment, yet time spent co-ruminating via social media was associated with less positive affect. Taken together, research regarding co-rumination through digital technology in adolescents has investigated either short-term outcomes of co-rumination via one digital modality (e.g., Frison et al., 2019; Van Zalk & Tillfors, 2017) or associations with state-level outcomes via a daily diary design (e.g., affect, relationship closeness; Battaglini et al., 2021). However, little is known of the longer-term consequences of adolescents co-ruminating via multiple digital modalities. Thus, additional research is needed to expand our understanding of co-rumination.

1.3 | The current study

The current longitudinal study investigated co-rumination across in-person and digital communication modalities (i.e., text, phone, and social media) and its association with co-rumination in the same and other modalities, depressive symptoms, and friendship quality over time during adolescence. We recruited a sample of adolescents during a time of stress: the transition to high school. The first year of high school is typically marked by uncertainty and distress (Benner, 2011; Isakson & Jarvis, 1999), necessitating emotion regulation and, thus, making it an ideal period to study co-rumination. Participants reported co-rumination across communication

modalities (i.e., in-person, text, phone, social media), depressive symptoms, and friendship quality with their best friend up to six times across the transition to high school.

Based on previous literature, the current study had three main hypotheses. First, we investigated the degree to which adolescents co-ruminated via in-person and digital modalities and differences in the degree to which they co-ruminated across modalities. In line with past research (Battaglini et al., 2021), we predicted that adolescents would report co-ruminating during in-person, text, phone, and social media interactions but would engage in greater co-rumination in person compared to other modalities. Second, we examined whether baseline co-rumination during in-person, text, phone, and social media interactions predicted the trajectory of co-rumination in the same and other modalities over time. This examination was conducted to enhance understanding of factors (i.e., baseline levels of co-rumination via multiple modalities) that may contribute to the evolution and contagion of co-rumination over time. Considering the pervasiveness of co-rumination (Bastin, Luyckx, et al., 2021; Bastin, Mezuli, et al., 2021; Battaglini et al., 2021), we predicted that greater co-rumination through one modality at baseline would be associated with increases in co-rumination in the same and other modalities over time. Third, we examined the consequences of in-person and digital co-rumination on concurrent and prospective depressive symptoms and friendship quality. Given that co-rumination via in-person, text, and phone is associated with mental health consequences yet interpersonal benefits (Battaglini et al., 2021; Keshishian et al., 2016; Murdock et al., 2019; Spindelw et al., 2017; Starr & Davila, 2009), we predicted that greater baseline co-rumination via in-person, text, and phone would be concurrently and prospectively associated with increases in depressive symptoms, yet also increases in friendship quality. However, research suggests that social media use is associated with pernicious affective and interpersonal outcomes (e.g., Battaglini et al., 2021; Shensa et al., 2020; Vogel et al., 2014). For instance, a meta-analysis investigating the association between social media use and mental health found a positive relationship between adolescent social media use and depressive symptoms (Ivie et al., 2020). In addition, research suggests that social media use is negatively associated with friendship closeness (e.g., Pouwels et al., 2021). Thus, we expected that greater baseline co-rumination via social media would be concurrently and prospectively associated with increases in depressive symptoms and decreases in friendship quality.

2 | MATERIAL AND METHODS

2.1 | Participants

A total of 109 adolescents (51 girls, 57 boys, and 1 nonbinary) provided data as part of the UBC Study of Adolescents. Participants residing in the Lower Mainland of British Columbia, Canada, were recruited using flyers, local media, and online advertisements. Parents/guardians completed screening for eligibility over the phone, which was confirmed at the first laboratory visit. Given the broader goals of the study, eligibility criteria were that adolescents were 11–13 years old, planned to begin high school in the upcoming fall, and were fluent in English. Ineligibility criteria included symptoms of a current substance use disorder, lifetime history of mania or psychosis, severe impairment caused by a learning disability, history of serious head trauma, an endocrine disorder, or use of medications that could influence biomarkers that were assessed as part of the larger study.

2.2 | Procedure

The present study complied with the Declaration of Helsinki for research involving humans and was approved by the University's Ethics Board. Participants were recruited from schools throughout the community using flyers posted in public places, local media, and online advertisements (e.g., Facebook). Participants attended the baseline laboratory session before starting high school with their parent/guardian. After obtaining consent from parents/guardians and assent from adolescents, adolescents completed a demographic questionnaire and measures of co-rumination, depressive symptoms, and friendship quality in addition to other measures completed as part of the larger study. Participants then completed follow-up measures of co-rumination, depressive symptoms, and friendship quality up to five additional waves of data collection: at the start of high school, every 3 months during high school (for 9 months), and at a final follow-up in May–June 2021, which was up to 24 months after participants' baseline assessment. Data collection took place before and during the COVID-19 pandemic, from 2018 to 2021. Parents/guardians were provided with remuneration for participating in each session.

2.3 | Measures

2.3.1 | Co-rumination

The Co-rumination Questionnaire—Short Form (CRQ-SF; Hankin et al., 2010; Rose, 2002) is a 9-item self-report questionnaire used commonly (Bastin, Luyckx, et al., 2021; Bastin, Mezulis, et al., 2021; Spindelw et al., 2017; Stone

et al., 2011) to assesses adolescents' co-rumination with their best/closest friend. Consistent with Keshishian et al. (2016), participants completed the CRQ-SF four times, once for each communication modality (in-person, text, phone, social media). Each modality was defined for participants: text was defined as text messaging, phone was defined as talking on the phone (not messaging), and social media was defined broadly (i.e., without specifying a specific platform) as chatting or messaging via a social media platform. Items were modified to specify each modality, an example item from the CRQ-SF modified for co-rumination via text was: "We text about problems that my friend or I are having almost every time we text each other." Participants rated each item on a scale from 1 (*Not at all true*) to 5 (*Really true*). The CRQ has strong psychometric properties (Rose, 2002), and Cronbach's α ranged from .91 to .98 across the baseline and five follow-up assessments.

2.3.2 | Depressive symptoms

The Center for Epidemiologic Studies Depression Scale for Children (CES-DC; Weissman et al., 1980) is a 20-item self-report measure of depressive symptoms. Participants rate the degree to which they experienced symptoms over the past week on a 4-point Likert scale. The CES-DC has good reliability and validity (Fendrich et al., 1990), and Cronbach's α ranged from .88 to .93 across the baseline and five follow-up assessments.

2.3.3 | Friendship quality

The Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993) is a 40-item questionnaire that assesses the closeness and quality of an individual's relationship with their best friend. Participants rate items on a 5-point Likert scale. The FQQ has good psychometric properties (Parker & Asher, 1993), and Cronbach's α ranged from .93 to .94 across baseline and the five follow-ups in the current study.

2.4 | The COVID-19 context

The World Health Organization declared COVID-19 a global pandemic on March 11, 2020. Data collection for this study (T1-T6) took place from 2018 to 2021, with all participants completing T1-T3 assessments before the pandemic (2018–2019), and the majority of participants ($n = 101$) completing T4–T6 assessments during the pandemic (2020–2021; $n = 8$ completed T5 during the pandemic). In many places worldwide, physical distancing requirements and online schooling were instated during the pandemic for public safety. These regulations may have affected how adolescents communicated with friends. Several analyses were conducted to better understand the impact of COVID-19 on co-rumination across communication modalities (i.e., in-person, text, phone, social media). First, we ran one-sample t -tests to examine whether adolescents co-ruminated during the COVID-19 pandemic, and found that levels of co-rumination via in-person, $p < .001$, text, $p < .001$, phone, $p < .001$, and social media $p < .001$, differed significantly from zero (see Supporting Information: Figure S1 in the Supplement). Second, paired-sample t -tests were conducted for participants who completed T4–T6 during the pandemic to compare their average level of co-rumination before the pandemic (T1–T3) to their average level during the pandemic (T4–T6). Results showed that levels of co-rumination significantly increased from before the pandemic to during it for in-person co-rumination, $t(73) = -3.68$, $p < .001$, phone, $t(72) = -2.05$, $p = .044$, and social media, $t(68) = -2.19$, $p = .032$ but not for co-rumination via text, $t(70) = -1.87$, $p = .065$. Taken together, results suggest that participants co-ruminated in each modality during the COVID-19 pandemic and that levels of in-person, phone, and social media co-rumination were higher during the pandemic compared to before. Interestingly, greater in-person co-rumination during the pandemic is supported by findings from Starr et al. (2021), which found that co-rumination during the pandemic occurred commonly in-person despite physical distancing requirements.

2.5 | Data analytic approach

R Version 4.0.4 (R Core Team, 2021) was used for all analyses. To test whether the amount of co-rumination in each modality differed from zero, one-sample t -tests were conducted on the average amount of co-rumination via each modality across all time points. To test whether the amount of co-rumination differed across communication modalities, a one-way repeated measures Analysis of Variance with modality (in-person, text, phone, social media) as the within-subject factor was conducted on average co-rumination across all time points. For hypotheses two and three, we considered various models (e.g., latent profile analysis, cross-lagged panel analysis); however, given the sample size, these models did not

converge (Maas & Hox, 2005). Thus, we conducted growth-curve multilevel models (MLMs) using the lme4 (Bates et al., 2015) and lmerTest (Kuznetsova et al., 2017) R packages. MLMs have the advantage of reaching convergence and producing unbiased estimates with smaller samples (i.e., $N \geq 50$; Maas & Hox, 2005), and they are robust to missing data (Bolger & Laurenceau, 2013). MLMs are also well-suited for the multi-wave, nested structure of the data from this study, as they can estimate both within- and between-person effects (within-person effects at Level 1 and between-person effects at Level 2), which is particularly useful for longitudinal designs. Additionally, MLMs take into account the dependence among repeated measures (intraclass correlation coefficients ranged from .44 to .57). In all MLMs, time was included as a predictor and random slope at Level 1 to examine the amount and variability of change over time. Time-invariant predictors were included at Level 2 to explain potential individual differences in trajectories of the outcome variable over time (i.e., the variation in the random slope), while controlling for the baseline association between predictor and outcome. All Level 2 variables were grand-mean centered.

3 | RESULTS

3.1 | Preliminary analyses

The sample characteristics and demographic breakdown of the sample are presented in Table 1. Participants completed an average of 3.72 (SD = 1.64) out of 6 time points. Little's Missing Completely at Random (MCAR) test was not significant, $X^2(1028) = 1032.31$, $p = .456$, suggesting that data were not missing systematically. Participants were only included in analyses for which they provided complete data; thus, degrees of freedom may differ across analyses. The number of assessments completed was not associated with any of the adolescents' demographic characteristics such as sex assigned at birth (hereafter referred to as *sex*), $t(107) = 0.06$, $p = .461$, gender, $t(106) = 0.15$, $p = .414$,¹ age, $r(107) = 0.17$, $p = .070$, or ethnic origin, $F(5, 101) = 1.50$, $p = .198$.² Correlations of the main study variables can be found in the Supplemental Material (see Supporting Information: Tables S1 and S2).

3.2 | Hypothesis 1: Co-rumination across modalities: In-person, text, phone, and social media

In Figure 1, we present the average degree that participants co-ruminated via in-person, text, phone, and social media interactions over the course of approximately 2 years. We predicted that participants would co-ruminate via in-person, text, phone, and social media, but would engage in greater co-rumination in-person compared to other modalities. As expected, participants engaged in co-rumination across all communication modalities. Specifically, levels of co-rumination via in-person, $t(102) = 34.88$, $p < .001$, text, $t(102) = 25.79$, $p < .001$, phone, $t(102) = 24.96$, $p < .001$, and social media interactions, $t(100) = 22.33$, $p < .001$, differed significantly from zero (see Figure 1). The same results were found during the COVID-19 pandemic; participants co-ruminated across all modalities, p 's < 0.001 (see Supporting Information: Figure S1). In addition, there was a significant difference in amount of co-rumination across modalities, $F(2.76, 276.37) = 62.85$, $p < .001$. As expected, pairwise comparisons with a Bonferroni correction indicated that adolescents co-ruminated in-person significantly more than via text, $p < .001$, 95% CI [0.39–0.70], phone, $p < .001$, 95% CI [0.45–0.77], or social media, $p < .001$, 95% CI [0.63 to –1.03]. In addition, adolescents co-ruminated via text, $p < .001$, 95% CI [–0.46 to –0.13], and phone, $p = .006$, 95% CI [–0.40 to –0.05], significantly more than via social media.

Moreover, exploratory analyses were conducted to assess whether there was a significant difference in the amount of co-rumination across modalities both before and during the COVID-19 pandemic. Before the pandemic, there was a significant difference in the amount of co-rumination across modalities, $F(2.66, 257.56) = 58.92$, $p < .001$. Pairwise comparisons with a Bonferroni correction indicated that adolescents co-ruminated in-person significantly more than via text, $p < .001$, 95% CI [0.36, 0.67], phone, $p < .001$, 95% CI [0.44–0.76], or social media, $p < .001$, 95% CI [0.63, 1.05]. Additionally, adolescents co-ruminated via text, $p < .001$, 95% CI [0.14, 0.51], and phone, $p = .070$, 95% CI [0.06–0.44], significantly more than via social media. During the pandemic, there also was a significant difference in the amount of co-rumination across modalities, $F(2.55, 175.63) = 25.56$, $p < .001$. Pairwise comparisons with a Bonferroni correction indicated that adolescents co-ruminated in-person significantly more than via text, $p < .001$, 95% CI [0.29–0.76], phone, $p < .001$, 95% CI [0.40–0.91], or social media, $p < .001$, 95% CI [0.58–1.25]. Furthermore, adolescents co-ruminated via text, $p = .009$, 95% CI [0.07–0.70] significantly more than via social media.

¹Only one individual reported their gender as nonbinary (completed 2 out of 6 time points); thus, they could not be included in this analysis.

²Twenty-six participants did not report their ethnic origin.

TABLE 1 Characteristics of the sample.

Variable	
<i>Sex (n)</i>	
Male	57
Female	51
<i>Gender (n)</i>	
Boy	56
Girl	51
Nonbinary	1
Age, <i>M</i> (SD)	12.83 (0.39)
<i>Ethnic Origin (n)</i>	
Chinese	14
Chinese-Japanese	1
Chinese-Korean	1
European-Canadian	52
European-Canadian-West Asian	2
European-Indigenous	2
Canadian-Japanese	1
Canadian-Korean	2
Latinx	3
Latinx-South Asian	1
South Asian	3
West Asian	1
<i>Co-rumination, M</i> (SD)	
In-person	2.83 (0.82)
Text	2.31 (0.91)
Phone	2.23 (0.91)
Social Media	1.98 (0.89)

Note: Adolescents reported their sex, gender, age, and ethnic origin. One participant did not report their age, sex, or gender. Twenty six participants did not report their ethnic origin.

3.3 | Hypothesis 2: Associations of co-rumination at baseline with co-rumination across modalities over time

We conducted MLMs to examine whether individual differences in the trajectory of co-rumination via in-person, text, phone, and social media were predicted by baseline levels of co-rumination in that modality and in all other modalities. Separate MLMs were conducted for co-rumination in each modality (i.e., in-person, text, phone, social media) as the outcome variable. Co-rumination in each modality (i.e., in-person, text, phone, and social media) was predicted as a function of time at Level 1. Baseline variables that could predict individual differences in the longitudinal trajectory of co-rumination in each modality were included at Level 2. Thus, at Level 2, we included co-rumination via each modality at baseline (grand-mean centered) predicting co-rumination over time, while controlling for the baseline association between co-rumination in each modality and outcome.³

We predicted that increases in co-rumination in each modality would be predicted by baseline levels of co-rumination in that same modality and in other modalities. Results showed that in-person co-rumination at baseline was negatively

³When including random slopes, the models were near singular. To account for this, the random slope was removed from the models (i.e., fixed slope) for the second hypothesis.

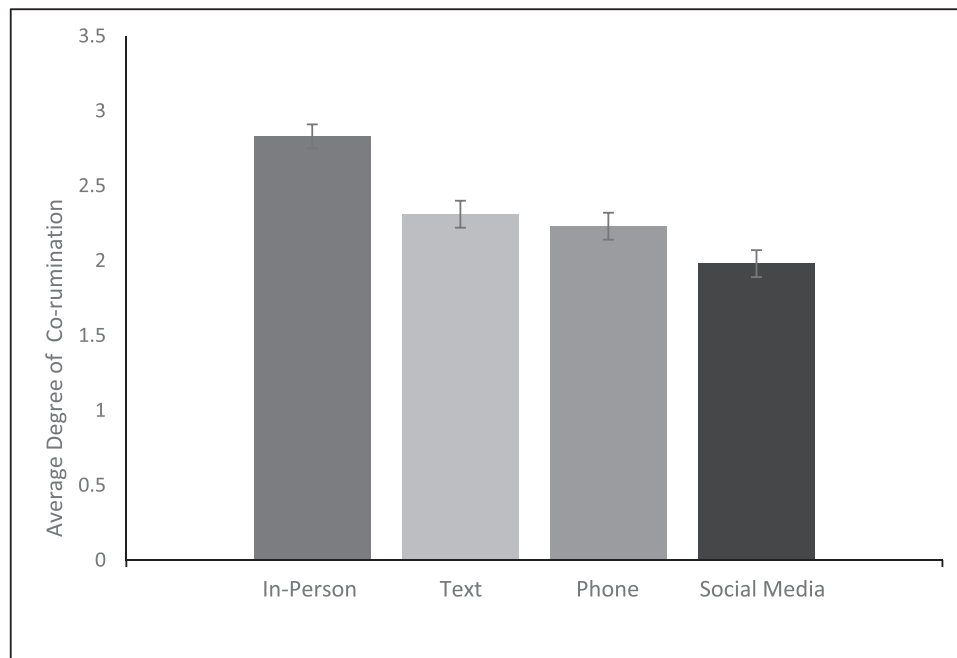


FIGURE 1 The degree participants co-ruminated (on a scale from 1 [Not at all true] to 5 [Really true]) via in-person, text, phone, and social media on average over the course of approximately 2 years.

associated with in-person co-rumination over time, $b = -0.12$, $p < .001$, 95% CI $[-0.17$ to $-0.06]$.⁴ The Johnson-Neyman test for the regions of significance (Hayes & Matthes, 2009; Johnson & Neyman, 1936) showed that when grand-mean centered in-person co-rumination at baseline was below 0.26, in-person co-rumination increased over time. However, when grand-mean centered in-person co-rumination at baseline was above 1.31, in-person co-rumination decreased over time (see Figure 2). No other predictors were associated with prospective changes in co-rumination (see Supporting Information: Table S3).⁵

Given that gender is an individual difference that may be associated with the level and trajectory of co-rumination over time (Bastin, Luyckx, et al., 2021; Bastin, Mezuli, et al., 2021; Rose, 2002), exploratory analyses were conducted to assess whether gender predicted the trajectories of co-rumination over time. Four MLMs were conducted with co-rumination via each modality (i.e., in-person, text, phone, social media) as an outcome in the respective models. Time was included as a predictor at Level 1 and gender was included at Level 2. Results showed a main effect of gender across all modalities, such that girls co-ruminated via each modality more than boys; however, gender did not predict the trajectory in any modality over time (see Supporting Information: Table S4).

3.4 | Hypothesis 3: Association of co-rumination at baseline with concurrent and prospective depressive symptoms and friendship quality

We conducted MLMs to examine whether co-rumination via in-person, text, phone, and social media was concurrently associated with depressive symptoms and friendship quality as well as whether individual differences in the trajectory of depressive symptoms and friendship quality was predicted by baseline levels of co-rumination via in-person, text, phone, and social media. Two MLMs were conducted (one for each outcome) with depressive symptoms and friendship quality predicted as a function of time at Level 1. At Level 2, we included co-rumination via each modality (grand-mean centered).

Results indicated that co-rumination via in-person, text, phone, and social media was not significantly associated with depressive symptoms at baseline. However, less co-rumination via text at baseline was significantly associated with the trajectory of depressive symptoms over time, $b = -1.14$, $p = .024$, 95% CI $[-2.12$ to $-0.15]$. The Johnson-Neyman test for the regions of significance showed that depressive symptoms increased over time when baseline text co-rumination was below 0.48 (grand-mean centered; Figure 3a). In addition, phone co-rumination at baseline was significantly associated with the

⁴The Benjamini Hochberg approach was used to account for the false discovery rate for multiple hypothesis testing (Bastin et al., 1995). Results showed that this effect remained significant.

⁵The same pattern of results was observed when pandemic status (0 = prepandemic, 1 = during the pandemic) was included as a time-varying covariate at Level 1 of the MLMs.

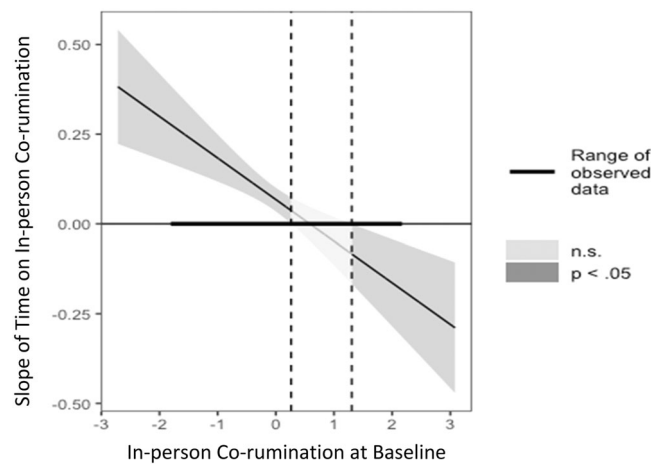


FIGURE 2 The Johnson-Neyman test for the regions of significance is presented. Results showed that when grand-mean centered in-person co-rumination at baseline was below 0.26, co-rumination via in-person increased over time. However, when grand-mean centered in-person co-rumination at baseline was above 1.31, co-rumination via in-person decreased over time.

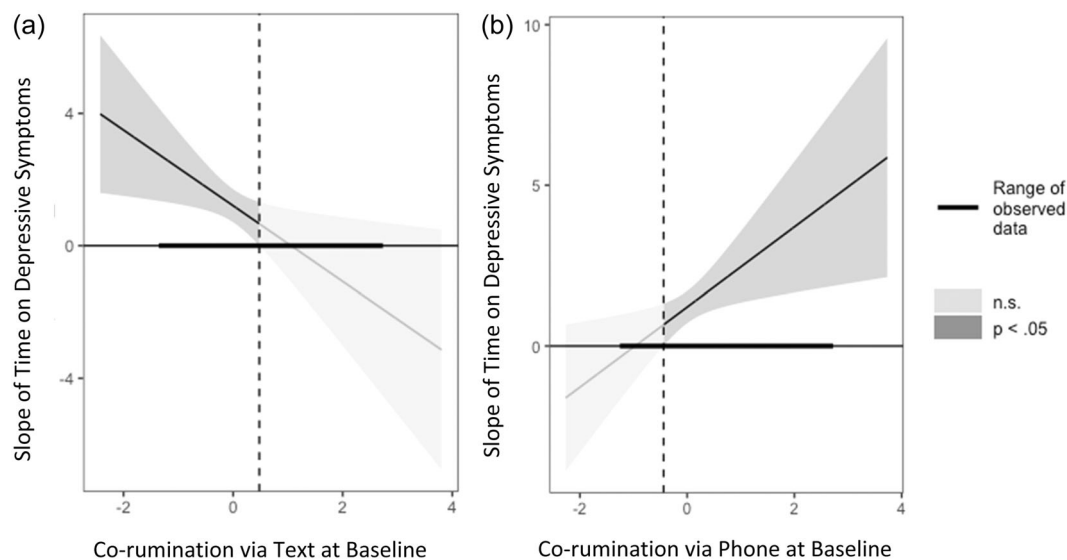


FIGURE 3 The Johnson-Neyman test for the regions of significance is presented. (a) Results showed that when grand-mean centered co-rumination via text at baseline was below 0.48, there was an increase in depressive symptoms over time. (b) Results also showed that when grand-mean centered co-rumination via phone at baseline was above -0.44 , there was an increase in depressive symptoms over time.

trajectory of depressive symptoms, $b = 1.25$, $p = .017$, 95% CI [0.33–2.28]. Findings from the Johnson–Neyman test showed that depressive symptoms increased over time when baseline phone co-rumination was above -0.44 (grand-mean centered; see Figure 3b). No other effects were significant (see Supporting Information: Table S4).

We next examined concurrent and prospective predictors of friendship quality. Greater in-person co-rumination at baseline was associated with greater friendship quality at baseline, $b = 0.27$, $p = .007$, 95% CI [0.09–0.46]. In addition, in-person co-rumination at baseline was significantly associated with the trajectory of friendship quality, $b = -0.06$, $p = .009$, 95% CI [–0.12 to –0.02]. The Johnson–Neyman test showed that friendship quality increased when baseline in-person co-rumination was below -0.54 (grand-mean centered). However, friendship quality decreased when baseline in-person co-rumination was above 0.58 (grand-mean centered; see Figure 4). No other effects were significant (see Supporting Information: Table S5).⁶

⁶The same pattern of results was observed when pandemic status (0 = prepandemic, 1 = during the pandemic) was included as a time-varying covariate at Level 1 of the MLMs.

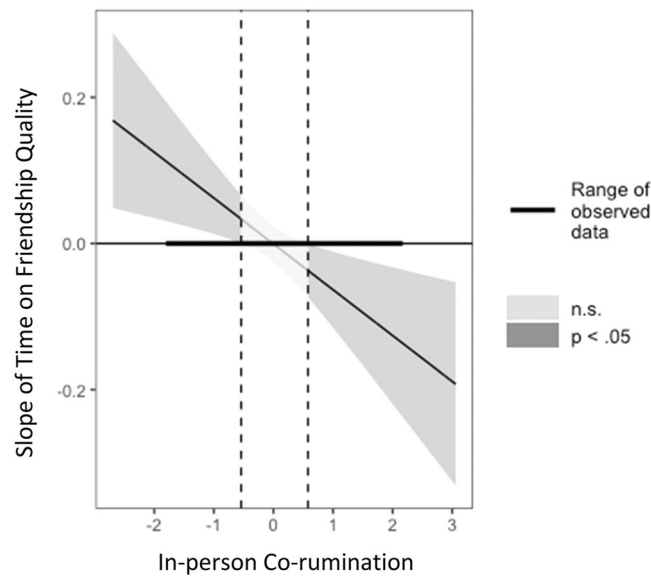


FIGURE 4 The Johnson-Neyman test for the regions of significance is presented. Results showed that when grand-mean centered in-person co-rumination at baseline was below -0.54 , there was an increase in friendship quality over time. Additionally, when grand-mean centered in-person co-rumination at baseline was above 0.58 , there was a decrease in friendship quality over time.

4 | DISCUSSION

Research investigating adolescents' co-rumination via in-person and digital technology (i.e., text, phone, and social media) has been limited, which is surprising considering the surge in both co-rumination and digital technology use during adolescence (Anderson & Jiang, 2018; Rose, 2002). The current study sought to examine the degree, associations among, and consequences (i.e., depressive symptoms, friendship quality) of adolescents' co-rumination via in-person, text, phone, and social media modalities over time. This study was the first to document the presence of co-rumination via in-person and digital modalities across 2 years of adolescence. We found greater co-rumination via some modalities (i.e., in-person) than others. We also found that in-person co-rumination at baseline predicted the trajectory of in-person co-rumination, and whereas text and phone co-rumination predicted depressive symptoms, only in-person co-rumination was associated with friendship quality.

As predicted for our first hypothesis, adolescents engaged in co-rumination across all communication modalities (in-person, text, phone, and social media). This finding extends past daily diary findings (also from this sample of adolescents; Battaglini et al., 2021) showing that they co-ruminated via a breadth of communication modalities day-to-day. The current study also found that adolescents co-ruminated more in-person, and less via social media compared to other modalities. There are multiple explanations for these findings. First, in-person co-rumination may offer nonverbal behaviors that encourage sustained co-rumination, which are scarce via digital communication (Tracy et al., 2015). For instance, non-verbal behaviors such as eye contact and nodding may signal attentiveness and interest (Ambady & Rosenthal, 1998), which may invite greater engagement in in-person co-rumination. Second, general communication preferences may influence the degree of co-rumination across modalities and may explain why adolescents co-ruminated the least via social media. Indeed, adolescents tend to communicate with friends via text and phone more than via social media (Lenhart, 2015); thus, they may have more opportunities to co-ruminate via text and phone. Therefore, future research is needed to investigate the factors (e.g., nonverbal behavior, preferred communication modality) influencing adolescents' choice of communication modality used to co-ruminate.

Notably, this is the first study to suggest that levels of in-person co-rumination at baseline predicts different trajectories of in-person co-rumination over time. Overall, findings showed that individuals with higher levels of in-person co-rumination at baseline exhibited decreases in co-rumination across early adolescence, whereas individuals with lower levels of in-person co-rumination at baseline exhibited increases in co-rumination over this same timeframe. It is possible that there is an upper threshold of in-person co-rumination at which the maladaptive affective consequences of co-rumination (e.g., negative affect) may dampen the reinforcing nature of in-person communication (e.g., nonverbal behavior) and adaptive outcomes associated with co-rumination (e.g., friendship quality), thereby leading to less in-person co-rumination over time. This possibility is partially supported by the findings from our third hypothesis, such that greater in-person co-rumination at baseline was associated with decreases in friendship quality over time. Conversely, there may be a lower threshold

of in-person co-rumination at which the reinforcing nature of in-person communication (e.g., nonverbal behavior) may contribute to greater in-person co-rumination over time.

Interestingly, co-rumination via other communication modalities (i.e., text, phone, social media) was not significantly associated with the trajectory of co-rumination across modalities. Our findings contrast past daily diary research conducted in this same sample of adolescents, which showed consistent use of co-rumination via phone and social media (Battaglini et al., 2021). Specifically, co-rumination via phone predicted greater next day co-rumination via phone, and co-rumination via social media predicted greater next day co-rumination in-person. Integrating past research and the present study, the transference of phone and social media co-rumination appears to operate quickly (i.e., day-to-day), whereas in-person co-rumination is associated with changes in in-person co-rumination across a longer period of time (i.e., across a 2-year period in this case). It is possible that digital modalities are readily available from 1 day to the next and, thus, allow more day-to-day continuation; conversely, in-person co-rumination requires physical proximity, which may not occur on a daily basis. Additional research is needed to investigate whether co-rumination via one modality at baseline may predict changes in that modality over time or show contagion across modalities such that it predicts increases in co-rumination via other modalities over time. Further research in this area may have implications for targeting co-rumination via certain modalities over others at baseline, considering potential long-term trajectories of co-rumination over time.

Our third hypothesis showed that increases in depressive symptoms were predicted by less co-rumination via text yet greater co-rumination via phone. There are important differences in text and phone communication that may explain these discrepant findings. Texting a friend about one's negative feelings and problems can be more laborious (e.g., writing and editing) and slower (i.e., waiting for a response) than engaging in a phone conversation, which occurs synchronously and in real-time. Indeed, research shows that adolescents' text message lengths are typically brief (i.e., mean of 6.9 words per message; Underwood et al., 2012). As a result, adolescents may co-ruminate via text for briefer durations or more concisely, which could facilitate interpersonal connection but preclude them from effective co-rumination by diluting the duration or complexity of the conversation. Thus, less co-rumination via text (and perhaps less interpersonal connection) could increase depressive symptoms over time. On the other hand, greater co-rumination via phone may result in more in-depth co-rumination that contributes to greater depressive symptoms over time.

Unexpectedly, co-rumination via in-person interactions was not significantly associated with concurrent depressive symptoms. Although other studies have found cross-sectional positive associations between in-person co-rumination and depressive symptoms (e.g., Calmes & Roberts, 2008; Rose, 2002), these studies have investigated in-person co-rumination exclusively. Interestingly, research investigating co-rumination via in-person *and* digital technology has failed to find concurrent significant associations between in-person co-rumination and depressive symptoms (Keshishian et al., 2016; Murdock et al., 2019). Including co-rumination via digital modalities in analyses with in-person co-rumination allows us to examine the unique contribution of in-person co-rumination on depressive symptoms after taking into account the contributions of co-rumination via other modalities. Considering the salient use of digital technology in adolescence (Anderson & Jiang, 2018; Lenhart, 2015), findings from this study may, therefore, represent a more ecologically valid examination of the influence co-rumination on depressive symptoms in early adolescents.

Our results also contrast studies showing that in-person co-rumination predicts greater depressive symptoms over time (e.g., Bastin et al., 2014; Rose et al., 2007). The timeframe in which in-person co-rumination and depression were investigated may play an important role in understanding these discrepant findings. Most longitudinal studies documenting a positive association between in-person co-rumination and depressive symptoms have investigated this association within a period of three to 6 months (e.g., Bastin et al., 2014; Rose et al., 2007). In contrast, studies—like ours—examining the co-rumination-depression link across longer periods of time have not found a significant association between the constructs. Starr and Davila (2009), for example, examined the association between in-person co-rumination and depressive symptoms in a sample of adolescents over 1 year and found that co-rumination did not predict changes in depressive symptoms. Thus, an intriguing possibility is that the influence of in-person co-rumination on depressive symptoms attenuates over time. This attenuation may occur because topics of co-rumination may closely resemble recent environmental events and problems, making topics of co-rumination in the past more obsolete over time.

In addition, whereas social media use has been associated with depressive symptoms (Keles et al., 2020), co-rumination via social media at baseline did not predict depressive symptoms in the current sample. Comparably, Frison et al. (2019) found that co-rumination via Facebook was not associated with depressive symptoms 6 months later. Indeed, social media may not be uniformly harmful for mental health in the long-term (Bryant et al., 2006; Best et al., 2014; McCrae et al., 2017). Rather, the way individuals communicate via social media (e.g., co-rumination) may determine whether social media use precipitates mental health concerns. Indeed, research suggests that it is important to examine the nuances of communication, including both how and with whom communication occurs (LeMoult et al., 2023).

We also observed that greater in-person co-rumination at baseline was associated with greater friendship quality at baseline, but less friendship quality over time. Interestingly, some longitudinal research suggests that greater in-person co-rumination may have harmful interpersonal outcomes. Greater in-person co-rumination is associated with more interpersonal stress over time (Hankin et al., 2010; Rose et al., 2017; Shapero et al., 2013). Studies have also found that

in-person co-rumination failed to predict changes in friendship quality (Bastin et al., 2018) and even decreased positive peer relations (Starr & Davila, 2009). This association may occur because negative self-disclosure (e.g., disclosing negative emotions and experiences) can result in interpersonal problems, especially when negative disclosures exceed positive disclosures (Willems et al., 2020). Therefore, higher co-rumination at baseline may result in greater friendship quality concurrently and in the short-term, but if co-rumination offsets positive self-disclosures it may predict pernicious effects on friendship quality over time. Future research is needed to examine the threshold at which co-rumination begins to have deleterious effects on friendship quality.

Additionally, co-rumination via digital modalities (i.e., text, phone, and social media) did not predict friendship quality concurrently or prospectively. Whereas past research found that co-rumination via text and phone predicted greater day-to-day relationship closeness in early adolescents (Battaglini et al., 2021), the results of this present study suggest that co-rumination via digital modalities may not contribute to friendship quality. Indeed, co-ruminating with a friend via text or phone may have the strength to influence momentary feelings of closeness; however, co-rumination via text and phone may not impact deeper or longstanding changes in the *quality* of friendships. Future research is needed to investigate the processes by which co-rumination via text and phone contribute to daily closeness but not concurrent or prospective friendship quality.

4.1 | Limitations and future directions

Importantly, the current study has both strengths and limitations. First, although this study examined co-rumination via a breadth of communication modalities, adolescents may use various social media platforms to communicate. Future research is needed to better understand when and how adolescents co-ruminate across different social media platforms. Second, co-rumination via social media was defined as chatting or messaging via a social media platform, which does not distinguish public from private messaging. Research shows that individuals communicate via social media both publicly and privately (e.g., Burkell et al., 2014). Thus, future research is needed to compare and contrast the consequences of public versus private co-rumination via social media. Third, adolescents reported on co-rumination with their closest friend and did not indicate whether this was a same-gender or other-gender relationship. Research on co-rumination in adults suggests that co-rumination may be more pernicious in same-gender relationships (see Rose, 2021), but it remains unclear whether co-rumination in adolescents differs in the context of same- versus other-gender relationships. Fourth, this study assessed co-rumination during a naturalistic stressor—the transition to high school—yet some participants completed portions of the study during the COVID-19 pandemic. Although exploratory results showed that, during the pandemic, participants still co-ruminated more in person compared to all other modalities, the COVID-19 pandemic may also be considered a naturalistic stressor that could have compounded adolescents' stress and uncertainty during the time of data collection (Pfeifer et al., 2021). Thus, future research may consider replicating the results of this study in a post-pandemic context.

4.2 | Conclusion

Co-rumination and digital technology use are both salient during adolescence. The present study sought to bridge the gap between co-rumination and digital technology use by investigating the degree, transference, and consequences of co-rumination via in-person and digital modalities over a 2-year period. Findings of the present study document the importance of the modality in which co-rumination occurs. For instance, although adolescents frequently co-ruminate in-person, they also regulate emotions via digital interactions, including those via text and phone. Results also suggested that text and phone co-rumination have opposite consequences on depressive symptoms, with increases in symptoms predicted by less co-rumination via text yet more co-rumination via phone. As such, adolescents' co-rumination with friends via phone may be a particularly important target for intervention and prevention efforts aimed at reducing depressive symptoms. This study has important implications for understanding the modalities through which adolescents co-ruminate, and that various modalities may have different consequences for adolescents' mental and social wellbeing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study will be openly available upon acceptance of the manuscript in the Open Science Framework (OSF) at https://osf.io/48af6/?view_only=68fbde0fa2514a2d80db12f4932b0860.

ETHICS STATEMENT

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the University of British Columbia (UBC) Behavioral Research Ethic Board.

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SUPPORTING INFORMATION

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