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ORIGINAL RESEARCH

Adjustment trade-offs and negative emotion reciprocation in adolescent-mother dyads during COVID-19

Natalie Wong[1] · **Skyler T. Hawk**[1]

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Abstract

Adolescents may benefit socially from family members' negative emotional reciprocation (e.g., having levels of concern about a certain thing that match with another family member), but excessive focus on their own anxiety can lead to negative outcomes. To date, implications of this 'trade-off' in adolescent-parent dyads (e.g., Rose in Child Development Perspectives 15(3):176–181 2021) for youth adjustment during the COVID-19 pandemic remain largely unexplored. During the fourth wave of COVID-19 in Hong Kong (September 2020 to April 2021), 349 first-year university students from varying socioeconomic backgrounds and following diverse study majors (T1 $M_{\text{adolescent age}} = 18.2$ years, 60.3% female) and their mothers gave bi-weekly reports of COVID-related preoccupation, negative affect, and perceived relational support from their dyad partner (5183 observations over 16 assessments). Multilevel response surface analyses tested whether congruence in COVID preoccupation between mothers and adolescents predicted relationship quality and negative affect over time. Results suggested that negative emotion reciprocation had 'trade-off' effects for adolescents' adjustment. Youth who matched high levels of COVID preoccupation with mothers reported the most relational support but also reported higher negative affect than youth with lower levels of COVID preoccupation. Mothers' reported support from adolescents was not related to either mothers' or adolescents' preoccupation. Mothers' negative affect was only associated with their own COVID preoccupation. Our findings suggest that adolescents may have derived some benefit from adolescent-mother negative emotion reciprocation, whereas mothers did not. The absence of trade-off effects in mothers may be linked to Chinese cultural norms of preserving the hierarchical family structure, such that the negative emotion reciprocation process in Chinese adolescent-mother dyads might be more adolescent-focused, i.e., revolving around the adolescents' distress rather than the parents'.

Keywords Negative emotion reciprocation · COVID-19 · Multi-level response surface analysis · Adolescents · Parents

Introduction

The COVID-19 pandemic has had significant implications for family dynamics, as shared family experiences of anxiety related to COVID-19 can lead to both positive (e.g., more positive interactions among family members; Gadermann et al., 2021; Kalil et al., 2020; Laufer & Bitton, 2023) and negative outcomes (e.g., increased distress; Feinberg et al., 2022). It is essential to understand the associations that parents' and children's joint experiences of negative emotion have on adolescents' well-being in critical times of family stress. Co-experiencing negative emotions with others has dual impacts on well-being, due to the trade-offs that may come with reciprocating others' feelings. Emotional reciprocity (i.e., matching levels of particular emotions between people) can strengthen relationships by facilitating the coordination of thoughts and by promoting mutual understanding and a sense of closeness (Hatfield et al., 1994; Keltner & Kring, 1998). Although adolescents may gain social benefits from family members' emotional reciprocation, focusing solely on anxiety can lead to negative outcomes. This 'trade-off' effect has been previously documented for adolescent-parent verbal sharing of negative emotions (e.g., co-rumination trade-offs; Rose, 2021). However, its implications for youth adjustment during the COVID-19 pandemic, which included significant disruptions to families' daily lives, remain largely unexplored. This study examined the potential trade-off effects of negative emotion reciprocation (i.e., matching levels of concern about COVID-19) in

✉ Natalie Wong
natalielywong@cuhk.edu.hk

[1] Department of Educational Psychology, The Chinese University of Hong Kong, Hong Kong, China

adolescent-mother dyads during the fourth wave of COVID-19 in Hong Kong (late September 2020 to April 2021), when in-person classes were suspended, university housing was closed, and social gatherings were tightly restricted.

Transformations in family life and distress during COVID-19 in Hong Kong

The global outbreak of COVID-19 has been an unprecedented public health crisis. From early 2020, numerous emergency restrictions were imposed around the world in order to contain the spread of the virus, including confinement measures and school closures. These measures were intended to safeguard public health, but they also caused significant disruptions to the lives of both adolescents and parents. When the fourth wave of COVID-19 struck Hong Kong in November 2020 (OT&P Healthcare, 2023), all schools, including tertiary institutions, suspended in-person attendance for over 5 months. During this period, the government rescheduled school reopening dates at least three times. These frequent changes in government regulations regarding school arrangements presented unique challenges for families. Additionally, social distancing policies restricted extra-familial gatherings and severely limited opportunities for activity outside of the home. Figure 1 provides a summary of government-initiated measures during the fourth wave in Hong Kong. Reports of psychological distress among both youth and adults nearly doubled in this period, compared to pre-pandemic levels (Zhuang et al., 2021). These restrictions provided family members with unique opportunities to witness the impact of COVID-19 on one another. The pandemic was also likely a source of frequent discussion for many families, including both informational exchange and the sharing of negative emotions. These interactions could potentially lead to more negative emotion reciprocation between parents and adolescents.

There has been little research investigating trade-off effects of negative emotion reciprocation in families during COVID-19, but studies investigating the impact of the pandemic on family well-being provide indirect evidence. Research examining social outcomes has found that families may benefit from shared experiences of stress. In particular, several studies found a greater frequency of positive parent–child interactions during COVID-19 (e.g., Gadermann et al., 2021; Kalil et al., 2020; Laufer & Bitton, 2023). However, research focused solely on the psychological effects of co-experiencing stress has only identified negative effects, such as heightened psychological difficulties (e.g., Feinberg et al., 2022). The simultaneous associations that shared experiences of stress hold with both negative psychological

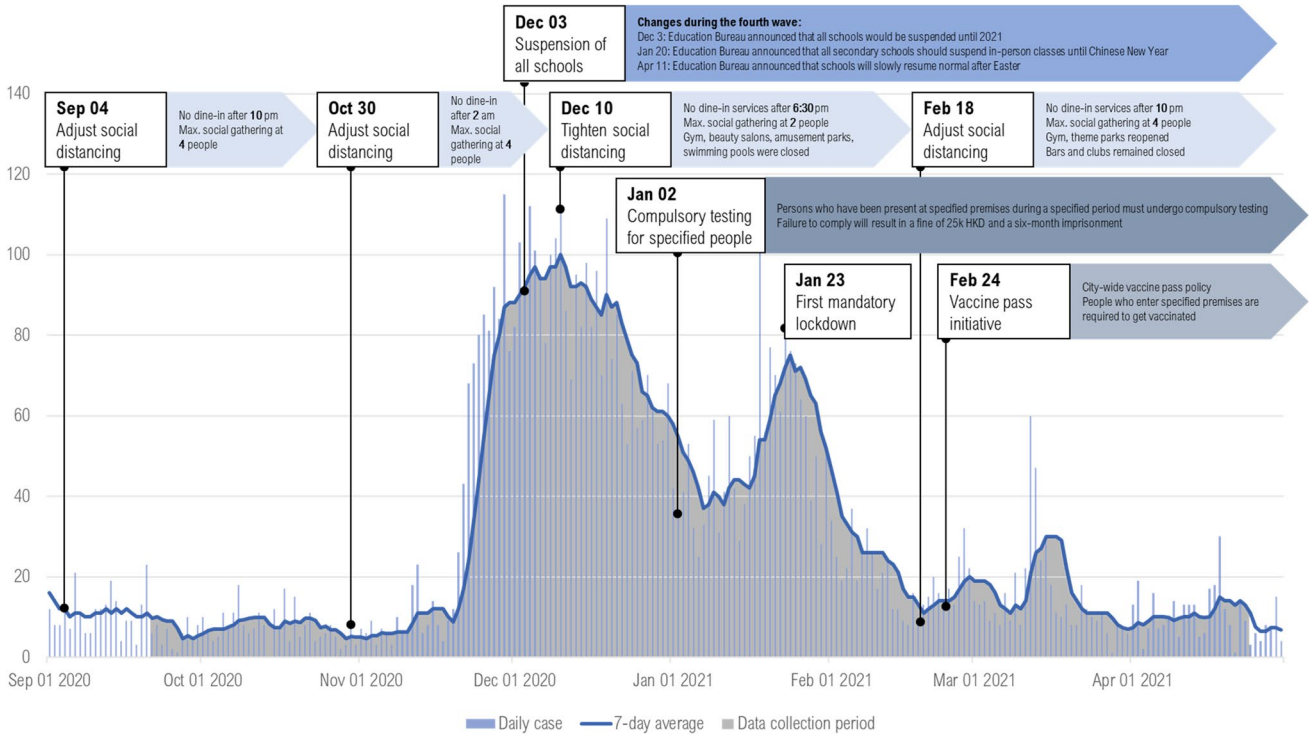

Fig. 1 Number of COVID-19 cases and government-initiated measures in Hong Kong during the data collection period of September 2020 to April 2021. *Note* The daily case number indicates new cases reported since the previous day. The case numbers are derived from Dong et al.'s (2020) real-time tracking application for COVID-19 cases. The government-initiated measures depicted in this figure are from the OT&P Healthcare (2023) archive. The area shaded in gray represents the period during which data were collected

outcomes and positive social outcomes might represent a 'double edged sword' of co-experiencing negative emotions. Considering the lack of research in this area and the shift to remote work and learning both during and after COVID-19, there is an urgent need to further examine the negative emotion reciprocation and its implications for family dynamics. The present study aims to fill this gap, by examining potential trade-off effects of adolescent-parent negative emotion reciprocation during COVID-19.

Adjustment trade-offs in negative emotion reciprocation

Reciprocating negative emotions in a relationship might have adjustment trade-offs based on its simultaneous associations with the promotion of understanding, which is linked to positive social adjustment, and the maladaptive focus on negative affect, which is linked to emotional adjustment difficulties (see Rose, 2021 for a detailed review). The adjustment trade-off in negative emotion reciprocation has been predominantly studied in the context of co-rumination, a type of negative emotion reciprocation that involves extensive discussion and shared experiences of stress. However, it is crucial to acknowledge that negative emotion reciprocation and related adjustment trade-offs can also occur without such discussion, such as feeling empathic distress when witnessing someone else's pain (Cao et al., 2017; Smith, 2015). Therefore, investigating broader family co-experiences of stress during the COVID-19 pandemic could provide a more comprehensive understanding of links between negative emotion reciprocation and family members' adjustment.

Adjustment trade-offs of negative emotion reciprocation have been previously identified in adolescent friendships (e.g., Ames-Sikora et al., 2017; DiGiovanni et al., 2021; Journault et al., 2023), a primary context in which adolescents acquire social support (Rose, 2021). Parents continue to be important sources of support into emerging adulthood, however, especially during stressful life experiences (Abel et al., 2020; Felix et al., 2020). In light of the critical role parents play in emotion socialization (see Miller-Slough & Dunsmore, 2016 for a review), some have argued that adolescent-parent negative emotion reciprocation could have both beneficial and detrimental effects on youth adjustment (e.g., Main et al., 2016; Miller-Slough & Dunsmore, 2021). As such, there is a need for further research into the potential advantages and disadvantages of negative emotion reciprocation between parents and adolescents in times of stress. To our knowledge, the only study on adolescents' negative emotion reciprocation during COVID-19 examined co-rumination with peers (Journault et al., 2023). Using data collected both pre- and post-pandemic, their research found that adolescents' co-rumination with friends *decreased* following the COVID-19 outbreak, after pandemic measures were introduced (including school closures and lockdowns). This could be expected, as adolescents spent significantly more time at home and less time with friends. Although youth might have had more opportunities to co-experience stress with their parents (and vice-versa) for the same reason, the study did not assess negative emotion reciprocation in family relationships. More research is needed to address this gap.

While positive social outcomes of negative emotion reciprocation (e.g., relationship quality) are extensively documented in adolescent friendships, adolescent-parent dyads have received less attention (see Rose, 2021 for a review). To our knowledge, associations between negative emotion reciprocation and family relationship quality have only been examined in two studies (i.e., Ames-Sikora et al., 2017; Calmes & Roberts, 2008). Both studies reported increased youth-parent relationship satisfaction, providing support for positive adjustment effects of negative emotion reciprocation, but were inconsistent as to whether this reciprocation also predicted negative affect. Specifically, the absence of significant associations between negative emotion reciprocation and depression in both studies is inconsistent with other research that did identify this link, but did not simultaneously examine changes in relationship quality (e.g., Abel et al., 2020; Felix et al., 2020; Miller-Slough & Dunsmore, 2021). Most of these studies on the negative effects of negative emotion reciprocation focused primarily on co-rumination, a subtype of negative emotion reciprocation that involves explicit discussions about stress. However, these studies also provide insight into the broader effects of negative emotion reciprocation, which encompasses both verbal and nonverbal emotional sharing. Another intensive longitudinal study (Stone et al., 2019) examined early- to middle-adolescents' reported anxiety levels following co-rumination with parents and peers over five days. Regardless of the interaction partner, co-rumination predicted higher anxiety. Similarly, an observational study (Miller-Slough & Dunsmore, 2021) in which youth (aged 13–18) discussed a past negative emotion experience separately with a parent and a peer found that focusing on negative affect during the interactions was positively correlated with youth depressive and anxiety symptoms. Moreover, a cross-sectional study on adolescent-parent joint recollection of a traumatic event (i.e., the Tuscaloosa-Birmingham tornado in the United States; Abel et al., 2020) showed that parents' reciprocation of adolescents' negative emotions was linked with greater youth anxiety. Across a variety of research designs, these various studies generally support expectations that adolescent-parent negative emotion reciprocation may adversely affect adolescents' emotional adjustment. The inconsistent results regarding adjustment trade-off effects in adolescent-parent negative emotion reciprocation, particularly regarding its impact on adolescents' negative affect, point to the need for further research in this area.

Several methodological issues may have contributed to the lack of consensus in the research on adolescent-parent negative emotion reciprocation, to date. First, the majority of studies used a cross-sectional design (e.g., Abel et al., 2020; Ames-Sikora et al., 2017; Felix et al., 2020; Miller-Slough & Dunsmore, 2021), and concurrent links between negative emotion reciprocation and psychosocial adjustment may not be indicative of longer-term associations. Second, many studies assessed negative emotion reciprocation only through youth reports (e.g., Ames-Sikora et al., 2017; Ioffe et al., 2020; Stone et al., 2019). The absence of multiple informants may impair understanding of reciprocal processes between two individuals. Furthermore, parents and youth have experienced different levels of stress and adopted different types of emotion regulation strategies during COVID-19 (Journault et al., 2023). It is unclear whether mismatched levels of stress between parents and children might also contribute to their relationship partner's adjustment. This is an important, yet understudied, question in the research on negative emotion reciprocation, (i.e., do people experience intensified negative affect when their anxiety is reciprocated, or when their anxiety is not reciprocated?). Having similar levels of stress may, on the one hand, promote a sense of understanding with a partner, which might result in a more positive relationship. On the other hand, having similarly high levels of stress may result in worsened affect. It is imperative that studies employ novel methods that can address these concerns, to gain a better understanding of negative emotion reciprocation.

Negative emotion reciprocation: effects on parents' well-being and the Chinese context

Although prior findings have highlighted potential detrimental effects of adolescent-parent negative emotion reciprocation, it is worth noting that most of the related research in the United States has focused exclusively on adolescents' outcomes (e.g., Abel et al., 2020; Miller-Slough & Dunsmore, 2021; Stone et al., 2019). However, some studies have found that negative emotion reciprocation predicted negative affective outcomes for both youth and parents in the United States (Felix et al., 2020; Kim et al., 2001), while also suggesting that adolescents might be more susceptible to the negative effects of co-rumination than parents due to their lower sensitivity thresholds (Felix et al., 2020). Further longitudinal research could allow a better understanding as to whether negative emotion reciprocation in families may predict parents' well-being, especially in the context of prolonged stressful events, as well as how it might impact the family's long-term development. Recent research has found that Spanish parents' heightened distress about COVID-19 may result in more adverse outcomes for children via parenting distress (Romero et al., 2020). A better understanding of the effects of negative emotion reciprocation on parents' well-being can assist in designing more effective family interventions for similar situations.

It is possible that the earlier findings from Western cultures cannot be readily generalized to cultures that place a greater emphasis on family hierarchy. Cross-cultural studies on co-reminiscing behaviors between mothers and children provide some insight into this issue (Kulkofsky et al., 2009). This research indicated that Chinese mothers were less likely than their European American counterparts to co-reminisce with children for conversational purposes (i.e., for the sake of sharing) and were less emotionally expressive. The authors suggested that mothers may hold differing views on the purpose and importance of parental hierarchy in emotion sharing. In the European American context, sharing emotions is thought to promote a sense of closeness between parent and child (e.g., Fivush et al., 2003). In the Chinese context, however, mothers believe more strongly that maintaining composure helps to reinforce their power in guiding the interaction (Wang, 2007). These hierarchy beliefs may reduce mothers' experience of reciprocal emotion in response to their children's distress (e.g., Van Kleef et al., 2008). Considering the cultural differences in parents' hierarchy beliefs in emotion reciprocation, the negative effects of adolescent-parent negative emotion reciprocation on parents' well-being may also vary. As noted in a recent review on the adjustment tradeoffs of negative emotion reciprocation (Rose, 2021), most research has been conducted with participants from middle- to upper-class European American backgrounds. There is still limited evidence as to whether the adjustment trade-off effects occur in other cultures, especially among parents.

The present study: response-surface analysis of negative emotion reciprocation

The present study investigated potential negative emotion reciprocation trade-off effects in adolescent-mother dyads over seven months of the COVID-19 pandemic in Hong Kong. This study aims to foster a more comprehensive understanding of the links between negative emotion reciprocation and family members' adjustment by examining the co-occurrence of COVID-19 preoccupation in adolescent-mother dyads, which involves negative emotions related to persistent worry and intrusive thoughts related to the pandemic. This study did not focus on testing for a congruence effect of preoccupation in adolescent-mother dyads. Rather, it aimed to demonstrate how the matched and mismatched levels of COVID-19 preoccupation between dyad members relate to the outcomes in a linear and curvilinear fashion. Specifically, we used multilevel polynomial regressions (i.e., timepoints nested within dyads) with response surface analysis (RSA) to examine

whether patterns of (in)congruence in adolescent- and mother-reported COVID-19 preoccupation related to their negative affect and perceived relational support. RSA is a valuable method for studying negative emotion reciprocation trade-offs in adolescent-parent dyads, as it permits the visualization of the relationship between adolescent- and mother-reported COVID-19 preoccupation and the outcome variables on a three-dimensional surface (see Fig. A1 in Supplemental materials). The surface plot parameters (i.e., a_1–a_5) are computed from the fitted model of a polynomial regression. In our study, the line of congruence (LOC) reflects how matched preoccupation between adolescent and mother is associated with an outcome variable, and the line of incongruence (LOIC) reflects how mismatched preoccupation is associated with an outcome variable. Both LOC and LOIC are tested for linear effects (i.e., a_1 and a_3 respectively; e.g., whether matching at high levels of COVID-19 preoccupation is related to a stronger negative affect than when matching at low levels of COVID-19 preoccupation) and curvilinear effects (i.e., a_2 and a_4 respectively; e.g., whether matching at extreme levels of COVID-19 preoccupation, either high or low, is related to stronger negative affect than when matching at mid-range levels of COVID-19 preoccupation). Unlike methods that collapse multi-informant data into a single difference score, this approach enables a more nuanced understanding of the degree to which both matched *and* mismatched levels of preoccupation between informants are associated with the outcome variables.

Hypotheses

In light of previous findings regarding the positive effects of negative emotional reciprocation on relational support (e.g., Ames-Sikora et al., 2017; Rose, 2021), we expected that:

H1 Adolescents would perceive more relational support from their mothers when both mothers' and adolescents' COVID-19 preoccupation levels were high (indicated by positive a_1).

H2 Adolescents would perceive more relational support from their mothers when mothers' and adolescents' COVID-19 preoccupation matched at extreme levels (vs. mid-range levels; i.e., a U-shaped curvature along LOC, indicated by positive a_2), as the adjustment trade-off for negative emotion reciprocation should be more apparent at higher levels (e.g., Felix et al., 2020). Figure 2a shows the hypothetical response surface for Hypotheses 1 and 2.

In light of previous findings regarding links between negative emotional reciprocation and negative affect (e.g., Main et al., 2016; Miller-Slough & Dunsmore, 2021), we expected that:

H3 Adolescents would report higher negative affect when both mothers' and adolescents' COVID-19 preoccupation were high (indicated by positive a_1).

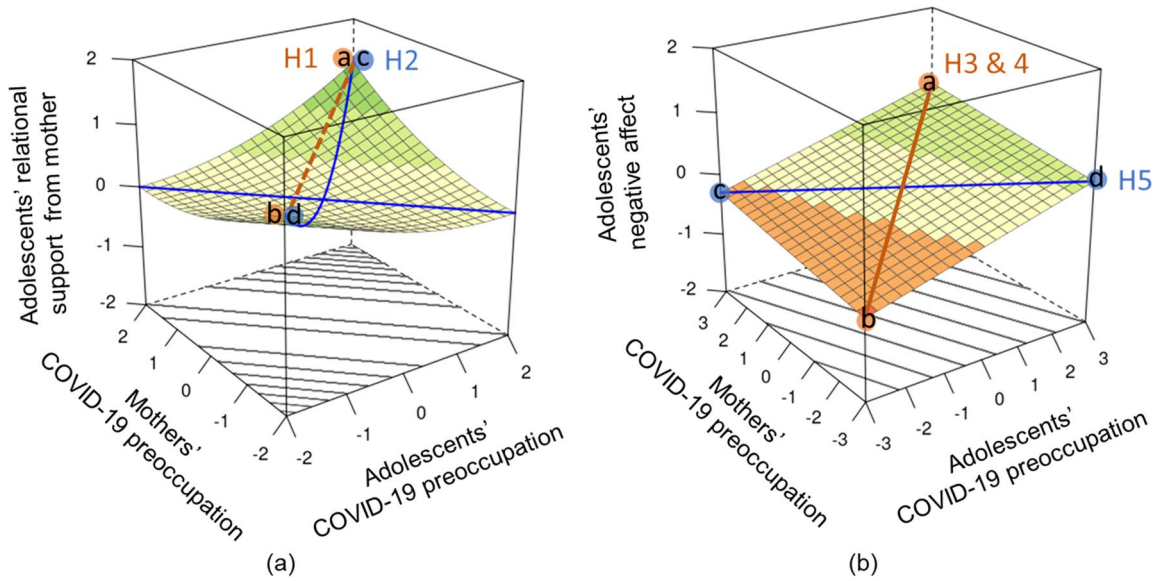

Fig. 2 Hypothetical response surfaces of COVID-19 preoccupation and adolescents' well-being. *Note* **a** Based on H1 and H2, we predicted a linear effect (a > b) and a U-shaped curvature across LOC (c–d), respectively. **b** We predicted a linear effect (H3) and no curvature (H4) across LOC (a > b). We predicted a linear slope (H5) across LOIC (c < d)

H4 Low COVID-19 preoccupation from both parties would be related to the least amount of adolescent negative affect (indicated by no curvature along LOC, $a_2 = 0$).

H5 Adolescents' negative affect would be higher when adolescents' COVID-19 preoccupation was greater than mothers', rather than when the mothers' COVID-19 preoccupation was greater than adolescents' (as own affect should be more strongly linked to own preoccupation, indicated by positive a_3). Figure 2b shows the hypothetical response surface for Hypotheses 3–5.

Studies on negative emotion reciprocation in families have given limited attention to parents' outcomes. In addition, the hierarchical nature of Chinese families may affect the generalizability of previous research conducted with parents from the United States. As a result, there is currently insufficient empirical evidence to support any a priori hypothesis regarding Chinese mothers' outcomes for negative emotion reciprocation. Consequently, the investigation of parents' outcomes of negative emotion reciprocation was purely exploratory, with the aim to generate new insights and knowledge in this field.

Method

Participants

Of the 354 mother-adolescent dyads recruited for this study, five pairs were excluded from the analysis ($N_{dyads} = 4$ both the mother and the adolescent did not take part in the study after providing demographic information; $N_{dyads} = 1$ the mother did not take part in the study). Multilevel modeling requires a minimum sample size, with guidelines recommending at least 10 units at level 1 (i.e., number of measurement points; Teneva & Lemay, 2020) and at least 100 units at level 2 (i.e., number of participants; Hox, 2013). Our sample size (16 waves; 349 mother-adolescent dyads) met the recommended criteria. Adolescents (60.3% female) were aged from 17 to 24 years at study onset ($M = 18.20$, $SD = 1.10$, with 90% aged 19 or younger). All youth resided in Hong Kong, and nearly all were ethnic Chinese (99.1%). The remaining 0.9% were of Southeast Asian descent. There was a wide range of study majors represented, including arts (16.9%), business administration (12.6%), education (3.7%), engineering (9.7%), law (1.1%), medicine (20.6%), science (11.5%), and social science (16.0%). Most youth (85.3%) lived with their mothers throughout the entire period of data collection. A small number were in university housing (0.4%) or with other relatives (0.7%).

The average age of mothers was 49.10 ($SD = 4.82$). Almost all of mothers (99.1%) resided in Hong Kong, with the remaining residing in Mainland China. Most (98.9%) identified themselves as ethnic Chinese, with the remainder being of south-east Asian descent. Most had completed high school (61.60%), followed by an associate degree (14.3%), primary school or lower (12.3%), a bachelor's degree (7.7%), and a master's degree (4.0%). Around half of the mothers worked full-time (49.9%), the remainder worked half-time (12.9%) or were homemakers (32.4%). Others reported being unemployed (4.9%).

Procedure

This convenience sample was recruited at a major university in Hong Kong before the outbreak of the fourth wave of COVID-19 (official onset 23rd November 2020; OT&P Healthcare, 2023). Participants were recruited online during first-year orientation programs as well as via college websites and mass mailings. The study adhered to ethical standards consistent with the principles outlined in the 1964 Declaration of Helsinki. Ethics approval was obtained from the Institutional Review Board of the corresponding author's institution. Active informed consent was obtained from participating youth and parents. Participants received information about the surveys, including their right to confidentiality and to withdraw without penalty. Data collection began in September 2020 and ended seven months later, in April 2021. A total of 16 bi-weekly surveys were administered. The two-week interval for data collection is appropriate because studies suggest that the effects of adolescent-driven factors are observed at the meso-timescale of two weeks to three months (see Boele et al., 2022 for details). Details about the data collection schedule can be seen in the Supplemental Materials. The survey items were combined with those for another study on parenting and adolescent adjustment. On average, participants spent around 11 min completing each survey. Each participant could earn up to HK$900 (around US$115) for participating. At the conclusion of the study, each participant received a report on their personal development during the project.

Compliance

A total of 11,168 questionnaires were planned for our final sample, of which 11,131 (99.7%) were successfully delivered to the participants. During data collection, a small number of questionnaires ($N = 37$; 0.003%) were inaccessible to participants due to technical issues related to updates made by the mobile app developers. Of the 11,131 successfully delivered surveys, participants completed 10,647 questionnaires. The average compliance rate in this study was 95.7%, which is much higher than the typical compliance rate for intensive longitudinal designs (i.e., 70–80%; Rintala et al., 2019).

Measures

All measures used in the study were translated into Chinese and then back-translated into English by bilingual speakers. Multilevel confirmatory factor analyses (MCFA) were used to estimate reliabilities using the semTools package (version 0.5–6; Jorgensen et al., 2016) in R 4.2.1 (R Core Team, 2022). Geldhof et al. (2014) reliability coefficients were computed. All models were estimated using the maximum likelihood method. A full list of the items used in the current study can be seen in the Supplemental materials.

COVID-19 preoccupation

Participants indicated their worry and intrusive thoughts about COVID-19 in the past week using a six-item measure adapted from existing scales (Clark & Rhyno, 2005; Foa et al., 1997; Wohlfarth et al., 2003). Participants reported on a 5-point Likert scale. The scale began with an instruction line that asked, "With regard to the recent COVID-19 PANDEMIC in Hong Kong, to what extent in the PAST WEEK have you (1 = not at all; 5 = very often)…", followed by six items: (1) Paid a lot of attention to occurrences in the city; (2) Found the situation taking up a great deal of your energy; (3) Tried to avoid thinking about the situation but failed; (4) Felt anxiety or distress; (5) Felt indecisive about what to do from one day to the next; and (6) Found yourself making "contingency plans" to deal with possible difficulties that might arise. The scale showed good within- and between-person reliability (mother: $\widetilde{\omega}^{w} = 0.78$; $\widetilde{\omega}^{b} = 0.97$; adolescent: $\widetilde{\omega}^{w} = 0.81$; $\widetilde{\omega}^{b} = 0.99$).

Negative affect

Six items from the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) assessed three dimensions of negative affect, including sadness (2 items), anxiety (2 items), and irritation (2 items). Participants reported their negative affect in the past week on a 5-point Likert scale. The scale began with an instruction line that asked, "How often in the PAST WEEK have you felt (1 = Not at all; 2 = Rarely; 3 = Occasionally; 4 = Often; 5 = Very often), followed by six items: (1) Sad; (2) Depressed; (3) Afraid; (4) Anxious; (5) Short-tempered; and (6) Hostile. The scale showed good within- and between-person reliability (mother: $\widetilde{\omega}^{w} = 0.80$; $\widetilde{\omega}^{b} = 0.90$; adolescent: $\widetilde{\omega}^{w} = 0.74$; $\widetilde{\omega}^{b} = 0.90$).

Relational support

Two items from the Networks of Relationships Inventory (NRI; Furman & Buhrmester, 1985) measured adolescents' perceived relational support from mothers and, mothers' perceived relational support from children in the past week. Participants reported on a 5-point Likert scale. The scale began with an instruction line that read, "Please respond to the following questions about your relationship with your mother/child over the PAST WEEK (1 = Not at all; 2 = A little bit; 3 = Moderate amount; 4 = A lot; 5 = The most)", followed by two items: (1) How pleasant has the relationship been with your mother/child, and (2) Did your mother/child show that he/she cares about you? The scale showed acceptable within and between-person reliability (mother: $\widetilde{\omega}^{w} = 0.44$; $\widetilde{\omega}^{b} = 0.75$; adolescent: $\widetilde{\omega}^{w} = 0.40$; $\widetilde{\omega}^{b} = 0.77$). While the relational support scales appear to have low within-person reliability, the generalizability for within-person changes between 0.40 and 0.60 is considered acceptable (Shrout, 1998). There have been recommendations to loosen the criterion even further, since within-person reliability (i.e., stability over time) is less important for longitudinal surveys (e.g., Nezlek, 2017). As such, we considered the reliability of our scales to be acceptable.

Data analysis

The data were assessed for skewness and kurtosis prior to analysis. Missing data in this study were handled using the MICE package (version 3.16.0; van Buuren & Groothuis-Oudshoorn, 2011) for full multiple imputation via chain equations. This approach has been shown to be superior to list-wise deletion when dealing with missing data in intensive longitudinal research (Ji et al., 2018). As our dataset had a nested structure (i.e., timepoints nested within mother-adolescent dyads), we followed the recommendations of Nestler et al. (2019) and conducted a multilevel response surface analysis (RSA) using lme4 (version 1.1–30; Bates et al., 2014) and RSA (version 0.10.4; Schönbrodt & Humberg, 2023) packages in R 4.2.1 (R Core Team, 2022). The analytic procedure of a multilevel RSA consists of four major steps: (1) data preparation (i.e., centering the predictors), (2) performing multilevel polynomial regressions, (3) obtaining average response surface parameters using regression coefficients, and (4) creating average surface plots using the response surface parameters to facilitate interpretation of the results.

Accordingly, the two predictor variables (i.e., mother-reported and adolescent-reported COVID-19 preoccupation) were centered on the grand mean across both variables prior to data analysis (Nestler et al., 2019). To test our hypotheses, we constructed separate multilevel polynomial regressions for each outcome variable. Specifically, the predictors (i.e., mother- and adolescent-reported COVID-19 preoccupation), their squared terms, and their interactions were used to predict (1) adolescent-reported relational support from mothers, (2) adolescent-reported negative affect, (3) mother-reported relational support from their children, and (4) mother-reported negative affect. In our current study, a

time-point was nested within a mother-adolescent dyad. The equations for the multilevel response surface model can be found in the Supplemental Materials.

The fitted models were then used to compute the average response surface parameters and create the average surface plots. The average response surface parameters were computed using the regression coefficients from our response surface model (equations available in the Supplemental Materials), where a_1 and a_2 are the linear and curvilinear effects (i.e., slope and curvature) along the line of congruence (LOC; when x = y), and a_3 and a_4 are the linear and curvilinear effects along the line of incongruence (LOIC; when x = − y). The R script of the multilevel RSA is available in the Supplemental Materials. We were not focused on testing for congruence effects of matched preoccupation, but note that multiple indicators should be considered to demonstrate it (Humberg et al., 2018). We did not assume a congruence effect and instead expected slopes and curvatures along the LOC.

In addition to the main analysis presented in this manuscript, we conducted a supplementary analysis to further explore the potential moderating effects of communication of thoughts related to COVID-19 on the trade-off effect of negative emotion reciprocation. Additionally, we also considered gender as a potential moderator of the negative emotion reciprocation trade-off, given that previous research has suggested that mother-son and mother-daughter relationships could differ in terms of relational closeness during childhood (Xu et al., 2018) and adolescence (e.g., Domene et al., 2011). Details about these supplementary moderation analyses are available in the Supplemental Materials.

Transparency and openness

We report how we determined our sample size, all data exclusions, and all measures in the study. This study did not include any experimental manipulation. Due to the ongoing nature of this project at the time of submission, the data are not currently available for public dissemination but will be shared with interested scholars upon reasonable request. This study was not preregistered.

Results

Descriptive statistics

The descriptive statistics and multilevel correlations of the study variables are presented in Table 1. The skewness of the study variables was close to zero, indicating that the distribution of these variables was close to symmetrical. The multilevel intraclass correlation coefficients (*ICC*s) indicated that a substantial portion (59–71%) of the variance was due to dyad differences, which supports the use of linear mixed modeling. As expected, adolescents' and mothers' COVID-19 preoccupation was positively correlated with their own negative affect. Adolescents' perceived relational support from mothers was positively correlated with mothers' perceived relational support from children. The within- and between-dyad correlations, for the most part, were in the same direction, with one exception. At the within-dyad level, mothers' COVID-19 preoccupation was negatively correlated ($r = -0.11$, $p = 0.04$) with perceived relational support from their children, but at the between-dyad level, the two variables had a very small but positive correlation ($r = 0.04$, $p = 0.01$). This is an example of the Simpson's paradox, where the observed correlation of two variables is reversed (or altered) at different levels of analysis.

Table 1 Descriptive statistics and correlations for study variables

	M	*SD*	Min–Max	Skewness	Kurtosis	*ICC*	1	2	3	4	5	6
1. Pre-AD	2.47	0.85	1–5	0.39	0.17	0.71	–	0.26**	0.37**	0.23**	0.02	− 0.11*
2. Pre-mother	2.57	0.70	1–5	0.44	0.84	0.65	0.14**	–	0.23**	0.58**	− 0.02	− 0.11*
3. NA-AD	2.30	0.73	1–5	0.38	− 0.02	0.66	0.12**	0.00	–	0.40**	− 0.21**	− 0.19**
4. NA-mother	1.98	0.64	1–5	0.49	0.26	0.67	0.02	0.19**	0.09**	–	− 0.11	− 0.30**
5. RS-AD	3.46	0.76	1–5	− 0.15	− 0.11	0.60	0.06**	0.01	− 0.02	− 0.03*	–	0.44**
6. RS-mother	3.30	0.76	1–5	− 0.01	− 0.20	0.59	0.00	0.04*	− 0.01	− 0.13**	0.11**	–

Note The multilevel correlations were computed using Misty (version 0.4.6, Yanagida, 2022) *Z*-tests were used to examine the significance of the multilevel correlations. Observations across 16 time-points are clustered within adolescent-mother dyads; Number of observations = 5183; Number of clusters = 349

Pre COVID-19 preoccupation, *NA* negative affect, *RS* relational support, *AD* reported by adolescents, *Mother* reported by mothers, *ICC* multilevel intraclass correlation coefficient. Within-dyad correlations are presented in the lower diagonal and between-dyad correlations are presented in the upper diagonal

*$p < 0.05$; **$p < 0.01$

Preliminary analysis

The dataset consisted of 349 mother-adolescent dyads with 5183 observations, encompassing 10,366 questionnaires from the adolescents and mothers, over 16 time-points. We used the checklist proposed by Humberg et al. (2018) to examine whether our congruence variables met the requirements for RSA. The three requirements were met: Congruence variables (i.e., COVID-19 preoccupation) were commensurable (i.e., measured by the same standard) and were grand-mean centered prior to data analysis. There was also no evidence of multicollinearity. All independent variables in the study had variance inflation factors, or VIFs, below 1.5, which were much lower than the conventional cutoff point (i.e., VIF > 5; e.g., Fox, 2015).

Main analysis

The results of the multilevel polynomial regression analyses and response surface parameters are presented in Table 2. To test our hypotheses, the response surface parameters were evaluated simultaneously (i.e., rather than in isolation) to avoid misinterpretation of the results (Humberg et al., 2018). The average surface plots are presented in Figs. 3 and 4. Bag plots (i.e., the bivariate extension of box plots) were included in our surface plots to indicate the location of the inner 50% (i.e., within the inner polygon) and the outer 50% of the points (i.e., between the boundary of the inner and the outer polygon) in our dataset.

Mothers' and adolescents' COVID-19 preoccupation and adolescents' well-being

Mothers' and adolescents' COVID-19 preoccupation was linked to adolescents' perceptions of mothers' support, as expected (see Table 2 and Fig. 3a). Specifically, the LOC coefficients were positive and significant (i.e., positive a_1 and a_2). Inspection of the surface plot (Fig. 3a), revealed the expected U-shaped pattern along the LOC (see Fig. 2a for our hypothesized plot). Taken together, adolescents reported higher relational support from mothers (1) when both the mother's and the adolescent's COVID-19 preoccupation was high (vs. when both were low; indicated by positive a_1, supporting H1) and (2) when the mothers' and adolescents' preoccupation matched at extreme levels (vs. mid-range levels; indicated by positive a_2, supporting H2). As seen in Table 2, the coefficients for LOIC (i.e., a_3 and a_4) were not significant. This indicates that the mismatch in preoccupation between mothers and adolescents was not linked to adolescents' perceptions of mothers support.

The congruence of mothers' and adolescents' COVID-19 preoccupation was also associated with adolescents' negative affect, as expected (see Table 2 and Fig. 3b). The surface plot (Fig. 3b) showed the expected rising ridge along the LOC and a left-to-right rising ridge along the LOIC (see Fig. 2b for our hypothesized plot). Specifically, the linear effects were positive and significant (i.e., positive a_1 and a_3). The curvilinear effects (i.e., a_2 and a_4) were non-significant. Taken together, the results suggested that (1) adolescents reported higher negative affect when both the mother and the adolescent had high COVID-19 preoccupation (vs. when both had low COVID-19 preoccupation; indicated by positive a_1, supporting H3); (2) the lowest adolescent negative affect was associated with a low level of COVID-19

Table 2 Dyadic polynomial regression coefficients and response surface parameters of adolescent-reported, and mother-reported COVID-19 preoccupation in the prediction of adolescent-reported and mother-reported relational support (RS) and negative affect (NA)

	Adolescent		Mother	
	RS	NA	RS	NA
Polynomial regression coefficients				
b_1—adolescent COVID-19 preoccupation	0.05**	0.14***	− 0.01	0.001
b_2—mother COVID-19 preoccupation	0.001	− 0.004	0.02	0.19***
b_3—adolescent COVID-19 preoccupation^2	0.03	0.02	− 0.001	0.005
b_4—adolescent x mother report	0.07*	− 0.03	0.02	− 0.02
b_5—mother COVID-19 preoccupation^2	0.01	− 0.001	− 0.02	− 0.01
Response surface parameters				
a_1—slope along LOC (x = y)	0.06*	0.13***	0.01	0.20***
a_2—curvature along LOC (x = y)	0.11*	− 0.02	0.001	− 0.02
a_3—slope along LOIC (x = − y)	0.05	0.14***	− 0.04	− 0.19***
a_4—curvature along LOIC (x = − y)	− 0.03	0.05	− 0.04	0.01
a_5—first principal axis	0.02	0.02	0.02	0.02

Note *RS* relational support, *NA* negative affect, *LOC* line of congruence, *LOIC* line of incongruence
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

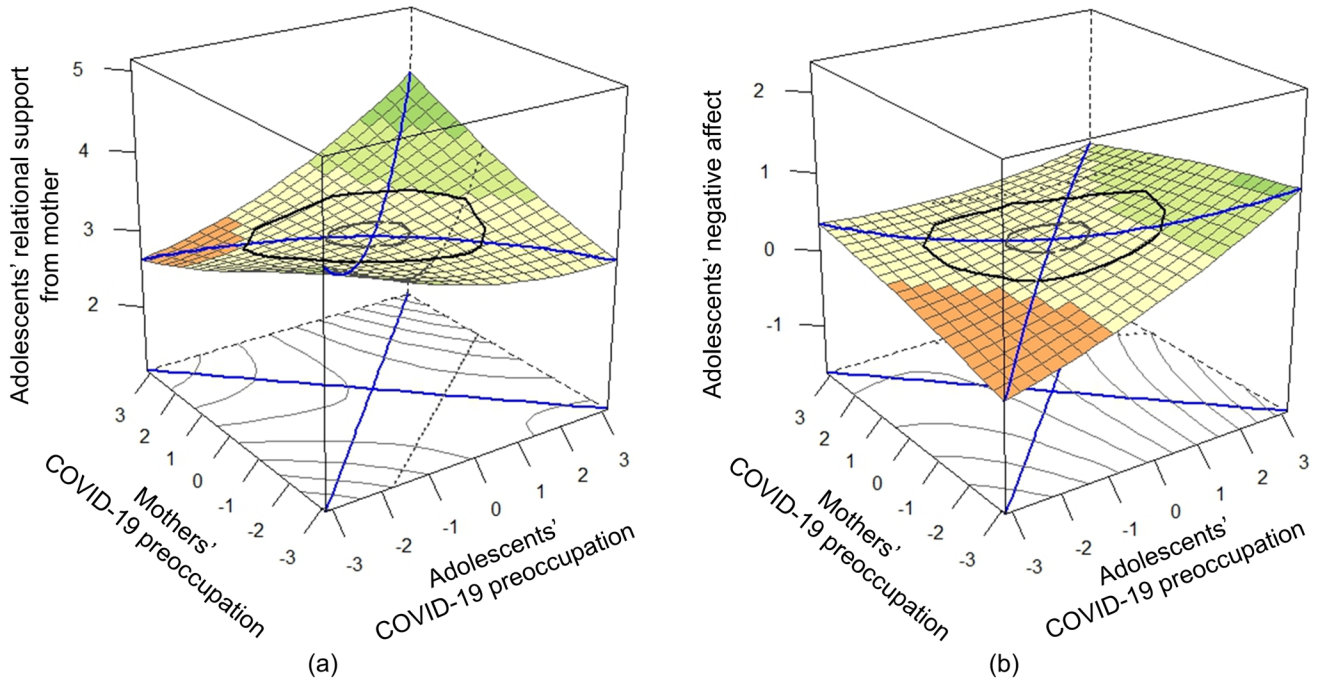

Fig. 3 Response Surface Plots of COVID-19 Preoccupation Predicting Adolescents' Well-being. *Note* The response surface plots portray the relationship between mothers' and adolescents' COVID-19 preoccupation on **a** adolescents' perceived mothers' support, and **b** adolescents' negative affect. While a surface plot was generated for each multiple imputed data set, only the plot from the last imputation was included for each model for the sake of simplicity. For all surface plots, kindly refer to the supplemental materials

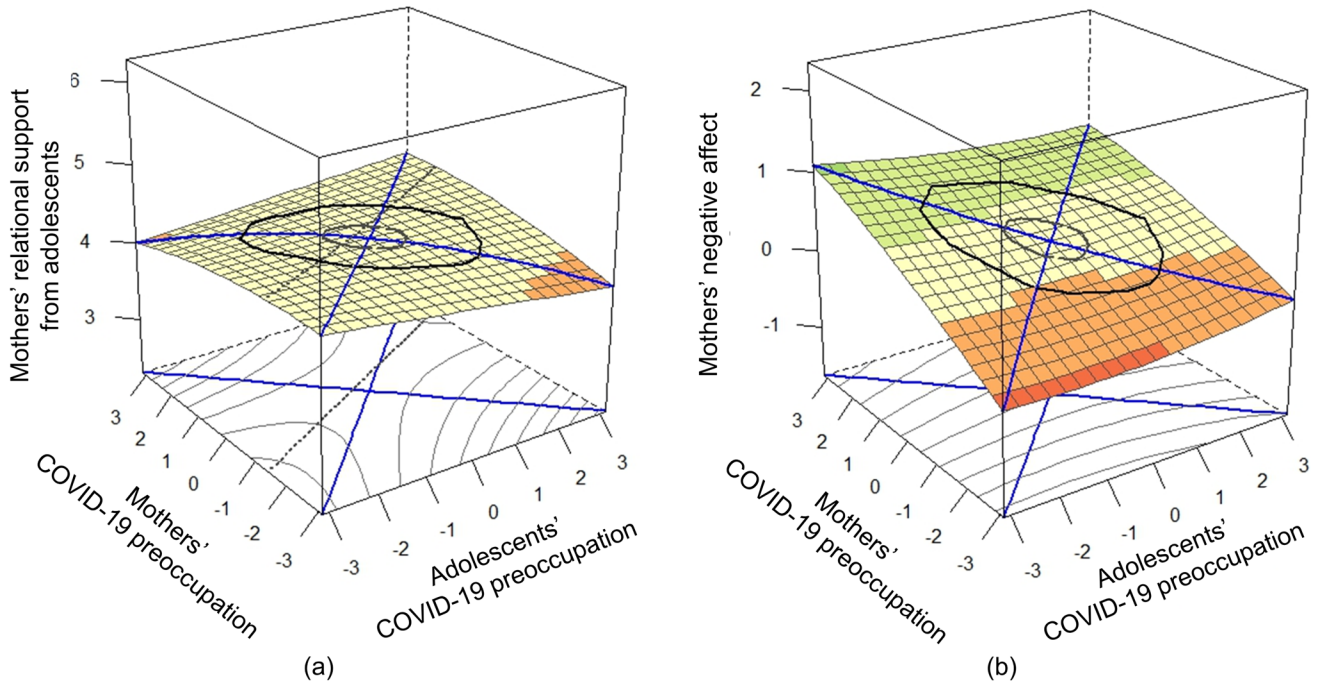

Fig. 4 Response Surface Plots of COVID-19 Preoccupation Predicting Mothers' Well-being. *Note* The response surface plots portray the relationship between mothers' and adolescents' COVID-19 preoccupation on **a** mothers' perceived support from their children and **b** mothers' negative affect. While a surface plot was generated for each multiple imputed data set, only the plot from the last imputation was included for each model for the sake of simplicity. For all surface plots, kindly refer to the supplemental materials

preoccupation from both parties while the highest adolescent negative affect was associated with a high level of COVID-19 preoccupation from both parties (i.e., no curvature along the line of LOC, indicated by non-significant a_2, supporting H4) and (3) adolescents reported higher negative affect when their COVID-19 preoccupation was greater than mothers', as opposed to when mothers' COVID-19 preoccupation was greater than adolescents' (indicated by positive a_3, supporting H5). In summary, there was a significant relationship between mothers' and adolescents' COVID-19 preoccupation and adolescents' negative emotions (H3 and H4). Furthermore, adolescents' own COVID-19 preoccupation had a comparatively stronger connection with their own negative affect (H5). Overall, our results suggested that negative emotion reciprocation was associated with trade-off effects for adolescents.

Mothers' and adolescents' COVID-19 preoccupation and mothers' well-being

We also examined whether the congruence between mothers' and adolescents' COVID-19 preoccupation was associated with (1) mothers' perceptions of children's support toward them and (2) mothers' negative affect. Neither mothers' own nor their children's COVID-19 preoccupation was related to mothers' perceptions of their children's support. All polynomial regression coefficients and response surface parameters were non-significant (see Table 2). As seen in Fig. 4a, the response surface appeared to be almost horizontal.

While COVID-19 preoccupation was not related to mothers' perceptions of support, it was significantly associated with mothers' negative affect. Significant but opposite directions of linear effects existed for predicting mothers' negative affect (see Table 2). Specifically, the linear LOC effect was positive (i.e., $a_1 = 0.20$), while the linear LOIC effect was of the same magnitude, but negative (i.e., $a_3 = -0.19$). Curvilinear effects (i.e., a_2 and a_4) were non-significant. As shown in the surface plot (Fig. 4b), mothers' negative affect was positively associated with their own COVID-19 preoccupation, but adolescents' preoccupation was not associated with mothers' negative affect (i.e., mothers' negative affect was constant at different levels of adolescents' preoccupation).

Discussion

The COVID-19 pandemic has been a significant source of stress for many families. Stringent and constantly changing social distancing measures during the fourth wave in Hong Kong resulted in many adolescents spending more time at home, and experiencing stress related to health, school, and work arrangements alongside family members. While some studies have identified positive relational outcomes of co-experiencing COVID-related stress (Gadermann et al., 2021; Kalil et al., 2020; Laufer & Bitton, 2023), others have identified negative outcomes, such as increased distress (Feinberg et al., 2022). These conflicting findings may be explained by the adjustment trade-offs involved in negative emotion reciprocation, which, to date, has been predominantly studied in the context of adolescent friendships (Rose, 2021). Our study extends previous research by examining this adjustment trade-off in adolescent-mother dyads during COVID-19, providing insights into how family dynamics under stress relate to youth development. The present study is one of the first to use multilevel response surface analysis (RSA) to examine negative emotion reciprocation in adolescent-mother dyads. By examining whether negative emotion reciprocation also predicts parents' outcomes, the current investigation provides a more nuanced understanding of trade-off effects involved in negative emotion reciprocation for adolescent-mother dyads.

Our results suggest that adolescents may gain some social benefits from the reciprocation of negative emotions with parents. As expected, adolescents reported higher relational support from mothers when both mothers' and adolescents' COVID-19 preoccupation was high, which was also observed in studies of youth-parent co-rumination before COVID-19 (Ames-Sikora et al., 2017; Calmes & Roberts, 2008). Additionally, adolescents perceived higher relational support from mothers when mothers' and their own COVID-19 preoccupation matched at extreme levels (vs. mid-range levels). This pattern suggests that high levels of negative emotion reciprocation may promote feelings of closeness (Rose, 2002). Low levels of preoccupation in parent-adolescent dyads were also related to higher levels of perceived support, albeit not as high as when dyads had matching high levels of COVID-19 preoccupation. There might be some benefits to having low levels of fixation on negative thoughts in a family, as it has been found to be related to adolescents' support-seeking orientations (Francisco et al., 2016). Although friendships are a primary context in which adolescents acquire support (Rose, 2021), our findings highlight that parents continue to play important roles in adolescents' adjustment, especially during stressful life experiences such as the COVID-19 pandemic. It is also important to note that "moderate" levels of mother and adolescent preoccupation might be more out of sync with one another at any given point, compared to when levels are both high or both low. Although we measured preoccupation over the previous week, it is possible that participants experienced fluctuations across specific days, which they later generalized to a more moderate score. Those day-to-day fluctuations might not have been highly synchronized between mothers and youth, which could result in a lower level of perceived support. To

further explore this issue, future studies should attempt to replicate the results through daily measurements.

The present study also found support for the trade-off effect of negative emotion reciprocation in families. As expected, adolescents reported more negative affect when both they and their mothers had high COVID-19 preoccupation, and reported the least negative affect when both the mother and the adolescent had low preoccupation. This finding coincides with studies using other analytical approaches that found associations between negative emotion reciprocation and negative emotional adjustment in adolescent-parent dyads (e.g., Abel et al., 2020; Kim et al., 2001; Miller-Slough & Dunsmore, 2021; Stone et al., 2019). Additionally, adolescents reported more negative affect when their COVID-19 preoccupation was greater than mothers', as opposed to when mothers' preoccupation was greater than adolescents'. This was to be expected; although parents' own distress and emotion (dys)regulation may have an impact on adolescents' adjustment (Daundasekara et al., 2021), adolescents' own negative affect should be more strongly related to their own distress (e.g., preoccupation) than their mothers'. Similar patterns have also been identified in cross-lagged studies on associations between mothers' and adolescents' depressive symptoms over time (e.g., Daundasekara et al., 2021).

We did not identify any negative emotion reciprocation trade-off for the mothers in our study. Specifically, mothers' negative affect was related only to their own COVID-19 preoccupation, and perceived relational support from their child was unrelated to COVID-19 preoccupation. These findings are inconsistent with previous research conducted in the United States, which found a positive association between adolescent-parent negative emotion reciprocation and parents' negative affect (e.g., Felix et al., 2020; Kim et al., 2001). However, they are somewhat consistent with studies showing that parents are less susceptible to (but not completely immune to) the negative effects of negative emotion reciprocation (Felix et al., 2020). The lack of negative emotion reciprocation trade-off for the mothers in the present study could be related to the emphasis on parental hierarchy in emotion-related conversations with youth in Chinese culture (e.g., Kulkofsky et al., 2009; Russell et al., 2010; Wang, 2007), which may lead to a reluctance to share one's own problems with adolescents. For instance, establishing 'friendships' with parents could be seen as inappropriate, and parental hierarchy is central to communication for Asian American adolescents (Russell et al., 2010). The negative emotion reciprocation process in Chinese adolescent-mother dyads might be more adolescent-focused (i.e., revolving around the adolescents' distress rather than the parents'), with neither a maladaptive focus on parents' own anxiety nor a promotion of understanding of parents' anxiety. This might explain why the negative emotion reciprocation trade-off effect was not identified for mothers in our study. However, more work is needed to test this speculation. Specifically, future research could differentiate between the focus on parents' problems and youth's problems in negative emotion reciprocation, examine the moderating role of parental hierarchy on the negative emotion reciprocation of personal problems with youth in parent-youth dyads, and compare different styles of negative emotion reciprocation between parents and youth across cultures.

Limitations and strengths

There are some limitations to our study. First, we assessed the associations between negative emotion reciprocation and general negative affect. We did not differentiate between different types of negative affect (e.g., sadness vs. anxiety) which could be associated with parent-adolescent negative emotion reciprocation differently according to past studies (Ames-Sikora et al., 2017; Calmes & Roberts, 2008). However, the reasons for these differences are still not clear, and more research is needed to explore this issue further. Second, while we assessed negative emotion reciprocation that included both the co-experience of COVID-19 preoccupation and co-experience of stress, we did not explicitly measure communication and exposure to each other's stress in our study. Although most adolescent-mother dyads lived together during our data collection period, measuring this component could have allowed us to disentangle the effects of one's own experience and shared experiences of COVID-19 preoccupation in the adolescent-mother dyads. Third, our COVID-19 preoccupation scale assessed participants' general worry and intrusive thoughts about the COVID-19 situation without differentiating between thoughts on parents' and adolescents' problems. Therefore, we were unable to provide any evidence on whether the negative emotion reciprocation identified in our study was adolescent-focused or not. In future research, it may be worthwhile to differentiate between preoccupation about parents' and adolescents' problems when investigating negative emotion reciprocation in adolescent-parent dyads. This distinction may clarify whether the negative emotion reciprocation process is adolescent-focused or parent-focused, and its impact on both adolescent's and parents' outcomes. It is also important to note that the measure of COVID-19 preoccupation used in this study included items related to the processing of negative affect during COVID-19. It should be emphasized, however, that while the repetitive negative thinking and hypervigilance, that comprises preoccupation is often linked to negative affect, the focus of preoccupation is on the cognitive processing itself and not the experience of negative affect. Therefore, preoccupation and negative affect are two distinct but related concepts. Fourth, the sample of adolescents recruited for the study was a convenience sample that might not represent the larger population. It is crucial to

acknowledge this limitation when interpreting results. Future research could benefit from using probability sampling methods to increase external validity. Finally, we focused on negative affect and did not examine positive affect as a potential outcome of negative emotion reciprocation. While there is no known evidence to suggest that positive affect is part of this trade-off effect, considering positive affect in future studies could lead to a more comprehensive understanding of its effect on emotional adjustment.

Despite these limitations, our study also has some important strengths. First, our study is among the few longitudinal studies that have considered both the positive and negative outcomes of negative emotion reciprocation for both adolescents and parents. Our assessment of parental outcomes of negative emotion reciprocation reveals important implications for future research on cultural differences and family dynamics. Second, we used multilevel response surface analysis, which allows for the visualization of the relationship between two component measures of negative emotion reciprocation and its outcomes. This approach allows for a more nuanced understanding of how the (non)reciprocation of negative emotions between mothers and adolescents is related to their adjustment. The linear and curvilinear associations between negative emotion reciprocation and adolescent outcome variables that we identified in the study highlight the importance of this technique over using a single difference score in studying reporter discrepancies. For example, we observed a curvature along the line of congruence (LOC), indicating that while matching levels of the same emotion as their parent is beneficial for the child, a lack of preoccupation with the pandemic also results in better relationship quality. This valuable insight would have been missed if traditional interaction analysis, such as linear regression, had been used. Third, we made extensive efforts to obtain a representative sample of Chinese adolescent-mother dyads from a university in Hong Kong. Our endeavors yielded a diverse range of students across different study majors. Moreover, the dyads in our sample came from varying socioeconomic backgrounds, with mothers possessing diverse levels of education and employment status. Overall, our sample inclusion efforts helped us establish a representative sample for our study. Additionally, our study also has practical implications. Specifically, the adjustment trade-off identified in adolescent-mother dyads suggests that adolescents may benefit socially from matching the same level of stress with their parents.

Another important strength of this study is that it highlights the trade-off effect of negative emotion reciprocity in the context of a global pandemic that continues to have prolonged effects on the world. It is undeniable that COVID-19 has transformed the world in many important ways. Even with social distancing measures lifted and life returning to "normal," public concerns about hygiene and the possibility of another pandemic have increased. Daily lifestyles have also experienced significant changes, such as more people working from home compared to before COVID-19. All these factors suggest that our focus on COVID-19 preoccupation is highly relevant to the current society. Even if certain aspects of COVID-19 preoccupation effects might not be generalizable, our research highlights the trade-off effect of negative emotion reciprocity during a globally stressful event. This is particularly noteworthy as negative emotion reciprocity is likely to be more pronounced and have a greater impact on well-being during such times. Our findings underscore the importance of understanding the dynamics of negative emotion reciprocity in the context of a worldwide crisis, as this can have significant implications for individual and collective well-being.

Conclusions

In this study, we examined the negative emotion reciprocation trade-off effect in adolescent-parent dyads during the fourth wave of COVID-19 in Hong Kong, using multilevel response surface analysis. Our results support the adjustment trade-off in our adolescent sample, but not in our mother sample. Our study provides important theoretical, methodological, and practical contributions to the research of negative emotion reciprocation in adolescent-mother dyads in critical times of family stress. By utilizing multilevel response surface analysis, our study provides a more nuanced understanding of the relationship between negative emotion reciprocation and its outcomes, highlighting the importance of understanding the complexities of this relationship. Consistent with the trade-off effect observed in adolescent friendships, our findings suggest that negative emotion reciprocation in adolescent-mother dyads may provide some social benefits for adolescents. However, the lack of a trade-off effect in our mother sample is inconsistent with existing studies on parents from the United States. This highlights the potential influence of cultural differences and the need for further research to develop a more comprehensive understanding of the negative emotion reciprocation trade-off effect and its impact on family dynamics. Our findings provide important implications for future studies on negative emotion reciprocation in adolescent-parent dyads.

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Data availability The dataset used in this study is available on request from the corresponding author.

Declarations

Conflict of interest The authors have no conflict of interest related to this publication.

Ethical approval Ethics approval was obtained from the Institutional Review Board of the corresponding author's institution [SBRE-18-366]. The study adhered to ethical standards consistent with the principles outlined in the 1964 Declaration of Helsinki.

Informed consent Active informed consent was obtained from participating youth and parents.

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