

Effects of structural and dynamic family characteristics on the development of depressive and aggressive problems during adolescence. The TRAILS study

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Abstract Both structural (i.e., SES, familial psychopathology, family composition) and dynamic (i.e., parental warmth and rejection) family characteristics have been associated with aggressive and depressive problem development. However, it is unclear to what extent (changes in) dynamic family characteristics have an independent effect on problem development while accounting for stable family characteristics and comorbid problem development. This issue was addressed by studying problem development in a large community sample ($N = 2,230$; age 10–20) of adolescents using Linear Mixed models. Paternal and maternal warmth and rejection were assessed via the Egna Minnen Beträffande Uppfostran for Children (EMBU-C). Aggressive and depressive problems were assessed via subscales of the Youth/Adult Self-Report. Results showed that dynamic family characteristics independently affected the development of aggressive problems. Moreover, maternal rejection in preadolescence and increases in paternal rejection were associated with aggressive

problems, whereas decreases in maternal rejection were associated with decreases in depressive problems over time. Paternal and maternal warmth in preadolescence was associated with fewer depressive problems during adolescence. Moreover, increases in paternal warmth were associated with fewer depressive problems over time. Aggressive problems were a stable predictor of depressive problems over time. Finally, those who increased in depressive problems became more aggressive during adolescence, whereas those who decreased in depressive problems became also less aggressive. Besides the effect of comorbid problems, problem development is to a large extent due to dynamic family characteristics, and in particular to changes in parental rejection, which leaves much room for parenting-based interventions.

Keywords Internalizing · Externalizing · Adolescence · Development · Parenting

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Introduction

Parenting has a crucial impact on the development of children and adolescents' emotional and behavioral problems [1, 2]. Positive parenting practices, such as parental warmth, have been associated with fewer aggressive and depressive problems in children [3]. However, negative parenting practices, such as parental rejection, thwart the universal need to belong [4, 5]. As such, rejection experienced early in life is crucial in shaping future behavior and interactions with others [6]. Not surprisingly, parental rejection has been associated with aggressive and depressive problems [7–10]. Longitudinal evidence is somewhat scarcer but showed that parenting factors (e.g., harsh discipline) in childhood predicted both internalizing and externalizing problems [2].

Likewise, in a sample of adolescents, Branje and colleagues [11] reported that a bad parent–child relationship quality (including measures of rejection and neglect) predicted depressive problems 2 years later.

Despite the abundance of studies examining the relationship between parenting and the development of aggressive and depressive problems, there are still several shortcomings in previous studies. First, the role of parenting behaviors should be seen in light of certain structural family characteristics that can have long-lasting and large effects on development [12, 13], and which may seep through into parenting and children's problems. Certain families and children are in a bad 'starting position' related to problem development, such as having a poor socioeconomic status [14, 15] or an increased familial vulnerability for problem development [7, 10, 16–18]. These structural factors are often hard to change and do not leave much room for intervention practices. More dynamic factors such as parenting behaviors, however, are more changeable [19, 20] and therefore more interesting for practitioners who want to counteract or decrease the development of adolescent aggressive and depressive problems. Therefore, we aim to examine to what extent dynamic family characteristics are independently associated with the development of aggressive and depressive problems during adolescence.

Second, most studies have focused on stable parenting characteristics, without taking changes in parental rejection and warmth into account. However, there is some evidence that changes in parental rejection in childhood can predict externalizing problems over a 3-year time span [17]. We aim to extend these findings and hypothesize that increases in parental rejection and a lack of warmth are associated with increases in aggressive and depressive problems over time.

Third, there are abundant studies showing strong comorbidity between aggressive and depressive problems [21, 22]. For example, Mason et al. [23] showed that children who reported more externalizing problems (including aggressive problems) at ages 10 and 11 were not only at risk for externalizing problems in young adulthood, but were also more than four times as likely to develop depressive symptoms. However, it is unclear how the development of aggressive problems is associated with the simultaneous development of depressive problems during adolescence, and vice versa. Moreover, given the strong effects of comorbid problem development, it is important to examine whether structural and dynamic family characteristics have an effect on problem development while accounting for this comorbidity.

Fourth, although most studies examined maternal parenting, it is argued that adolescents' externalizing problems are more strongly affected by paternal parenting [24]. With regard to internalizing problems, there is evidence that the mother–child relationship quality is predictive of

depressive problems in boys and girls, whereas the father–child relationship quality is only predictive of depressive problems in boys [11]. However, it is unclear whether maternal and paternal *parenting* (instead of relationship quality) is differently related to depressive problems. Given the scarce evidence on these differences in parenting, we explored whether paternal and maternal were differently associated with the development of aggressive and depressive problems during adolescence.

Finally, several cross-sectional studies reported gender differences [8, 25–28], but most accounts are unclear on whether gender is related to different relations between parental rejection and the development of behavioral problems. Hence, we formulated no specific hypotheses but merely explored potential gender differences in problem development.

In sum, in the current study we addressed the above-mentioned limitations by focusing on the association of structural and dynamic family characteristics with the development of aggressive and depressive problems during adolescence (age 10–20) in a large community sample.

Method

Sample

Data were collected in a general population study called TRAILS (TRacking Adolescents' Individual Lives Survey), a large prospective population study of Dutch adolescents with bi- or triennial measurements from age 11 to at least early adulthood [29–32]. Parental informed consent was obtained after the procedures had been fully explained. Detailed information about sample selection and analysis of non-response bias has been reported elsewhere [33]. The four assessment waves ran from March 2001 to July 2002 (T1), September 2003 to December 2004 (T2), September 2005 to December 2007 (T3), and October 2008 to September 2010 (T4). At T1, 2230 children (mean age = 11.09, SD = 0.56) enrolled in the study of whom 2149 (96.4 %; mean age 13.56, SD = 0.53) participated at T2, 1816 (81.4 %; mean age 16.27, SD = 0.73) at T3, and 1881 (84.3 %; mean age 19.1, SD = 0.60) at T4.

Measures

Aggressive and depressive problems

To assess aggressive and depressive problems, we used the Youth Self-Report (YSR) from T1 to T3 and the Adult Self-Report (ASR) at T4 because all respondents were adults during that wave [34]. The YSR and ASR cover behavioral and emotional problems in the past 6 months. Participants

responded on a three-point scale (0 = true, 1 = sometimes or somewhat true, 2 = very often or true). Good reliability and validity of the American version were confirmed for the Dutch version [35]. The Aggressive Behavior subscale consists of 17 items at T1–T3 (α 's ≥ 0.80) related to physical aggression, disobedience, and attention seeking. At T4, some items were replaced by others. New items included impatience, easily distressed, and mood swings, whereas items related to damaging possessions and disobedience at school were left out. At T4, the scale consisted of 15 items ($\alpha = 0.85$). The Withdrawn/Depressed subscale consists of eight items at T1–T3 (α 's ≥ 0.64) and includes items such as being unhappy and preferring to be alone. At T4, four items related to making and keeping friends, cross-sex relationships, getting along with others, and being liked were added. At the same time items related to shyness, being unhappy, and passive behavior were left out. The scale at T4 thus consisted of nine items ($\alpha = 0.76$).

Socioeconomic status (SES)

Socioeconomic status consisted of education of mother and father, occupation of mother and father, and family income at T1. Parent reports were used to assess SES. Education consisted of five levels ranging from elementary education to university. Occupation was determined using the International Standard Classification of Occupations and classified into nine levels [10]. Family income was assessed on a nine-point scale (1 = less than €680 per month to 9 = more than € 3587 per month). All five items were standardized and subsequently averaged to form a continuous scale ($\alpha = 0.84$).

Family composition

At T1, parents were interviewed about their family situation. Parents could indicate whether they were divorced, lived in a single-parent household, or whether the child had a step-parent. These three measures were combined into a dichotomous family composition measure, indicating whether one or more of these situations were applicable (0 = two-parent household, 1 = other). Based on parent and child reports at T2, T3, and T4, we constructed a variable that indicated whether parents were divorced between T1 and T4. We used this information to construct a dummy to assess 'change in family composition between T1–T4' that indicated whether family composition had changed (coded 1) or remained stable (coded 0).

Familial vulnerability

Familial vulnerability with respect to depression, anxiety, substance abuse, antisocial behavior, and psychoses was

measured via the Brief TRAILS Family History Interview [36], administered during the parent interview at T1. Each syndrome was introduced by a vignette describing its main symptoms and followed by a series of questions to assess lifetime occurrence, professional treatment, and medication use. The scores for substance abuse and antisocial behavior were used to construct a familial loading for externalizing disorder. The scores for depression and anxiety disorder were used to construct a loading for internalizing disorder. For each syndrome, parents were assigned to any of the categories [(0 = (probably) not, 1 = (probably) yes, 2 = yes and treatment/medication (substance abuse, depression, and anxiety) or picked up by police (antisocial behavior)]. Subsequently, familial loadings were calculated according to the scores for both parents, for the domains of externalizing and internalizing disorders separately. As outlined by Veenstra et al. [37], the construction of a familial vulnerability index was based on Kendler et al.'s [16] study, who found evidence for two genetic common factors: one externalizing and one internalizing. We used the path coefficients found in Kendler et al.'s study as regression coefficients in our own analysis. The scores for substance abuse and antisocial behavior were used to construct a familial vulnerability index for externalizing disorder. The regression coefficient for substance abuse was constructed as the mean of the path coefficients for alcohol dependence (0.58) and other drug abuse or dependence (0.65). The regression coefficient for antisocial behavior was constructed as the mean of the path coefficients for adult antisocial behavior (0.56) and conduct disorder (0.37). The scores for depression and anxiety disorder were used to construct a familial vulnerability index for internalizing disorder. The regression coefficient for depression was 0.54. The regression coefficient for anxiety was constructed as the mean of the path coefficients for generalized anxiety disorder (0.53) and phobia (0.33). The following regression equations were used: familial loading for externalizing disorder = 0.61 (substance abuse mother + substance abuse father) + 0.47 (antisocial mother + antisocial father); familial loading for internalizing disorder = 0.54 (depression mother + depression father) + 0.43 (anxiety mother + anxiety father).

Perceived parenting

To assess the perception of parental warmth and rejection by respondents, we used part of the Egena Minnen Beträffande Uppfostran (Memories of My Upbringing) for Children (EMBU-C) [38] at T1 and T4. The original EMBU-C contained 81 items. Markus et al. [38] also developed a shorter version, which we used. At T1 the EMBU-C contains three scales on parenting (also

overprotection). Respondents could rate items in the EMBU-C as 1 = no, never, 2 = yes, sometimes, 3 = yes, often, or 4 = yes, almost always. In the current study, we only used the warmth and rejection scales because these were assessed at both waves. At T1, the parental warmth contained 18 items for fathers ($\alpha = 0.91$) and mothers ($\alpha = 0.91$). Scales on parental warmth included items related to affection, love and interest of the parents as perceived by the child. The scale for rejection contained 12 items with an internal consistency of 0.84 for fathers and 0.83 for mothers. Rejection was characterized by hostility, punishment (physical, abusive), derogation, and blaming of subject (“Do your parents sometimes punish you even though you haven’t done anything wrong?”). At T4, we used a shortened version of the EMBU-C. Parental warmth was assessed via four items, with high internal validity for fathers ($\alpha = 0.88$) and mothers ($\alpha = 0.86$). Parental rejection was also assessed with four items with moderate internal validity for fathers ($\alpha = 0.70$) and mothers ($\alpha = 0.67$). We calculated change scores by subtracting the T1 warmth and rejection scores from their respective T4 scores.

Analysis

Means and standard deviations were calculated for structural and dynamic family characteristics, and aggressive and depressive problems for all four waves, when applicable. Furthermore, we calculated correlations between all continuous study variables. Subsequently, we examined the longitudinal effect of parental rejection on the development of aggressive and depressive problems during adolescence. To this end, we used Linear Mixed models (LMM) [39–41] in IBM SPSS Statistics 19.0, which allows for the estimation of fixed and random effects that adjust for the dependencies in the data (i.e., repeated measures from the same individual are dependent). Assessment wave was used as measure of time and its covariance structure was defined as autoregressive for the prediction of aggressive problems, indicating higher correlations between measures that are closer in time. A diagonal covariance structure was defined for the prediction of depressive problems. This means that the covariance was assessed separately for each wave. Age 10 was set at zero, to facilitate easier interpretation of the estimated effects. The continuous independent variables were standardized to a mean of zero and a standard deviation of one to facilitate the ease of interpreting the interaction effects. All parameters and standard errors were estimated using maximum likelihood algorithms.

In the LMM analyses, we used gender and structural (i.e., two-parent family, change in family composition, SES, familial loading psychopathology) and dynamic (i.e., paternal and maternal warmth and rejection and change in warmth and rejection) family characteristics to predict the development of aggressive and depressive problems separately. In the first step, in model 1, we estimated a growth model in which we determined what part of the variance in problem development could be attributed to within- and between-individual differences. The covariance structure was defined as *variance components* to allow for the estimation of the variances of the intercepts and slopes [41]. We added a random term for all individuals to indicate that there was some non-zero covariance between the observations of aggressive and depressive problems within the same individual. Moreover, we estimated the amount of between-subject variance in the model and included an intercept associated with each individual. Age was inserted as a predictor of differences between individuals as well as a random effect to account for changes within individuals over time. We also added a quadratic effect of age to examine whether a nonlinear development of aggressive and depressive problems would fit the data better than a linear development.

In the second model, we added gender and the structural family characteristics to the model. Gender, family composition (ref = two parent family), and change in family composition between T1 and T4 (ref = no change) were considered as categorical fixed factors. Familial psychopathology loadings and SES were added as fixed continuous covariates. Furthermore, interactions with age were added to this model, to examine how gender and the structural family characteristics were related to the development of aggressive and depressive problems. In model 3, we included fixed effects of parental rejection and warmth and the change in parental rejection and warmth as well as their interactions with age. We also examined whether interactions with quadratic functions of age would improve model fit significantly. In model 4, we estimated structural and dynamic family characteristics simultaneously. Finally, in model 5 we controlled for the comorbid development of depressive and aggressive problems, respectively. All models presented in Table 3 and 4 significantly fitted the data better than the previous model(s) based on the -2 log-likelihood comparisons.

Significant interactions between age and structural and dynamic family characteristics and comorbid problem development were depicted using the predicted fixed values based on the Linear Mixed models. For ease of interpretation, categories for low, average, and high values of the moderator were computed based on the standardized scores.

Results

Table 1 shows the means and standard deviations of the study variables. Both aggressive and depressive problems remained rather stable during the first three waves, but showed a strong drop at the fourth wave. Moreover, average parental warmth and rejection remained relatively stable from the first to the fourth wave. In Table 2 correlations between study variables are reported. In general, lower SES was associated with more aggressive and depressive problems. Family loadings of internalizing problems were positively associated with depressive problems, but not at T3. Family loadings of externalizing problems were positively associated with both aggressive and depressive problems at all waves, but not at T1. Paternal and maternal rejection was positively associated with aggressive and depressive problems, whereas paternal and maternal warmth was negatively associated with aggressive and depressive problems. Aggressive and depressive problems were positively associated at each wave. From preadolescence to late adolescence, higher scores on aggressive problems were thus associated with higher concurrent scores on depressive problems.

Linear mixed models: aggressive problems

Table 3 shows the maximum likelihood estimates and standard errors of the LMM analyses with aggressive problems as the dependent variable. Model 1 shows the fixed and random effects of the quadratic growth model. Boys at age 10 scored on average 0.34 on aggressive problems, whereas girls scored significantly lower with (0.340–0.072 = 0.27) at age 10. Significant age effects showed that the development of aggressive behavior showed a quadratic shape, with an initial increase in pre- and early adolescence followed by a decrease later in adolescence. For boys, this decrease started already in early adolescence and then followed a steep decline, whereas for girls it started in middle adolescence and followed a slower decline.

The random effects describe effects related to the repeated measures over time (i.e., AR1 diagonal and AR1 rho). The first constitutes the variance of the random errors, which was estimated at 0.039. The second parameter describes the correlation of adjacent errors over time, suggesting that the adjacent errors have a correlation of 0.25. That is, errors associated within the same adolescent at adjacent time points were correlated positively. The variance of the intercepts shows that there was significant variation between respondents in initial levels of aggression. Moreover, there was also significant variation in changes (i.e., the slope) in aggressive problems, as indicated by the variance in age.

Table 1 Distribution of gender and family composition and means, standard deviations, and ranges of structural and dynamic family characteristics and aggressive and depressive problems

	Percentage	Range	<i>N</i>
Gender (girl)	51.3 %	–	2,142
Two-parent family T1	76.8 %	–	2,142
Change in family composition T1–T4	8.2 %	–	2,230
	Mean (SD)		
Socioeconomic status	–0.03 (0.78)	– 1.94–1.73	2,108
Familial loading: internalizing	0.55 (0.80)	0.00–3.88	2,079
Familial loading: externalizing	0.14 (0.42)	0.00–4.32	2,085
Perceived paternal rejection T1	1.48 (0.34)	1.00–3.59	2,141
Perceived maternal rejection T1	1.48 (0.33)	1.00–3.94	2,194
Perceived paternal warmth T1	3.15 (0.56)	1.00–4.00	2,143
Perceived maternal warmth T1	3.28 (0.50)	1.06–4.00	2,195
Perceived paternal rejection T4	1.48 (0.47)	1.00–4.00	1,505
Perceived maternal rejection T4	1.43 (0.43)	1.00–4.00	1,581
Perceived paternal warmth T4	3.00 (0.84)	1.00–4.00	1,505
Perceived maternal warmth T4	3.31 (0.70)	1.00–4.00	1,579
Difference paternal rejection (T4–T1)	0.00 (0.52)	– 2.22–3.00	1,485
Difference maternal rejection (T4–T1)	–0.05 (0.47)	– 2.82–2.82	1,565
Difference paternal warmth (T4–T1)	–0.17 (0.87)	– 2.83–2.56	1,486
Difference maternal warmth (T4–T1)	0.02 (0.72)	– 2.83–2.22	1,564
Aggressive problems			
T1 (age 10–12)	0.31 (0.25)	0.00–1.41	2,191
T2 (age 12–15)	0.31 (0.24)	0.00–1.53	2,092
T3 (age 15–18)	0.31 (0.23)	0.00–1.47	1,660
T4 (age 18–21)	0.24 (0.26)	0.00–1.60	1,696
Depressive problems			
T1 (age 10–12)	0.34 (0.29)	0.00–1.63	2,187
T2 (age 12–15)	0.34 (0.30)	0.00–1.88	2,092
T3 (age 15–18)	0.37 (0.32)	0.00–1.75	1,658
T4 (age 18–21)	0.23 (0.27)	0.00–1.67	1,696

Next, we examined the effects of structural family characteristics on aggressive problems in model 2. Interactions with age showed that participants from families with two biological parents at T1 and those who experienced no change in family composition between T1 and T4 decreased in aggressive problems over time, as indicated by the significant *age x two parent family* and *age x Δ family composition T1–T4* interactions. Moreover, the negative interaction with SES shows that socioeconomic status was associated with decreases in aggressive problems (see Fig. 1). In particular, higher SES was associated with fewer aggressive problems during adolescence.

Table 2 Correlations between structural and dynamic family characteristics and aggressive and depressive problems

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
1. SES	–																						
2. Familial loading: INT	–.09																						
3. Familial loading: EXT	–.21	0.25																					
4. Paternal rejection T1	–.03	–.01	–.02																				
5. Maternal rejection T1	–.05	0.02	0.01	0.68																			
6. Paternal rejection T4	–.09	0.016	0.00	0.21	0.13																		
7. Maternal rejection T4	–.08	0.07	0.04	0.19	0.25	0.58																	
8. Paternal warmth T1	0.15	–.02	–.04	–.35	–.22	–.12	–.11																
9. Maternal warmth T1	0.13	–.02	–.01	–.21	–.34	–.09	–.15	0.79															
10. Paternal warmth T4	0.12	–.04	–.10	–.14	–.14	–.43	–.25	0.28	0.20														
11. Maternal warmth T4	0.11	–.02	–.06	–.17	–.20	–.37	–.36	0.28	0.28	0.28	0.92												
12. Δ Paternal rejection	–.04	0.03	0.03	–.45	–.33	0.78	0.40	0.14	0.09	–.30	–.24												
13. Δ Maternal rejection	–.05	0.05	0.06	–.32	–.46	0.44	0.74	0.08	0.12	–.13	–.20	0.60											
14. Δ Paternal warmth	0.02	–.03	–.07	0.10	0.01	–.34	–.17	–.35	–.30	0.80	0.71	–.38	–.18										
15. Δ Maternal warmth	–.00	0.00	0.00	0.01	0.05	–.16	–.30	–.29	–.37	0.47	0.68	–.16	–.31	0.64									
16. Aggressive problems T1	–.04	0.04	0.04	0.36	0.39	0.08	0.12	–.20	–.21	–.08	–.13	–.17	–.16	0.03	–.00								
17. Aggressive problems T2	–.06	0.04	0.08	0.19	0.22	0.19	0.16	–.11	–.10	–.11	–.12	0.03	–.01	–.03	–.04	0.45							
18. Aggressive problems T3	–.09	0.02	0.10	0.13	0.13	0.28	0.26	–.07	–.04	–.17	–.17	0.15	0.15	–.12	–.12	0.32	0.51						
19. Aggressive problems T4	–.10	0.05	0.09	0.14	0.17	0.33	0.34	–.07	–.06	–.21	–.22	0.19	0.19	–.16	–.15	0.25	0.37	0.51					
20. Depressive problems T1	–.05	0.07	0.03	0.30	0.32	0.08	0.08	–.19	–.17	–.09	–.11	–.11	–.13	0.04	0.02	0.46	0.27	0.19	0.21				
21. Depressive problems T2	–.03	0.07	0.05	0.19	0.19	0.14	0.12	–.14	–.09	–.13	–.14	–.00	–.02	–.03	–.05	0.20	0.40	0.22	0.28	0.43			
22. Depressive problems T3	–.08	0.04	0.05	0.15	0.11	0.18	0.20	–.12	–.07	–.20	–.20	0.07	0.10	–.12	–.10	0.16	0.23	0.34	0.34	0.32	0.52		
23. Depressive problems T4	–.07	0.07	0.05	0.11	0.13	0.21	0.23	–.11	–.10	–.21	–.23	0.11	0.12	–.13	–.14	0.20	0.24	0.28	0.56	0.26	0.38	0.54	

Correlations in bold were significant at $p < 0.01$

SES Socioeconomic Status; INT Internalizing problems; EXT Externalizing problems

Table 3 Linear mixed models of structural and dynamic family characteristics on aggressive problems

	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 3 Estimate (SE)	Model 4 Estimate (SE)	Model 5 Estimate (SE)
Fixed effects					
Intercept	0.340 (0.008)***	0.369 (0.023)***	0.328 (0.010)***	0.332 (0.026)***	0.338 (0.024)***
Age	0.005 (0.004)	0.014 (0.005)**	0.005 (0.004)	0.017 (0.006)**	0.010 (0.005)
Age squared	-0.002 (0.000)***	-0.002 (0.000)***	-0.002 (0.000)***	-0.002 (0.000)***	-0.001 (0.000)**
Girl	-0.072 (0.011)***	-0.073 (0.012)***	-0.054 (0.013)***	-0.054 (0.013)***	-0.057 (0.012)***
Depressive problems	-	-	-	-	0.091 (0.006)***
Structural family characteristics					
Two-parent family	-	-0.025 (0.013)	-	-0.012 (0.017)	-0.015 (0.015)
Change in family composition T1-T4	-	-0.010 (0.018)	-	0.003 (0.020)	0.002 (0.018)
Socioeconomic status (SES)	-	-0.003 (0.005)	-	0.013 (0.006)*	0.010 (0.006)*
Familial loading: externalizing problems	-	0.004 (0.006)	-	0.012 (0.008)	0.008 (0.007)
Dynamic family characteristics					
Paternal rejection	-	-	0.043 (0.012)***	0.045 (0.012)***	0.039 (0.011)**
Maternal rejection	-	-	0.065 (0.012)***	0.064 (0.012)***	0.041 (0.012)***
Paternal warmth	-	-	-0.012 (0.014)	-0.011 (0.014)	0.005 (0.013)
Maternal warmth	-	-	-0.004 (0.014)	-0.004 (0.014)	-0.010 (0.013)
Δ Parental rejection	-	-	-0.000 (0.010)	-0.000 (0.010)	-0.006 (0.009)
Δ Maternal rejection	-	-	-0.007 (0.010)	-0.009 (0.010)	-0.003 (0.009)
Δ Paternal warmth	-	-	0.010 (0.010)	0.012 (0.010)	0.007 (0.009)
Δ Maternal warmth	-	-	-0.016 (0.010)	-0.017 (0.010)	-0.011 (0.009)
Interactions with age					
Age × girl	-	-	-	-	-
Age × two parent family	-	-	-	-	-
Age × Δ family composition T1-T4	-	-	-	-	-
Age × SES	-	-	-	-	-
Age × familial externalizing	-	-	-	-	-
Age × paternal rejection	-	-	-	-	-
Age × maternal rejection	-	-	-	-	-
Age × paternal warmth	-	-	-	-	-
Age × maternal warmth	-	-	-	-	-
Age × Δ paternal rejection	-	-	-	-	-
Age × Δ maternal Rejection	-	-	-	-	-
Age × Δ paternal warmth	-	-	-	-	-
Age × Δ maternal warmth	-	-	-	-	-
Age × depressive problems	-	-	-	-	-
Age squared × Girl	0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
Age squared × paternal rejection	-	-	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)

Table 3 continued

	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 3 Estimate (SE)	Model 4 Estimate (SE)	Model 5 Estimate (SE)
Age squared × maternal rejection	—	—	0.001 (0.001)**	0.002 (0.001)**	0.001 (0.001)
Age squared × paternal warmth	—	—	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)
Age squared × maternal warmth	—	—	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)
Age squared × Δ paternal rejection	—	—	-0.001 (0.000)*	-0.001 (0.000)*	-0.001 (0.000)**
Age squared × Δ maternal rejection	—	—	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Age squared × Δ paternal warmth	—	—	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Age squared × Δ maternal warmth	—	—	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Age squared × depressive problems	—	—	—	—	0.002 (0.000)**
<i>Random effects</i>					
ARI diagonal	0.039 (0.001)**	0.039 (0.001)**	0.034 (0.001)**	0.033 (0.001)**	n/a
ARI rho	0.248 (0.028)**	0.253 (0.028)**	0.202 (0.029)**	0.206 (0.029)**	n/a
Variance intercept	0.016 (0.001)**	0.016 (0.001)**	0.012 (0.001)**	0.012 (0.001)**	0.013 (0.001)**
Variance age	0.000 (0.000)**	0.000 (0.000)**	0.000 (0.000)**	0.000 (0.000)**	0.000 (0.000)**
-2 Log Likelihood	-1401.53	-1505.65	-1896.63	-1922.33	-2574.87

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; two-sided tests; n/a not applicable due to the diagonal covariance structure for repeated measures that was required for model 5

In model 3, we examined the dynamic family effects on aggressive problems. Paternal and maternal rejection at age 10 was positively related to aggressive problems. Moreover, there was a positive interaction between the quadratic effect of age and maternal rejection, suggesting that the association between high maternal rejection at T1 and aggression decreased during adolescence, but showed a slight increase in late adolescence (see Fig. 2). In contrast, the association between low/average maternal rejection at T1 and aggression increased initially, followed by a decrease in the second half of adolescence. There was also a significant quadratic age effect of changes in paternal rejection on aggressive problems. Figure 3 shows that increasing levels of paternal rejection were associated with increased aggressive problems during the first half of adolescence, followed by a decrease at the end of adolescence. Stable or decreasing levels of paternal rejection

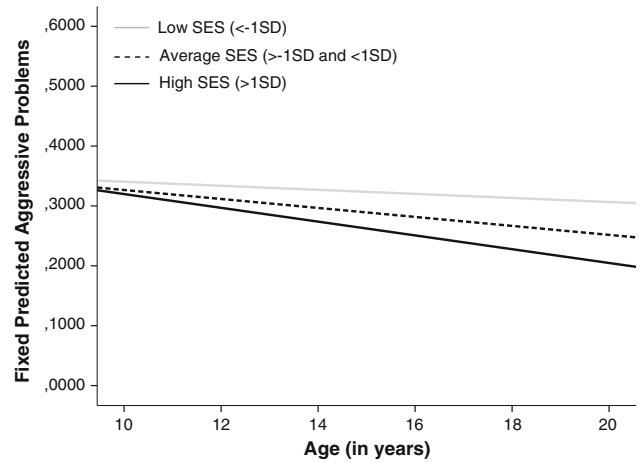


Fig. 1 Development of aggressive problems based on predicted values (model 2) during adolescence for low, average, and high socioeconomic status (SES)

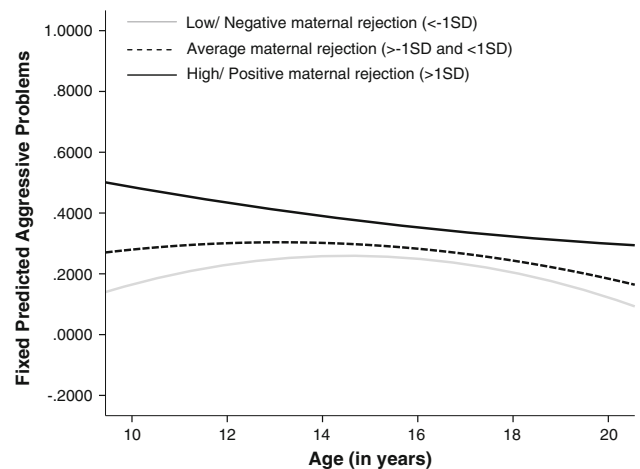


Fig. 2 Development of aggressive problems based on predicted values (model 3) during adolescence for low, average, and high standardized scores in maternal rejection

were associated with high levels of aggressive problems in preadolescence, but this association showed a linear decrease during adolescence. Random effects in model 3 also indicated more explained variance compared to model 1 as the variances in intercept and age decreased when adding the dynamic family characteristics.

In model 4, we examined the effects of structural and dynamic effects simultaneously. Except for the finding that higher SES was associated with more aggression, parameters did not differ in direction or significance. However, examining these clusters of effects simultaneously resulted in better overall model fit.

Finally, in model 5 we included the simultaneous development of depressive problems. As a result, a large part of the development in aggressive problems could be

explained by the intercept and development of depressive problems. In particular, as shown in Fig. 4, adolescents who had more depressive problems reported more aggressive problems during adolescence, whereas those who had fewer depressive problems reported also fewer aggressive problems. Of note, when controlling for depressive problems, (changes in) family composition and maternal rejection no longer had an effect on aggressive problems. Moreover, depressive problems explained additional variance between individuals as shown by the decrease in random effects.

Linear mixed models: depressive problems

Table 4 shows the maximum likelihood estimates and standard errors of the LMM analyses with depressive problems as the dependent variable. Participants rated themselves 0.32 on depressive problems at age 10. Age effects showed that the development of depression followed a curvilinear trend, with an initial increase in problems followed by a decrease in late adolescence. This trend was significantly stronger in girls than boys, as indicated by the significant *age squared x girl* interaction. For the random effects, we had to fit a different covariance structure compared to the model for aggressive problems and estimated the variance per wave and for the intercepts and slopes. Random effects suggested significant variance at each wave as well as significant differences in the intercepts and slopes between individuals.

In model 2, we added structural family effects to the model to predict the development of depressive problems. Only familial loadings of internalizing problems had a significant effect, indicating that higher familial loadings of internalizing problems were associated with more depressive problems.

In model 3, we added dynamic family characteristics. Paternal and maternal rejection was significantly associated with more depressive problems at age 10. Paternal and maternal warmth was associated with the development of depressive problems as indicated by the significant interactions with age. As shown in Fig. 5, low paternal warmth was associated with more depressive problems at the onset of adolescence, but over time this association decreased. The association between maternal warmth and depressive problems showed a similar pattern although the initial differences in warmth appeared to have a weaker association with depressive problems (see Fig. 6). Furthermore, the positive *age x Δ maternal rejection* interaction showed that depressive problems decreased over time when maternal rejection decreased, and increased slightly when maternal rejection increased (see Fig. 7). Finally, changes in paternal warmth were negatively associated with the development of depressive problems. As Fig. 8 shows,

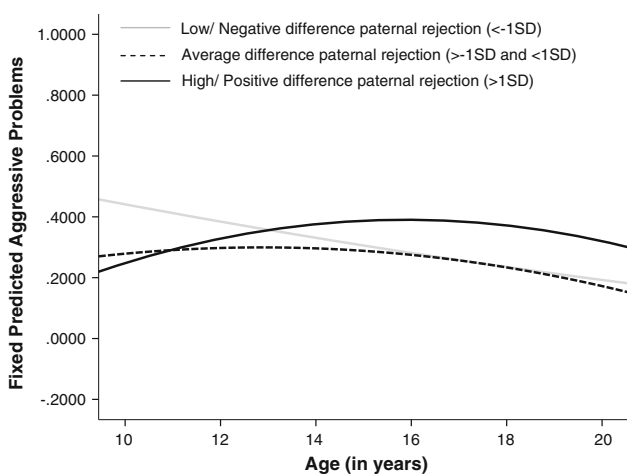


Fig. 3 Development of aggressive problems based on predicted values (model 3) during adolescence for low, average, and high standardized difference scores of paternal rejection (T4–T1)

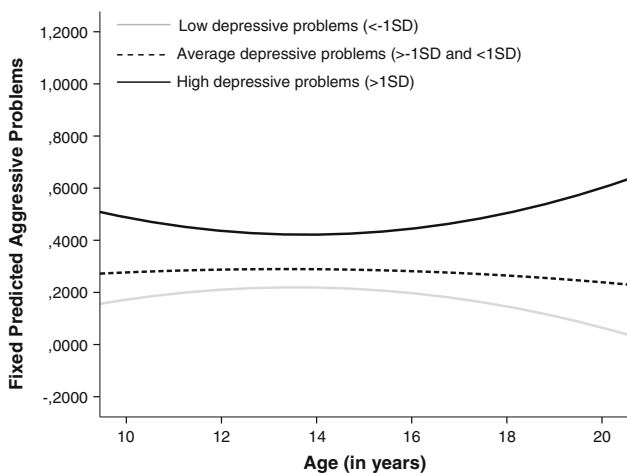


Fig. 4 Development of aggressive problems based on predicted values (model 5) during adolescence for low, average, and high levels of simultaneous depressive problems

Table 4 Linear mixed models of structural and dynamic family characteristics on depressive problems

	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 3 Estimate (SE)	Model 4 Estimate (SE)	Model 5 Estimate (SE)
Fixed effects					
Intercept	0.321 (0.010)***	0.352 (0.027)***	0.318 (0.012)***	0.324 (0.031)***	0.305 (0.029)***
Age	0.007 (0.005)	0.011 (0.006)	0.006 (0.005)	0.012 (0.007)	0.006 (0.007)
Age squared	−0.002 (0.000)***	−0.002 (0.000)***	−0.002 (0.001)***	−0.002 (0.001)**	−0.001 (0.001)
Girl	0.012 (0.014)	0.009 (0.014)	0.019 (0.016)	0.016 (0.016)	0.042 (0.015)**
Aggressive problems	–	–	–	–	0.106 (0.004)***
Structural family characteristics					
Two-parent family	–	−0.027 (0.015)	–	−0.003 (0.019)	0.005 (0.018)
Change in family composition T1-T4	–	−0.011 (0.021)	–	−0.004 (0.024)	−0.004 (0.022)
Socioeconomic status (SES)	–	−0.007 (0.006)	–	0.008 (0.007)	0.003 (0.007)
Familial loading internalizing problems	–	0.016 (0.006)**	–	0.015 (0.007)*	0.014 (0.006)*
Dynamic family characteristics					
Paternal rejection	–	–	0.030 (0.012)*	0.032 (0.013)*	0.012 (0.012)
Maternal rejection	–	–	0.056 (0.013)***	0.056 (0.013)***	0.036 (0.012)**
Paternal warmth	–	–	−0.065 (0.014)***	−0.066 (0.014)***	−0.061 (0.013)***
Maternal warmth	–	–	0.029 (0.014)*	0.028 (0.014)*	0.028 (0.013)*
Δ Paternal rejection	–	–	0.011 (0.010)	0.014 (0.010)	0.009 (0.009)
Δ Maternal rejection	–	–	−0.014 (0.010)	−0.017 (0.010)	−0.012 (0.009)
Δ Paternal warmth	–	–	−0.001 (0.010)	0.004 (0.010)	−0.001 (0.009)
Δ Maternal warmth	–	–	−0.010 (0.010)	−0.016 (0.010)	−0.011 (0.009)
Interactions with age					
Age × girl	0.032 (0.006)***	0.033 (0.007)***	0.035 (0.007)***	0.036 (0.007)***	0.028 (0.007)***
Age × two parent	–	−0.004 (0.002)	–	−0.006 (0.003)*	−0.003 (0.003)
Age × Δ family composition T1–T4	–	−0.001 (0.003)	–	−0.002 (0.003)	0.001 (0.003)
Age × SES	–	−0.001 (0.001)	–	−0.002 (0.001)	−0.001 (0.001)
Age × familial internalizing	–	−0.000 (0.001)	–	−0.000 (0.001)	−0.000 (0.001)
Age × paternal rejection	–	–	−0.000 (0.002)	0.001 (0.001)	0.003 (0.002)
Age × maternal rejection	–	–	−0.004 (0.002)	−0.005 (0.002)**	−0.004 (0.002)*
Age × paternal warmth	–	–	0.005 (0.002)*	0.006 (0.002)**	0.005 (0.002)**
Age × maternal warmth	–	–	−0.005 (0.002)*	−0.005 (0.002)*	−0.005 (0.002)*
Age × Δ paternal rejection	–	–	0.001 (0.001)	0.001 (0.001)	−0.001 (0.001)
Age × Δ maternal rejection	–	–	0.006 (0.001)***	0.005 (0.002)**	0.003 (0.001)
Age × Δ paternal warmth	–	–	−0.004 (0.001)**	−0.003 (0.002)*	−0.002 (0.001)
Age × Δ maternal warmth	–	–	−0.001 (0.001)	−0.000 (0.001)	−0.000 (0.001)
Age squared × girl	−0.004 (0.001)***	−0.004 (0.001)***	−0.004 (0.001)***	−0.004 (0.001)***	−0.004 (0.001)***
Random effects					
Variance wave 1	0.056 (0.002)***	0.056 (0.002)***	0.051 (0.002)***	0.051 (0.002)***	0.045 (0.002)***
Variance wave 2	0.049 (0.002)***	0.049 (0.002)***	0.050 (0.002)***	0.049 (0.002)***	0.047 (0.002)***
Variance wave 3	0.056 (0.002)***	0.057 (0.002)***	0.056 (0.003)***	0.056 (0.003)***	0.055 (0.003)***
Variance wave 4	0.032 (0.002)***	0.031 (0.002)***	0.029 (0.003)***	0.029 (0.003)***	0.025 (0.002)***
Variance intercept	0.030 (0.002)***	0.029 (0.001)***	0.022 (0.002)***	0.022 (0.002)***	0.016 (0.001)***
Variance age	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***
−2 Log Likelihood	1658.43	1486.27	631.81	523.34	−191.11

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Two-sided tests

increases in warmth were associated with fewer depressive problems, whereas decreases in warmth were unrelated to changes in depressive problems. Random effects showed that adding dynamic family characteristics explained more

variance in intercepts and slopes of depressive problems compared to model 1.

In model 4, we estimated the effect of structural and dynamic family effects simultaneously. Although the

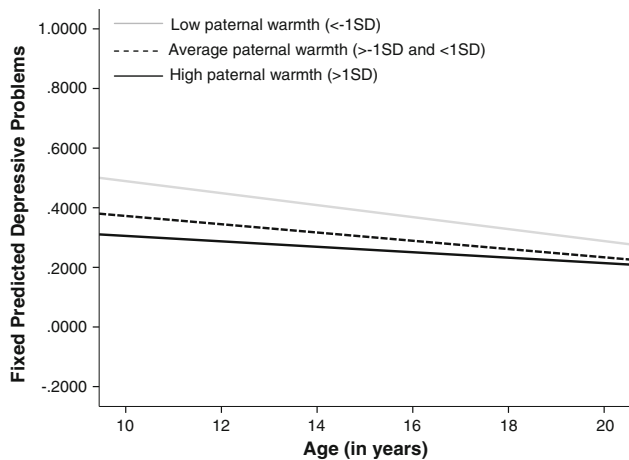


Fig. 5 Development of depressive problems based on predicted values (model 3) during adolescence for low, average, and high levels of paternal warmth

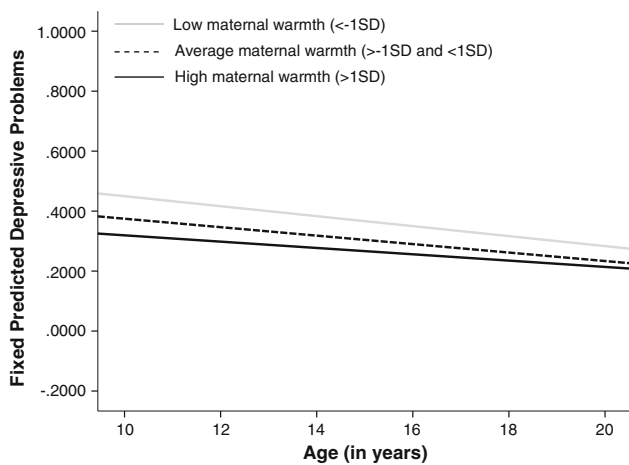


Fig. 6 Development of depressive problems based on predicted values (model 3) during adolescence for low, average, and high levels of maternal warmth

direction and significance of the parameters remained largely unchanged, adding these family effects simultaneously increased model fit.

Finally, in model 5 we included the simultaneous development of aggressive problems. Importantly, aggressive problems were positively associated with depressive problems at age 10, but not with the development of depressive problems during adolescence (not included in Table 4 because adding the interaction between age and aggressive problems did not improve model fit). Accounting for the development of aggression had also quite an impact on the other model estimates. While controlling for comorbid aggressive problems, the main effect of paternal rejection as well as effects of changes in maternal rejection and paternal warmth were no longer significantly associated with depressive problems.

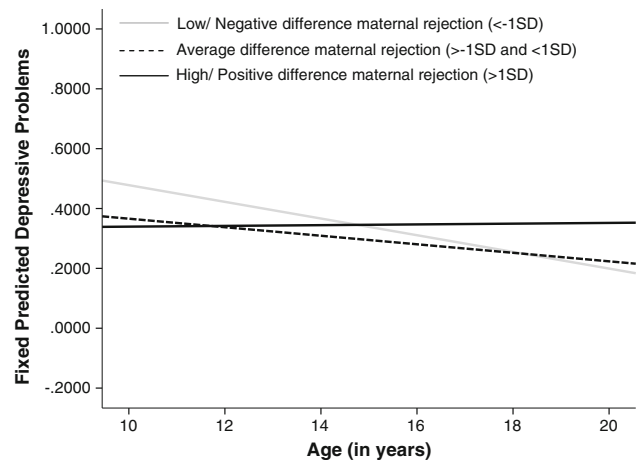


Fig. 7 Development of depressive problems based on predicted values (model 3) during adolescence for low, average, and high standardized difference scores of maternal rejection (T4–T1)

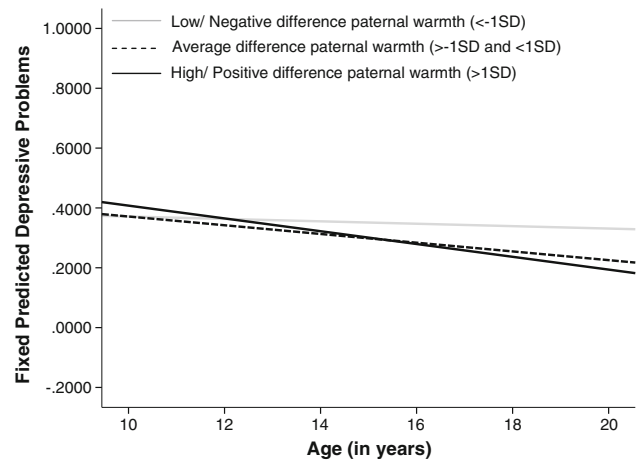


Fig. 8 Development of depressive problems based on predicted values (model 3) during adolescence for low, average, and high standardized difference scores in paternal warmth (T4–T1)

Discussion

In the current study, we examined the role of structural and dynamic family characteristics on the development of aggressive and depressive problems during adolescence. Our analyses resulted in several important findings. First, as reported in previous research [42–44], we found that aggressive problems initially increased in adolescence, followed by a decrease. Girls and boys generally followed a similar pattern, although boys’ aggressive problems decreased earlier and faster. Moreover, in line with previous TRAILS studies [32, 45–47], depressive problems followed a curvilinear pattern, with an increase in the first half of adolescence, followed by a decrease in the second half. This pattern was stronger in girls compared to boys.

Aggressive problem development

In line with our first aim, we showed that dynamic family characteristics are independently associated with the development of aggressive above and beyond the effects of structural family characteristics. Having (and keeping) two biological parents and coming from a high socioeconomic status family were associated with decreases in aggressive problems. However, compared to the effects of (changes in) parental rejection, these factors only accounted for a small amount of explained variance in aggressive problems. Our findings thus suggest that structural family characteristics may not be as strongly correlated with problem development as we initially expected. If anything, the effects of some structural family characteristics (i.e., family composition) on problem development seem to be partially mediated by dynamic family characteristics and comorbid problem development. Although we did not empirically test this, theoretically it makes sense that unfavorable structural family characteristics are associated with bad parenting, which in turn is associated with problem development. Several studies support such a mediation model, showing that the effect of SES and maternal depression on educational outcomes and peer preference was mediated by parenting practices [48, 49]. Future research may want to test this in more detail.

With regard to dynamic family characteristics, we showed that in particular parental rejection was associated with the development of aggressive problem, whereas parental warmth had no effect. There were also specific differences in maternal and paternal rejection. That is, maternal rejection in preadolescence was concurrently associated with aggressive problems, but this association decreased over time. However, increases in paternal rejection were associated with aggressive problems, whereas decreases in paternal rejection were related to decreases in aggressive problems. These findings are in line with our expectations and previous research in childhood [17]. Because we were not able to discern the causal relationships between parenting and problem development, it is difficult to interpret our findings in light of interventions that focus on changing the family environment and parenting skills in general population samples [19, 50]. However, despite this causality issue, our findings offer an optimistic note: compared to structural family characteristics, those factors that are easier to change also seem to bear more fruit in counteracting aggressive problems.

Depressive problem development

A similar picture can be painted for the results regarding depressive problem development. Only familial loadings of internalizing problems were related to higher levels of

depressive problems at age 10, but were unrelated to the development of depressive problems. Instead, dynamic family characteristics accounted for a substantial amount of the variance in depressive problems during adolescence. Adolescents who perceived paternal and maternal rejection and less paternal warmth reported more depressive problems at age 10, in line with earlier studies on these data [10, 27, 28, 46]. However, the effects of maternal and paternal rejection on depressive problems decreased during adolescence. Furthermore, when maternal rejection decreased, adolescents' depressive problems also decreased over time. Although this finding may be important for intervention practices, it should be noted that this effect disappeared while accounting for the development in aggressive problems. This suggests that it is important to tackle both problems simultaneously as their development is heavily intertwined.

We also found that adolescents who perceived increases in paternal warmth during adolescence, also decreased in depressive problems. Despite previous observations that contact with parents decreases during adolescence [51], fathers appear to remain important for healthy behavioral development of their children in terms of the warmth they display. A possible explanation for this effect may be that fathers have changed their parenting styles in response to their child's problems [52]. Adolescents who had more depressive problems may thus have required more warmth from their fathers, in comparison to adolescents who had fewer depressive problems to begin with.

Comorbid problem development

Finally, we showed that dynamic family characteristics affected problem development above and beyond comorbid problem development. Regarding this comorbidity, aggressive problems were a stable predictor of depressive problems over time, which is in line with previous studies [23, 53]. Moreover, depressive problems were associated with aggressive problems over time and this effect followed a positive curvilinear trend. In particular, those high on depressive problems became more aggressive during adolescence, whereas those lower on depressive problems became also less aggressive. This supports the idea of diverging pathways of comorbid psychopathology: those who are worse off in one domain of psychopathology also become worse off in the other domain. Mechanisms of social selection and person–environment interactions may account for this behavioral development [33]. On the one hand, individuals at risk for developing psychopathology may seek out risky environments that further enhance negative experiences and (comorbid) psychopathological problems. On the other hand, individuals with a more vulnerable personality may respond differently to stressors

in life and hence also show a wide range of psychopathological problems. For future research, it is thus important to examine which mechanism is at play when it comes to the comorbidity between aggressive and depressive problems.

In addition, the inclusion of aggressive problem development in explaining depressive problems accounted for the variance explained by several family effects, but not the other way around. Specifically, after controlling for aggressive problems, the effects of changes in maternal rejection and paternal warmth on depressive problems disappeared. Although this may have a methodological reason (i.e., over controlling), it could also indicate that changes in perceived parenting are associated with aggressive problems, which in turn are associated to depressive problems. Mediation analyses in a ‘true’ longitudinal design are needed to shine more light on this finding.

Limitations

Our findings should be interpreted against the backdrop of several limitations. First, both perceived paternal and maternal rejection and aggressive and depressive problems were based on self-reports and may thus have led to a shared-method bias. In part, this may also explain the strong comorbidity between aggressive and depressive problems. However, with regard to perceived parenting, self-reports may be the best determinant. That is, even if children’s perception of rejection or warmth is unjustified, these false perceptions may still, or because of this misperception, elicit aggressive or depressive problems. A second and related issue is that perceptions of parental rejection and warmth may depend upon personality [26, 54]. It thus remains to be seen whether a more objective report of parenting (e.g., observations) would yield different results. Third, we were only able to assess paternal and maternal rejection and warmth in late childhood, but not earlier. Ideally, we would assess parenting also in early childhood given that research on attachment and parenting styles has shown that especially early rearing experiences shape individuals’ way of coping with rejection and a lack of warmth [6]. Still, we were able to show that even in adolescence perceived parenting and changes in perceived parenting were significantly associated with the development of aggressive and depressive problems. Fourth, we were unable to adequately examine whether changes in problem behaviors were also related to changes in parenting practices. For example, a recent study by De Haan et al. [52] showed that aggressive behaviors were related to changes in parental warmth and vice versa, indicating that parents may adjust their parenting styles in response to their child’s behavior.

Future research and implications

For future research it may be important to follow the development of aggressive and depressive problems into early adulthood. Theories on the desistance of problem behavior (at least regarding aggressive problems) suggest that for most individuals problem behaviors are limited to adolescence [55, 56]. Extending our findings to early adulthood can thus give insight into the persistence and desistance of the current trajectories of aggressive and depressive problems. Moreover, it would be important to see whether levels of rejection and warmth also seep through into relationships with peers and romantic partners. Previous studies indeed showed that childhood rearing experiences, including extreme forms such as child abuse and neglect, are associated with romantic relationships that are characterized by negative interactions and conflict [57, 58]. In turn, the continuation of such relationships could keep individuals on a high stable (or even increasing) track of aggressive and depressive problems. This can be explained from an ecological systems model; rejection in one context may create expectations in other contexts and may as such have an impact on adjustment [59]. For example, parental rejection may shape expectations about social interactions with others, and may lead to perceived rejection biases when interacting with peers. These biases may in turn lead to problems such as aggression and depression. Alternatively, effects of parental rejection may be tempered or exacerbated by rejection in other contexts [27]. Finally, when it comes to counteracting aggressive problems, our findings suggest that interventions aimed at increasing parental warmth may be less effective than targeting parental rejection. However, when the aim is to decrease depressive problems, both parental warmth and rejection should be targeted. Moreover, our findings suggest that there are specific nuances regarding differences in paternal and maternal parenting that could be helpful for practitioners. Whereas decreasing maternal rejection may be important to decrease depressive problems, in fathers only increases in warmth appear to have a positive effect.

Conclusions

To summarize, we were able to assess the longitudinal association between (changes in) paternal and maternal rejection and warmth and the development of aggressive and depressive problems during adolescence in a large community sample. Above and beyond the effects of structural family characteristics, dynamic family characteristics were associated with concurrent aggressive and depressive problems and the development of aggressive and depressive problems in adolescence.

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Conflicts of interest Dr. Verhulst is a contributing author of the Achenbach System of Empirically Based Assessment, from which he receives remuneration. Drs. Sijtsema, Oldehinkel, Veenstra, and Ormel report no financial interests or potential conflicts of interest.

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