

Developmental pathways from toddler difficult temperament to child generalized psychopathology and adult functioning

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ABSTRACT

Background: Early difficult temperament and child mental health problems are consistently associated with impaired functioning in adulthood. We examined three potential pathways between difficult temperament in toddlerhood (age 2) and depressive symptoms (ages 21–23) and well-being (age 23): i) direct – early difficult temperament directly associates with these outcomes, ii) mediated – these direct effects are also mediated by a general psychopathology factor in late childhood/early adolescence (GPF; ages 7, 10, and 13), and iii) moderated-mediated – these mediated effects are also moderated by negative (age 42 months) and positive (age 33 months) parenting behaviors.

Methods: The analytic sample included 1892 mother-child dyads (33.4% male children) from the Avon Longitudinal Study of Parents and Children (ALSPAC). Mothers reported on their child's difficult temperament, negative parenting, positive parenting, and child's mental health symptoms. In adulthood, participants reported their own depressive symptoms and well-being (i.e. mental well-being, life satisfaction, happiness).

Results: First, early difficult temperament associated directly and positively with depressive symptoms, but negatively with well-being in adulthood. Second, the GPF in late childhood/early adolescence mediated these direct associations. Third, the mediated pathways were not moderated by negative or positive parenting.

Limitations: i) low risk community sample, ii) early risks are based on maternal reports.

Conclusions: Temperament is a risk factor for impaired psychosocial functioning in adulthood, manifested through increased susceptibility to psychopathology in childhood/adolescence. Although more research is needed to test their generalizability, these findings suggest that targeting early difficult temperament may alleviate the risk for later mental health difficulties and may increase general well-being.

1. Introduction

Depression is a highly prevalent and debilitating psychiatric disorder, estimated to affect over 320 million people worldwide (World Health Organization, 2017). Individuals who report symptoms of depression have elevated risk for comorbid psychiatric disorders (Kim-Cohen et al., 2003) and impaired psychosocial functioning (Fergusson and Woodward, 2002), as well as a six-fold increased risk for suicide attempts (Nock et al., 2013). Equally important here is the concept of well-being, which has been found to longitudinally associate

with important life outcomes and indicators of flourishing and thriving, such as the capacity to experience satisfying intimate relationships and both mental and physical health (Lyubomirsky et al., 2005). Atypical development pathways may lead to increased risks for both depressive symptoms and diminished well-being. Therefore, identifying early life risks for these sub-optimal outcomes could point to key targets for early intervention.

One such risk factor may be difficult temperament, defined by Thomas and Chess (1977) as an early-emerging constellation of predominantly negative mood, high intensity of emotional expression, low

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adaptability to the environment, low approach to novelty, and reduced rhythmicity. To the best of our knowledge, no study has yet examined how an overall factor of difficult temperament, as defined by Thomas and Chess (1977), longitudinally associates with adjustment in adulthood. Here, we review the literature for three possible types of relationship (direct, mediation, and moderated-mediation) between dimensions of difficult temperament and impaired functioning (i.e. depressive symptoms and reduced well-being) in adulthood.

First, a direct relationship could exist between temperamental difficulties and adult outcomes. For example, mother-reported negative emotionality at age 6, a temperament dimension that overlaps with negative mood and high intensity, has been found to prospectively associate with depression in adulthood (Bould et al., 2014). Specifically, these children were found to be 20% more likely to report a diagnosis of depression at age 18. With regard to well-being, Caspi and Silva (1995) found that difficult temperament (e.g. irritability, distractibility, and lability in emotional response) may associate with well-being in adulthood, defined as having a happy disposition, positive self-regard, and cheerful future outlook. Here, using a person-centered approach, age 3 children were classified into five groups, one of which (the “Under-controlled” group mentioned above) resembled Thomas and Chess’s difficult temperamental profile. At age 18, this group reported the lowest levels of well-being, although the overall group difference was non-significant. In the present study, we will directly examine this longitudinal association.

Second, especially across a large temporal gap, the direct effect may also be mediated. One possible mediator here is the general psychopathology factor (e.g. p-factor), or a general susceptibility to psychopathology; (Lahey et al., 2012, 2021; Riglin et al., 2019), which is analogous to the “g” factor of general intelligence. Given the frequently observed phenotypic correlation between different forms of psychopathology, studies have examined the latent structure underlying psychiatric disorders (e.g. Caspi et al., 2014; Lahey et al., 2017; Riglin et al., 2019). Across these studies, a bifactor model consisting of a general psychopathology factor (GPF) along with specific factors for internalizing (emotional) and externalizing (behavioral), and/or neurodevelopmental problems, have often shown good fit to the data. Studies have also found neurophysiological and genetic correlates of the GPF. For instance, higher scores in the GPF was found to associate with reduced gray matter volume of the cerebello-thalamo-cortical circuit (Romer et al., 2019). Similarly, higher polygenic risk scores for schizophrenia and ADHD associate with higher scores for GPF (Riglin et al., 2019). The GPF has also been found to associate with aspects of difficult temperament and mental health problems. For instance, Hankin et al. (2017) found that the tendency to experience negative mood associates concurrently with the p-factor among preadolescents (mean age 7.7 years) and youths (mean age 13.6 years). Similarly, parent-reported dimensions of difficult temperament at age 2 (i.e., negative mood, high intensity, low adaptability, and low rhythmicity) were found to prospectively associate with the presence of clinical diagnoses for internalizing and externalizing problems at age 7 (Sayal et al., 2014). This tendency to develop psychopathology may then associate with later depression and diminished well-being. For example, a study combining several birth cohorts found that a general psychopathology factor at age 7 prospectively associated with depression diagnoses at age 18 and decreased mental well-being at age 21 (Sallis et al., 2019). Taken together, these results suggest that early difficult temperament could directly associate with depression and well-being in adulthood, and that this direct effect may also be mediated by an earlier generalized risk for psychopathology.

Third, these mediated effects may also be moderated by environmental factors such as parenting. This is consistent with the “differential susceptibility” hypothesis (Belsky and Pluess, 2009), which suggests that certain characteristics (e.g. difficult temperament) make children more susceptible to environmental influences, for better and for worse. In a meta-analysis, Slagt et al. (2016) found that temperamentally difficult

children displayed worse adjustment (i.e. more internalizing and externalizing problems) when also exposed to negative parenting (e.g. harsh discipline). Conversely, temperamentally difficult children, when exposed to positive parenting (e.g. parental warmth), displayed less problems in adjustment. Therefore, temperamentally difficult children who are exposed to higher and lower levels of negative and positive parenting, respectively, may be especially at risk for poor mental health outcomes, which in turn leads to impaired functioning.

Using two decades of prospective data drawn from a large UK cohort, the present study is the first to test the ability of these three longitudinal relationships (i.e. direct, mediation, moderated-mediation) to explain how overall difficult temperament early in life prospectively associates with increased risk for depressive symptoms and reduced well-being in adulthood. In doing so, we also incorporate recent work on general psychopathology factor into the long-term sequelae of difficult temperament. We propose three main hypotheses: i) difficult temperament is directly associated with more adult depressive symptoms and lower well-being, ii) this effect is mediated by late childhood/early adolescent general factor of psychopathology; and iii) negative and positive parenting will individually moderate this mediated association.

2. Methods

2.1. Sample

Data were drawn from the Avon Longitudinal Study of Parents and Children (ALSPAC), an ongoing, population-based study investigating factors that influence the health and development of children. Pregnant women who resided in the former Avon Health Authority, England, with expected delivery dates between Apr. 1st, 1991 and Dec. 31st, 1992 were eligible (Fraser et al., 2013). The initial sample comprised 14,541 pregnancies, with 13,988 children alive at 12 months of age. The overall sample broadly reflected the U.K. general population compared to the 1991 National Census Data (Boyd et al., 2012). The present sample consists of mothers and children who were primarily White (>97%). Based on the Registrar General Occupational Classification (Office of Population Censuses and Surveys, 1991), the majority of mothers in our sample belong to social class II (intermediate, 37.3%) and social class IIINM (non-manual, 41.9%). Here, social class groups ranged from class I (professional/managerial) to class V (unskilled manual workers), with class III split into non-manual and manual.

Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees. Further information on ALSPAC data (<http://www.bris.ac.uk/alspac/>) is available online through a fully searchable data dictionary and variable search tool (<http://www.bristol.ac.uk/alspac/researchers/our-data/>).

2.2. Measures

Difficult temperament was assessed at age 2 using the Carey Toddler Temperament Scale (CTTS; Carey and McDevitt, 1978). Mothers rated their children’s temperamental characteristics on a 6-point scale ranging from 1 (“almost never”) to 6 (“almost always”). The five dimensions of difficult temperament as defined by Thomas and Chess (1977) were initially included, measured with the most internally consistent items: mood (3 items, e.g. “is pleasant during face washing”), intensity (4 items, e.g. “screams when frustrated”), adaptability (4 items, e.g. “accepts delay for desired objects”), approach (9 items, e.g. “approaches new visitors at home”) and rhythmicity (7 items, e.g. “takes daytime naps at different times”). Items were coded such that higher score reflected more difficult temperament. With the exception of rhythmicity ($\alpha = 0.66$), all subscales demonstrated acceptable reliability, ranging from $\alpha = 0.70$ (adaptability) to $\alpha = 0.87$ (approach). A second order confirmatory factor analysis (CFA) was performed to investigate the factor structure of difficult temperament. The dimensions of approach

and rhythmicity were both excluded from the model, as both had low factors loadings ($\Lambda_{\text{approach}} = 0.06$, $\Lambda_{\text{rhythmicity}} = 0.29$) and rhythmicity also demonstrated low internal reliability. The factor scores were saved and included in subsequent analyses.

In addition to internal reliability, mother-reported CTTS ratings have been found to converge with ratings provided by other raters, as well as with other instruments. First, maternal ratings at ages 2–3 have been found to converge with ratings by day-care caregivers on all 5 difficult temperament dimensions plus activity (Northam et al., 1987). Additionally, the scale has also demonstrated strong convergent validity (Goldsmith et al., 1991) when compared with other temperament scales for toddlers such as the Emotionality Activity Sociability Temperament Survey (Buss and Plomin, 1975, 1984), especially between the mood subscale of the CTTS and emotionality subscale of the EAS.

Negative parenting was assessed at age 42 months by items from an interview designed to assess the quality of parenting (Dunn et al., 1999). Mothers reported, on 5-point scales ranging from 1 (“never”) to 5 (“daily”), the frequency with which they (i) “smack the child”, and (ii) “shout at the child” when the child is naughty. The scale demonstrates a high level (90–100%) of agreement between global ratings of the quality of parenting by interviewers and observers (Quinton and Rutter, 1988). A summed and standardized score was used in the present analysis.

Positive parenting was assessed at age 33 months using the maternal enjoyment subscale of a maternal bonding scale (Bowen et al., 2008). Mothers rated 4 statements (e.g. “Toddlers are fun” and “I really love my toddler”) on a 4-point scale ranging from 1 (“this is exactly how I feel”) to 4 (“I never feel this way”). A summed and standardized score was used in the present analysis.

The general psychopathology factor was derived from symptoms as assessed at ages 7, 10, and 13 using the Development and Well-being Assessment (DAWBA; Goodman et al., 2000), a well-established measure developed for the British Child Mental Health Surveys (Goodman et al., 2000). Mothers rated symptoms of each diagnosis for their child introduced with the stem “Over the last 6 months, and as compared with other children the same age, has s/he often...”, on a 3-point scale ranging from 0 (“No more than others”) to 2 (“a lot more than others”). Emotional problems included symptoms of generalized anxiety (7 items), depression (12 items), separation anxiety (10 items), specific phobia (7 items), and social anxiety (6 items). Behavioral problems included symptoms of conduct disorder (6 items) and the three components of oppositional defiant disorder: headstrong (4 items), irritability (3 items), and hurtful (2 items). Neurodevelopmental problems included symptoms of hyperactivity/impulsivity (9 items), inattention (9 items), and social-communication problems as assessed by Social and Communication Disorders Checklist (Skuse et al., 2005). Internal reliability of the subscales ranged from $\alpha = 0.68$ (conduct disorder) to $\alpha = 0.95$ (inattention). Symptom scores in each diagnostic area were summed across the three timepoints, then used to create a latent bifactor variable consisting of a general psychopathology factor (GPF) and three specific factors of “emotional”, “behavioral”, and “neurodevelopmental” problems (Riglin et al., 2019).

Adult depression symptoms were reported by the young people themselves (i.e. the offspring) at ages 21, 22, and 23 years using the short 13-item version of the self-reported Mood and Feelings Questionnaire (SMFQ; Angold et al., 1995). Participants rated their depression symptoms in the past two weeks (e.g. “has felt miserable or unhappy”) on a 3-point scale ranging from 0 (“not true”) to 2 (“true”). Responses for each item was then summed across all 3 measurement points to create 13 items that capture the variance across time. The scale demonstrated excellent internal reliability ($\alpha = 0.94$). Three residual correlations among highly correlated items (mean $r = 0.684$) were included in the model.

Well-being was derived from three measures reported by the young people themselves (i.e. the offspring) at age 23. First, mental well-being was assessed with the 14-item, self-reported Warwick Edinburgh Mental Well-being scale (Tennant et al., 2007). Respondents answer items such

as “I’ve been feeling good about myself” or “feeling close to other people” on a 5-point scale ranging from 0 “none of the time” to 4 “all of the time”. Second, life satisfaction was measured with the 5-item, self-reported Satisfaction with Life Scale (Diener et al., 1985). Participants answer questions such as “in most ways, my life is close to my ideal” on a 7-point scale from 1 “strongly disagree” to 7 “strongly agree”. Third, happiness was measured with the self-reported Subjective Happiness Scale (Lyubomirsky and Lepper, 1999). Subjects answer questions such as “compared to most of my peers, I consider myself...” on a 7-point scale, from 1 to 7. Mental well-being ($\alpha = 0.93$), life satisfaction ($\alpha = 0.90$), and happiness ($\alpha = 0.90$) demonstrated excellent reliability. We estimated a latent bifactor variable, which consists of a general “well-being” factor and three specific factors corresponding to the three scales.

See Appendix ST1 for full information on model fit indices of study variables, and Appendix ST2 and ST3 for bifactor-specific fit indices of the GPF and well-being.

Covariates. We controlled for family adversity and child characteristics across all models. The Family Adversity Index (FAI; Bowen et al., 2005) was used to measure the former, including family financial difficulty, maternal psychopathology, maternal education, and maternal substance use. At three time periods (pregnancy to birth; 0–2 years postnatal; 2–4 years postnatal), items assessing each risk factor was summed and each risk factor was coded as 0 (no risk) if the score is below a cut-off point or 1 (risk) if it is above. Family financial difficulty was measured using a set of 5 derived questions such as “difficulty in affording food”. Maternal education was assessed by whether mandatory schooling was completed. Maternal psychopathology was assessed by using the 10-item Edinburgh Postnatal Depression Scale (e.g. “I have blamed myself unnecessarily when things went wrong”; Cox et al., 1987) and the 25-item Crown-Crisp Experimental Index (e.g. “Do you worry a lot”; Crown and Crisp, 1966) to measure mother’s depression and anxiety, as well as a single question (“You attempted suicide”) to measure mother’s suicide attempt. Maternal substance use was assessed by reports of the mother’s use of drugs or alcohol.

For child characteristics, we controlled for IQ measured at age 8 using the Wechsler Intelligence Scale for Children III^{UK} (Wechsler, 1998), and gender reported at age 2 months. In a sensitivity analysis, we additionally controlled for the average depressive symptoms scores measured at ages 12.5 and 13.5 using the SMFQ (Angold et al., 1995).

2.3. Included vs excluded sample

Participants who provided full data on depressive symptoms and well-being in adulthood were included, which, in conjunction with the early childhood measures, provided data on 1892 mother-child dyads (33.4% male children). In a multivariate logistic regression, we examined child and mother characteristics as predictors of exclusion from the analytic sample. Odds ratios (ORs) indicated that children excluded from the study were more likely to have lower IQ ($OR = 0.98$, $p < .001$). Moreover, mothers excluded from the study were more likely to have financial difficulties ($OR = 1.16$, $p = .007$), more psychopathology ($OR = 1.090$, $p = .01$) and lower education ($OR = 1.17$, $p < .001$).

2.4. Data analysis

All analyses were conducted in Mplus version 8.4 (Muthén and Muthén, 2019). Maximum-likelihood estimation (ML) was used in conjunction with bootstrapping ($B = 1000$) to correct for potential skew in standard errors underlying indirect effects within mediation models (Preacher and Hayes, 2008). Additionally, according to Finney and DiStefano (2006), bootstrapping can also be used to accommodate severely non-normal continuous data. Full-information maximum-likelihood (FIML) method was used to handle missing data. Model fit was considered acceptable if the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) were above 0.90 (Bentler and Bonett, 1980),

and the root mean square error of approximation (RMSEA) was below 0.08 (Browne and Cudeck, 1993).

Relationships between early difficult temperament (age 2) and depressive symptoms (age 21–23) and well-being (age 23) were tested sequentially (Fig. 1). First, we tested if difficult temperament directly associated with depressive symptoms and well-being, assuming the two outcomes are correlated. Second, we tested if the aforementioned relationships are mediated by the GPF. Third, we tested if negative or positive parenting moderated the mediated effects.

3. Results

3.1. Descriptive statistics

Table 1 shows descriptive statistics and intercorrelations for all study variables. Difficult temperament was positively correlated with negative parenting, GPF, depressive symptoms, and family adversity (i.e. sum of FAI), but negatively correlated with positive parenting, well-being, and IQ. The GPF was positively correlated with adult depressive symptoms, negative parenting, and family adversity, but negatively correlated with positive parenting, well-being, and IQ. Depressive symptoms in adulthood were positively correlated with family adversity, but negatively correlated with well-being and IQ.

3.2. Direct effects

First, we tested the direct effects of difficult temperament on depression symptoms and well-being (Table 2). Higher levels of mother-reported difficult temperament at 2 associated with more self-reported depressive symptoms ($\beta = 0.09, p < .001$), and lower self-reported well-being ($\beta = -0.08, p < .001$) in adulthood. A strong, negative correlation existed between depressive symptoms and well-being ($\beta = -0.75, p < .001$).

3.3. Mediation effects

Second, we tested if this direct effect was mediated by generalized psychopathology in late childhood/early adolescence (Fig. 2; Table 2). Higher levels of difficult temperament were associated with higher GPF ($\beta = 0.25, p < .001$), which in turn was associated with more adult depression symptoms ($\beta = 0.13, p < .001$) and reduced well-being ($\beta = -0.16, p < .001$). Indirect effects from difficult temperament through GPF to depression symptoms ($\beta = 0.03, 95\%$ bootstrapped C.I. [.02, 0.05]) and well-being ($\beta = -0.04, 95\%$ bootstrapped C.I. [-0.06, -0.02]) were both significant. These indirect effects accounted for 36.47% and 56.34% of the total effects, respectively. With the GPF mediator included in the model, the direct effects from difficult temperament on depressive symptoms ($\beta = 0.05, p = .02$) remained significant, but not well-being ($\beta = -0.03, p = .31$).

3.4. Moderated-mediation effects

Third, we tested if the mediated effect is moderated by negative or positive parenting (Figs. 3 and 4; Table 2). In both models, the significance of path coefficients and indirect effects remain unchanged. Additionally, neither negative parenting at 42 months ($\beta = 0.03, p = .39$) nor positive parenting at 33 months ($\beta = -0.03, p = .25$) moderated the mediated pathway.

3.5. Sensitivity analysis

For the mediation model, we additionally controlled for depressive symptoms in adolescence on the path between the GPF and depressive symptoms in adulthood. This ensures that the observed relationship is not due to overlap in measurement, as measures of the GPF includes items measuring depression as well. Significance of the path coefficients remained the same after including this additional covariate. In particular, the GPF was still significantly associated with later depression ($\beta = 0.08, p = .007$) and the indirect effect from difficult temperament to depression in adulthood through the GPF remained significant as well (β

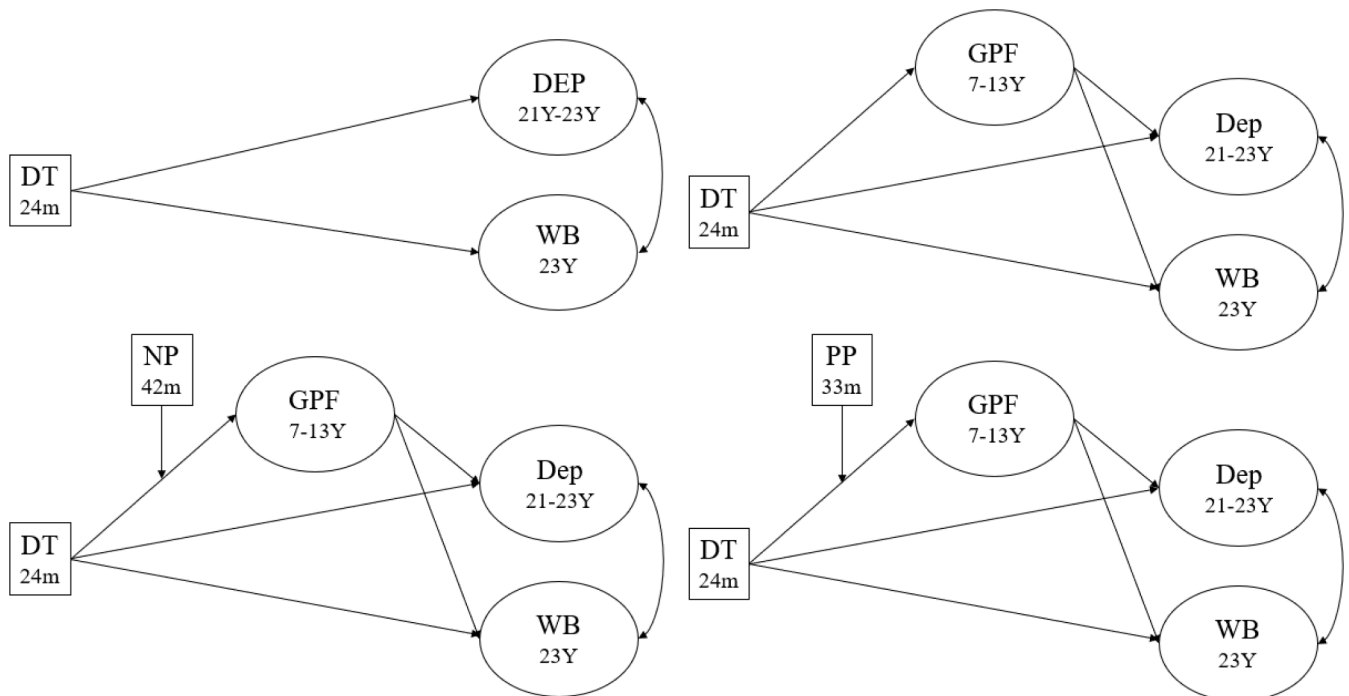


Fig. 1. Summary of analytic models. Note. DT= Difficult temperament; GPF= General psychopathology factor; Dep= Depression; WB= Well-being; NP= Negative parenting; PP= Positive parenting; we controlled for family adversity (i.e. family financial difficulty, maternal psychopathology, maternal education, and maternal substance use), and child sex and IQ on all paths.

Table 1
Descriptive statistic and bivariate associations for study variables.

	Difficult Temperament	Negative Parenting	Positive Parenting	GPF	Depression	Well-being	IQ	Family Adversity
Difficult Temperament	1							
Negative Parenting	.234***	1						
Positive Parenting	−0.207***	−0.155***	1					
GPF	.261***	.225***	−0.231***	1				
Depression	.080**	.016	−0.046	.151***	1			
Well-being	−0.082***	−0.037	.055*	−0.189***	−0.661***	1		
IQ	−0.088***	−0.087**	.018	−0.133***	−0.079**	.043	1	
Family Adversity	.153***	.051*	−0.238***	.206***	.171***	−0.162***	−0.090**	1
M(SD)	−0.001 (0.76)	.00 (0.78)	−0.016 (0.99)	38.49 (30.62)	57.69 (14.70)	77.77 (18.46)	109.23 (16.15)	1.69 (1.72)
Min	−2.40	−2.31	−4.90	0	39	9	45	0
Max	2.20	1.34	0.87	237	115	119	149	10

Note. * $p < .05$; ** $p < .01$; *** $p < .001$; GPF= General Psychopathology Factor.

Table 2
Summary of results from the models.

	Direct effect	Indirect effect	Moderated Mediated effect (NP)	Moderated Mediated effect (PP)
Effects on GPF				
Difficult temperament		.25***	.21***	.34***
Negative parenting (NP)			.20***	
Difficult temperament * NP			.03	
Positive parenting (PP)				−0.19***
Difficult temperament * PP				−0.13
Effects on depression				
Difficult temperament	.09***	.05*	.05*	.05*
GPF		.13***	.12***	.13***
Effects on well-being				
Difficult temperament	−0.08***	−0.03	−0.05	−0.03
GPF		−0.16***	−0.16***	−0.16***
Model Fit				
χ^2	$\chi^2(635)=4600.52, p < .001$	$\chi^2(1109)=5707.21, p < .001$	$\chi^2(1191)=5797.908, p < .001$	$\chi^2(1191)=5820.156, p < .001$
CFI	.92	.92	.92	.92
TLI	.91	.91	.91	.91
RMSEA	.06	.05	.05	.05
R ² GPF		.07, $p < .001$.11, $p < .001$.11, $p < .001$
R ² depression	.01, $p = .03$.03, $p = .003$.03, $p = .003$.03, $p = .003$
R ² well-being	.01, $p = .09$.03, $p = .005$.03, $p = .006$.03, $p = .006$

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. Path coefficients: According to Cohen’s population effect size statistics, small, medium, and large effects are $\beta = 0.10$, $\beta = 0.24$, $\beta = 0.37$ respectively.

= 0.02, 95% bootstrapped C.I. [0.01, 0.04]).

4. Discussion

To our knowledge, the present study is the first to examine multiple processes through which an overall factor of difficult temperament in toddlerhood associates with depressive symptoms and well-being in adulthood through generalized psychopathology. We highlight three key findings: i) toddler difficult temperament was directly associated with depressive symptoms and well-being in adulthood, ii) these direct

effects were also mediated by generalized psychopathology (i.e. GPF), and iii) the mediated pathways were not moderated by negative or positive parenting. We note that, contrary to our expectations, only the dimensions of mood, intensity, and adaptability loaded adequately onto the second order difficult temperament variable when using CFA to identify the latent structure of difficult temperament. In other words, our construct of temperamental difficulty captures the majority of difficult temperament dimensions, as set out by Thomas and Chess (1977), but excludes aspects of biological rhythmicity (e.g. “Child is sleepy at the same time each evening”) or response to novel stimuli (e.g. “reacts to stranger with acceptance”).

First, toddler difficult temperament (i.e. intense and negative mood with low adaptability) was directly associated with elevated risks for depressive symptoms and diminished well-being in adulthood, above and beyond an extensive range of early life covariates. Further, the fact that different raters completed the measures 20 years apart suggests that these long-term associations are non-trivial and that very early-appearing dispositions may be an important indicator of an at-risk developmental trajectory. Regarding depressive symptoms, a precursor model (Klein et al., 2011) may partly account for the observed relationship; this model postulates that the two constructs may have shared etiological factors, such that those with more difficult temperament are also more susceptible to developing depression. Indeed, the tendency to experience intense negative mood is central to both the tripartite model of depression (Clark and Watson, 1991) and difficult temperament (Bates, 1980). This could then be further exacerbated by reduced self-regulatory capacities characterized by low adaptability. Relatedly, the propensity to experience intense, negative mood is also likely to diminish well-being in adulthood. Moreover, temperamentally difficult children have also been found to have a high level of interpersonal alienation at age 26 (Caspi and Silva, 1995), which could contribute to a reduced sense of well-being.

Second, the direct effects were also mediated by the general psychopathology factor in late childhood/early adolescence, where early difficult temperament was found to confer transdiagnostic risks that in turn predicted to increased risk for depressive symptomatology and decreased levels of well-being. Several studies support the association between difficult temperament and a general factor of psychopathology. For example, Sayal et al. (2014) found that high negative mood, high intensity, and low adaptability at age 2 were each associated with the presence of any diagnosis for psychiatric disorders; intensity, in particular, was associated with both internalizing and externalizing disorders. Similarly, in a meta-analysis (Kostyrka-Allchorne et al., 2020), the propensity to experience intense negative emotions and distress in infancy was found to prospectively associate with externalizing problems, internalizing problems, ASD, and ADHD in childhood and adolescence; moreover, the latter three outcomes were also associated with reduced self-regulation. Here, negative emotionality (i.e. negative mood) and

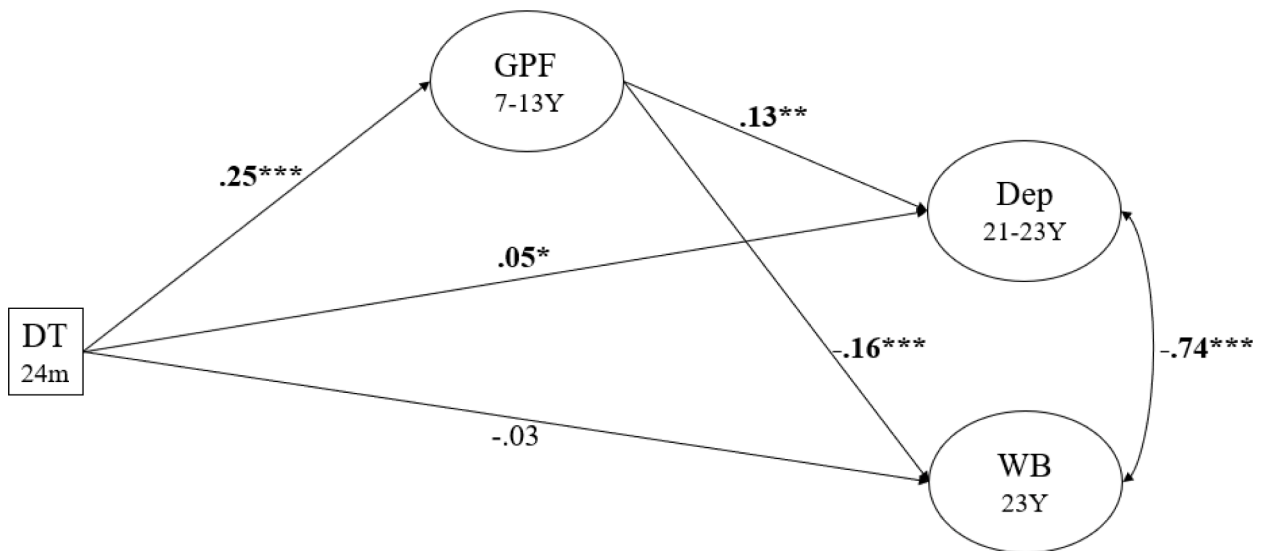


Fig. 2. Model assessing mediated effects. *Note.* DT= Difficult temperament; GPF= General psychopathology factor; Dep= Depression; WB= Well-being; * $p < .05$; ** $p < .01$; *** $p < .001$. Path coefficients: According to Cohen’s population effect size statistics, small, medium, and large effects are $B = 0.10$, $B = 0.24$, $B = 0.37$ respectively we controlled for family adversity (i.e. family financial difficulty, maternal psychopathology, maternal education, and maternal substance use), and child sex and IQ on all paths.

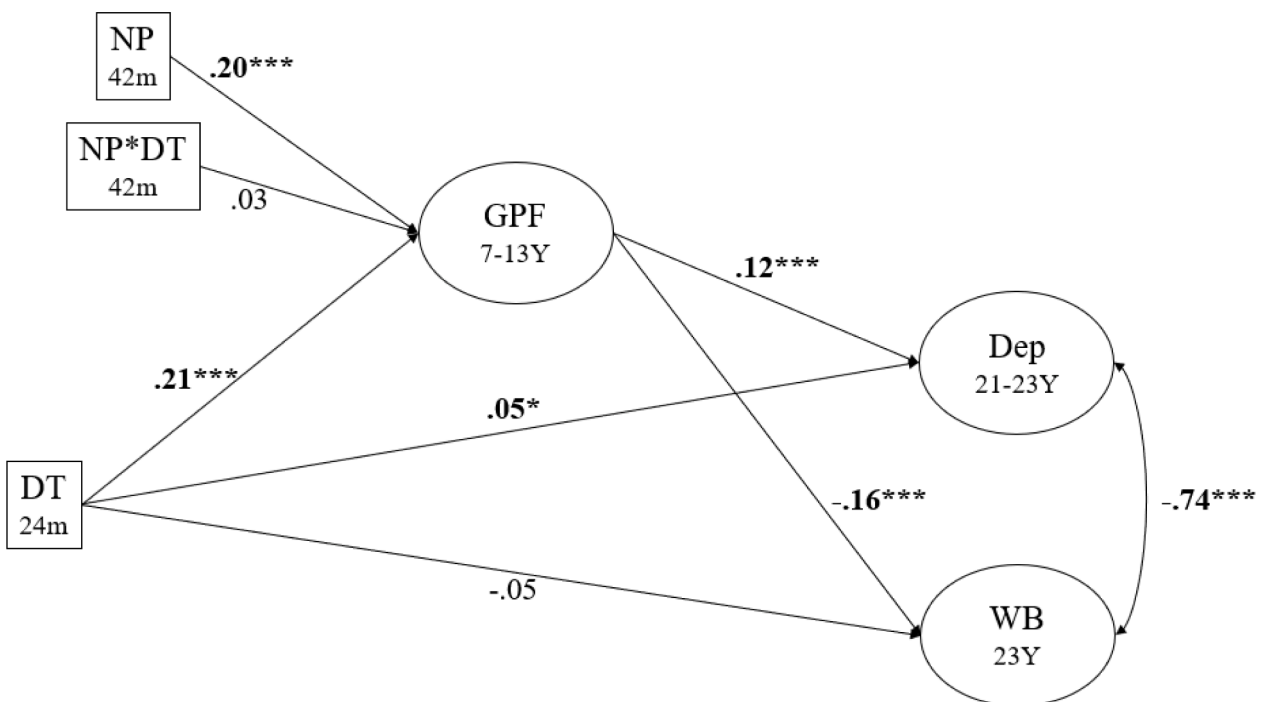


Fig. 3. Model assessing moderated-mediated model with negative parenting. *Note.* DT= Difficult temperament; GPF= General psychopathology factor; Dep= Depression; WB= Well-being; NP= Negative parenting; * $p < .05$; ** $p < .01$; *** $p < .001$. Path coefficients: According to Cohen’s population effect size statistics, small, medium, and large effects are $B = 0.10$, $B = 0.24$, $B = 0.37$ respectively; we controlled for family adversity (i.e. family financial difficulty, maternal psychopathology, maternal education, and maternal substance use), and child sex and IQ on all paths.

reduced self-regulatory capacities may indicate atypical development in the arousal and regulatory systems, which lead to greater risk for multiple psychopathologies (Conway et al., 2018; Johnson, 2012). To note, adaptability in the present study also probes elements of self-regulation (e.g. “accepts delay for desired objects”), and the deficit of which also jointly contributes to the development of psychopathology.

In our analysis, the GPF was in turn associated with depressive symptoms and diminished well-being in adulthood, similar to past findings (Sallis et al., 2019). Consistent with the precursor model (Klein

et al., 2011), it is possible that the shared variance across domains of psychopathology represents a shared etiology between the GPF and later depressive symptoms. Therefore, children with this general susceptibility to psychopathology are also predisposed to developing depressive symptoms. Of note, this effect remained significant after additionally controlling for depressive symptoms in adolescence, suggesting that the observed relationship is not a due to overlap in measurements. Similarly, the presence of psychopathological symptoms has also been found to associate with decreased well-being. Using a large sample of Dutch

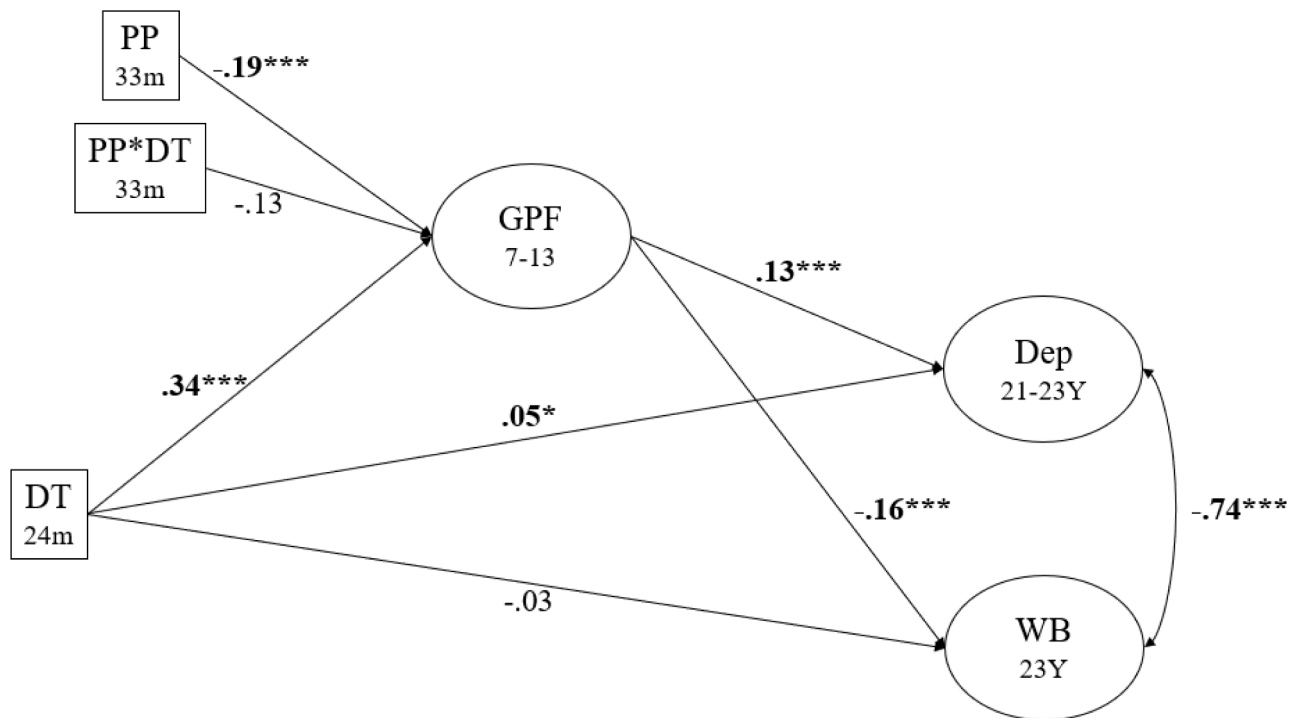


Fig. 4. Model assessing moderated-mediated model with positive parenting. Note. DT= Difficult temperament; GPF= General psychopathology factor; Dep= Depression; WB= Well-being; PP= Positive parenting; * $p < .05$; ** $p < .01$; *** $p < .001$. Path coefficients: According to Cohen's population effect size statistics, small, medium, and large effects are $B = 0.10$, $B = 0.24$, $B = 0.37$ respectively; we controlled for family adversity (i.e. family financial difficulty, maternal psychopathology, maternal education, and maternal substance use), and child sex and IQ on all paths.

adults, Lamers et al. (2015) found that the presence of psychopathology prospectively predicted reduced well-being 9 months later. This relationship is expected because mental health problems are often associated with interpersonal relationship problems (Sroufe et al., 2000), which could associate with reduced well-being.

Taken together, these findings suggest that the confluence of difficult temperament and generalized psychopathology may be associated with i) later depressive symptoms via shared etiology and/or potentially ii) reduced well-being arising in part from relationship problems. One potential shared etiology is genetic factor. Here, Bartels et al. (2013) found a negative association between well-being and psychopathology symptoms in a sample of adult Dutch twins. Moreover, they found that this relationship is primarily explained by a genetic overlap between well-being and psychopathology. Therefore, it would be important to investigate if the present findings can also be explained by a genotypic overlap, given that temperament (Saudino, 2005), generalized psychopathology (Riglin et al., 2019), and depression (Levinson, 2006) all have strong genetic components.

Finally, contrary to the literature (e.g. Slagt et al., 2016), indicators of negative and positive parenting did not moderate the mediated pathway in our study, which could be explained in part by measurement differences. In their study (Slagt et al., 2016), several behaviors of negative (e.g. over-reactivity, intrusiveness, overprotection) and positive (e.g. responsiveness and authoritative discipline) were included, while our analysis focused on harsh discipline and maternal warmth only. Furthermore, it was found that parenting-by-temperament interactions were stronger when parenting was assessed using observation, compared to questionnaires (Slagt et al., 2016). Future research could incorporate additional negative parenting behaviors and observation measures to test the moderated-mediated effects.

As difficult temperament in our study includes aspects of emotional (i.e. intensity and mood) and behavioral (i.e. adaptability) regulation, the present findings suggest that interventions targeting these traits may attenuate the risk for later psychopathology. This is supported by a

recent randomized control trial of an early intervention for children between ages 3 to 6 (Luby et al., 2018). Over 18 weeks, these children were trained on aspects of emotional regulation and competence, such as recognizing, understanding, and regulating emotions in self and others, as well as moderating reactivity to negative and positive stimuli. Children in the experimental group were found to have lower rates and severity of depression at follow-up/ later in the childhood. It is possible such intervention could alleviate the risks of developing downstream mental health problems among temperamentally difficult children.

4.1. Strengths and limitations

There are three main strengths to this study. First, its longitudinal design across developmental stages allowed us to examine how early-life difficult temperament associates with depression symptoms and well-being in adulthood. Second, nearly 2000 mother-child dyads were included, providing ample statistical power. Third, the present study demonstrates how early difficult temperament associates with not only mental health problems (i.e. depression), but also well-being in general in adulthood.

Our findings, however, should also be interpreted in the context of five limitations. First, temperament, parenting, and early mental health problems were all mother-reported (i.e. based on mother's perception), introducing the possibility of bias. It is important to note, though, that parents have been found to rate their children's temperament more positively (i.e. as less difficult) compared to trained observers (Seifer, 2005). Therefore, this (positive) attributional bias, if present, might be expected to attenuate the relationship between difficult temperament and long-term outcomes. Regardless, a significant association was present, suggesting a non-trivial relationship. Second, it is also possible that maternal reports could be influenced by mothers' mood states (e.g. postpartum depression). However, the literature has suggested that maternal ratings on child behaviors from depressed mothers are as accurate as those from other informants (Richters, 1992). Additionally, a

recent study found no evidence of mothers' history of psychiatric disorders as a potential source of bias in child temperament ratings (Olino et al., 2020). Here, they investigated measurement invariance between mothers with and without psychiatric disorders, and found that mental health problems did not affect the reported item levels (i.e. intercepts) and the factor structure of temperament (i.e. factor loading). We have also attempted to account for potential biases by controlling for self-reported maternal psychopathology on all paths in our models. Third, our positive parenting factor was defined based on maternal warmth rather than actual parenting behavior; however, parental warmth is widely considered as a defining feature of positive parenting (e.g. Davidov and Grusec, 2006; Kulkarni, 2010; Seay et al., 2014). Moreover, warm parenting as measured in this study, along with maternal confidence, has been found to prospectively associated with observed positive parenting behaviors (Thomson et al., 2014). Similarly, our negative parenting factor was defined based on harsh discipline. Here, maladaptive/harsh parenting behaviors are also widely considered to be important features of negative parenting (see Slagt et al., 2016 for a review). Specifically, negative parenting behaviors in their meta-analysis include physical punishment and harsh discipline, which are captured by our measure of negative/harsh parenting as well. Fourth, similar to most longitudinal cohorts, attrition has occurred in ALSPAC over time. In the current study, our analysis indicated that mothers who are more disadvantaged (i.e. higher rates of financial difficulties, psychopathology, and lower education attainment) and children with lower IQ were more likely to be lost to attrition. The present sample thus underrepresents at-risk families with children who would be more likely to experience depressive symptoms and other mental health problems. However, research suggests that, in APSAC, such attrition can result in the observed estimates being more moderate than the likely true effects (Wolke et al., 2009). Lastly, there is a need to replicate these findings in further cohorts beyond ALSPAC, as characteristics of the present sample may limit generalizability to families of other ethnic and social groups, as well as those of higher clinical risk. For example, a recent study using severe clinical cases (i.e. inpatient diagnosis) has yielded different associations between dimensions of early difficult temperament and mood disorders in adulthood (Brannigan et al., 2020). Specifically, they found no associations between a diagnosis of mood disorder and the dimensions of mood, adaptability, and intensity. However, it is important to note that the study was underpowered, as the number of participants who were hospitalized for psychiatric disorders was very small (6.1%).

5. Conclusion

Given the prevalence and societal impact of depression and the impact of well-being on future functioning, an understanding of early risk factors is vital. To our knowledge, the present study is the first to test the direct, mediated, and moderated-mediated relationships between a construct of overall early difficult temperament and functioning in adulthood. The results suggest that early difficult temperament could be an important target for preventive interventions for later mental health problems in childhood/adolescence, as well as impaired functioning in adulthood; however, more research with more diverse samples is needed to increase the generalizability of present findings.

Author contribution

Wu, Barker, and Maughan conceived of the presented idea and derived all the models. Wu performed the analysis with the help of Meehan on bifactor-specific indices. Wu and Barker verified the analytical method. Wu prepared the manuscript with input from all authors. All authors discussed the results and helped shape the final manuscript. Barker and Maughan supervised the work.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2022.01.012.

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