


ORIGINAL ARTICLE

Dissecting maternal care: Patterns of maternal parenting in a prospective cohort study

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Abstract

Parental care has a strong impact on neurodevelopment and mental health in the offspring. Although numerous animal studies have revealed that the parental brain is a highly complex system involving many brain structures and neuroendocrine systems, human maternal parenting as a multidimensional construct with cognitive, emotional, and behavioural components has not been characterised comprehensively. This unique multi-method analysis aimed to examine patterns of self-reported and observed parenting from 6 to 60 months postpartum in a cohort of 496 mothers (mean maternal age = 32 years). Self-report questionnaires assessed motivational components of mothering, parenting stress, parenting-related mood, maternal investment, maternal parenting style, mother-child relationship satisfaction, and mother-child bonding at multiple time points. Observed parenting variables included the Ainsworth Sensitivity Scales at 6 and 18 months, the Behavioral Evaluation Strategies Taxonomies at 6 months, an Etch-A-Sketch cooperation task

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at 48 months, and the Parent-Child Early Relationship Assessment at 60 months. To examine whether different latent constructs underlie these measures of maternal parenting, we conducted an exploratory factor analysis. Self-report measures of parenting correlated only weakly with behavioural observations. Factor analysis on a subsample ($n = 197$) revealed four latent factors that each explained from 7% to 11% of the variance in the data (32% total variance explained). Based on the loadings of the instruments, the factors were interpreted as: *Supportive Parenting*, *Self-Enjoyment Parenting*, *Overwhelmed Parenting*, and *Affectionate Parenting*. These factor scores showed specific associations with maternal education and depressive symptoms, as well as with child outcomes, including maternally reported internalising and externalising behavioural problems, school readiness, and child-reported symptoms of mental health. These findings parallel the complexity of the parental brain, suggesting that maternal parenting consists of multiple components, each of which is associated with different maternal characteristics and child outcomes.

KEYWORDS

child development, maternal behaviour, maternal cognition, maternal mood, maternal motivation, mother-child interactions

1 | INTRODUCTION

Parental care profoundly influences the course of child development.¹⁻³ Human parenting involves multiple overlapping brain and neuroendocrine systems involved in perception, cognition, executive function and theory of mind, affect and reward, reproductive behaviour, and motivation.⁴ In humans, the primary care person, usually the mother, must maintain and adapt parenting behaviours over an extended period of time. These processes are guided by maternal hormones, distinct brain systems, memory and learning, personal history, and socio-cultural context, amongst others.⁴ Although the complex interplay between the endocrine and the neuronal systems involved in parenting has been widely acknowledged in research on the parental brain, less attention has been paid to patterns in behavioural and self-reported emotional, cognitive, and motivational aspects of parenting in humans.

Research on the effects of maternal care on child development typically entails either observational or self-report measures of maternal parenting, although rarely both. However, a comprehensive characterisation of maternal parenting is warranted to allow for a better understanding of patterns underlying human maternal parenting and how these may relate to endocrine and neuronal findings.

An important and extensively researched behavioural aspect of parenting is maternal sensitivity, which is the mother's ability to accurately recognise, interpret, and respond to her child's cues.² Maternal sensitivity predicts many positive child outcomes, including cognitive and socio-emotional development, self-regulation, and attachment security.^{1,3,5} By contrast, maternal insensitivity and harsh discipline are associated with behavioural problems in children.^{6,7} At the same time, different facets of maternal sensitivity might

become apparent during the course of development in response to the changed demands that a mother needs to fulfil as a child develops autonomy and learns how to influence the environment more decisively. A mother must adapt her behaviour dynamically, with an optimal, contextually-dependent balance between parental guidance and child self-direction.⁸⁻¹⁰ These behavioural changes are paralleled by structural, functional, and endocrine changes in the parental brain.^{10,11}

In addition to the behavioural components, parenting is strongly related to maternal mood, cognition, attitudes, parenting-related stress, and motivational strategies to maintain maternal care, all of which can be measured through self-report questionnaires. Again, these psychological aspects of parenting are linked to the endocrine system and the parental brain, and might change during the child's development.¹⁰

Although few studies have linked observational measures of maternal behaviour to maternal self-reported parenting, these studies usually find weak or no associations between these two methodologies.¹²⁻¹⁵ These findings suggest that self-report assessments and observational measures might measure different aspects of parenting.^{13,15} At the same time, these results indicate that self-report assessments in combination with observational measures may provide a more comprehensive picture of parenting.¹⁶ Furthermore, single measures of parenting often yield small effects on child outcomes,¹ but these small effects might aggregate to larger effects when both self-report and behavioural observations are combined in the same analysis.

Alternatively, maternal behaviour, affect, and cognition could form distinct patterns, which then affect child outcomes. A meta-analysis¹ on infant-caregiver attachment categorised maternal

behaviours using a Similarity Sorting Task, which yielded five clusters of maternal behaviours: synchrony, mutuality, positive attitude, emotional support, and stimulation. Although these categorised constructs were related to infant attachment, most of the effect sizes were small. In a study on multiple aspects of parenting, Zaslow et al¹⁷ used different methodologies, including self-reports, naturalistic home observation of a mother-child interaction, and a structured observational measure of parenting, aiming to predict different child outcomes. Applying a manifest variable approach, it was found that many of the different parenting measures were correlated, although the correlations across the three methodologies were weak. Taken together, maternal parenting behaviour, affect, and cognition appear to reflect a highly complex phenotype, which parallels the complexity seen in the endocrine and neuronal functioning of the parental brain.

The overall aim of the present study was to systematically characterise maternal parenting in a cohort of Canadian mothers. The first goal was to explore the associations between different parenting-related measures available in the Maternal Adversity, Vulnerability and Neurodevelopment (MAVAN) project, a longitudinal study with several self-report questionnaires as well as behavioural observations assessed at several time points throughout the child's early development from 6 to 60 months postpartum. The second goal was to identify interpretable patterns underlying these maternal parenting measures using a latent variable approach. The third and final goal was to examine whether the identified patterns would be associated with distinct factors known to influence maternal care, notably maternal socio-economic factors and symptoms of depression, as well as child outcomes, including school readiness, child self-reports of mental health, and maternal reports of child internalising and externalising behavioural problems. The identification of interpretable and meaningful patterns underlying maternal parenting could inform future research on the parental brain and guide interventions for mothers at risk for adverse parenting styles.

2 | MATERIALS AND METHODS

2.1 | Participants and procedures

The sample consisted of 496 mothers participating in the MAVAN project, which surveys mother-child dyads and their families from the prenatal period through to late childhood. The sample consists of families recruited in Montreal ($n = 299$) and Hamilton ($n = 197$), Canada. Mothers were recruited at obstetric clinics in hospitals during pregnancy and were screened for study eligibility. Inclusion criteria were: mothers aged 18 years or older at birth of their child and fluent in English or French. Exclusion criteria comprised serious obstetric complications, extremely low birth weight, prematurity (≤ 37 weeks of gestation) or any congenital disease of the child at birth. All mothers provided their written informed consent at study enrollment. The protocol was approved by the Ethics Committees from the Douglas Mental Health University Institute for the Montréal cohort and from St. Joseph's Hospital for the Hamilton cohort.

After delivery, mothers were followed up at regular time intervals until the child reached 12 years, through both home and laboratory visits. The study design and a detailed description of the MAVAN study protocol is provided in Figure 1.¹⁸ For the present study, we examined a variety of indicators of maternal parenting across multiple time points from 6 to 60 months postpartum. The instruments included maternal self-report questionnaires and behavioural observations. More detailed information on the instruments and the sample sizes per measure included in the present study is provided in Figure 1 and the Supporting information (Table S1).

The mean \pm SD age of the mothers at birth of the child (53% boys) was 32 ± 5.0 years (range 18-43 years). In total, 113 (28%) mothers were below the cut-off for low total family income according to Statistics Canada¹⁹; 217 (47%) had a University degree, 153 (33%) completed Community College or some University, 38 (8%) attended some community college and 58 (12%) had a high school diploma or less; for 30 mothers, we did not have any information on education. An estimated 86% of the mothers reported Caucasian ethnicity, approximately 4% were of African or African-American descent; 4% were from Latin America; and 6% reported other ethnicities.

2.2 | Measures

2.2.1 | Self-report questionnaires

The self-report measures included the Health and Well-Being Questionnaire (HWB),²⁰ the Childbearing Attitudes Questionnaire (CAQ)²¹ and the Parental Authority Questionnaire (PAQ).²² The HWB is a large composite questionnaire consisting of multiple short forms of well-established questionnaires assessing parenting stress, relationship satisfaction with the child, and maternal care regulation (engagement in external, introjected and identified strategies), and was completed at 6, 12, 24, 36, 48, and 60 months. The CAQ measured maternal dysphoria, bonding with the child, and maternal investment at 6, 18, and 60 months. The PAQ identifies parenting styles that correspond to authoritative, permissive or authoritarian prototype at 60 months postpartum. High scores on each scale of the HWB, CAQ, and PAQ reflect high levels of parenting stress, high relationship satisfaction, strong engagement in a given maternal care regulation strategy, high maternal dysphoria, strong bonding to the child, high parental investment, and strong identification with a given parenting style, respectively. In addition to self-report parenting measures, mothers completed questionnaires on sociodemographic parameters at birth and symptoms of depression (Centre of Epidemiological Studies Depression Scale; CES-D²³) at 6, 12, 24, 36, 48, and 60 months postpartum. A detailed description of all questionnaires is provided in the Supporting information (Appendix S1).

2.2.2 | Behavioural observations

The behavioural measures included the (i) Ainsworth Sensitivity Scales (AINS)²⁴ to assess maternal sensitivity at 6 and 18 months, with subscores integrated into an overall measure of maternal sensitivity;

(ii) the Behavioural Evaluation Strategies Taxonomies (Educational Consulting, Inc. Florida, US) (BEST)²⁵ at 6 months, which assessed quantitative components of maternal behaviour, namely, proportion of time spent paying attention to the child, playing, communicating, engaging in instrumental behaviour (e.g., grooming), and tactile behaviour; (iii) the Etch-A-Sketch (Ohio Art®, Bryan, OH, USA) task (EAS)²⁶ at 48 months, during a mother-child cooperation task, which assessed affirmative parenting, critical assessment, physically controlling behaviours, and verbal guidance; and, finally, (iv) the Parent-Child Early Relational Assessment (PCERA)^{27,28} at 60 months, which measured maternal behaviour on three composite scales, including maternal positive affective involvement and verbalisation, maternal negative affect and behaviour, and maternal intrusiveness, insensitivity, and inconsistency. A high score indicates that a given behaviour was observed more often. At 6 and 18 months, observations were performed at home, whereas the observations at 48 and 60 months were completed in the laboratory. More detailed information on each instrument is provided in the Supporting information (Appendix S1).

2.2.3 | Child outcome measures

We explored three aspects of child outcome measures to examine the predictive value of the parenting components. Trained study personnel administered the Lollipop Test²⁹ to assess school readiness at

5 years as an indicator of cognitive development and recorded the child's own reports of his or her mental health symptoms at 6 years using the Dominic.³⁰ All tests are well validated for children in this age range. The Lollipop test was developed as a training test for school readiness²⁹ and includes 52 questions, divided into four subtests: (i) knowledge about colours and forms; (ii) knowledge about spatial relationships; (iii) knowledge about numbers; and (iv) knowledge about letters. For the present study, we investigated the total score across the four subtests. The Dominic questionnaire is a structured pictorial instrument assessing mental health in 6-11-year-old children.³⁰ The Dominic assesses a child's perception of her/his own symptoms, which is critical to balance parents' and school professionals' perception. Ninety-nine drawings represent situations corresponding to DSM-III based diagnoses. For our analysis, we selected the scales for major depressive disorder, separation anxiety, and attention-deficit hyperactivity disorder (ADHD). The paper version of the Dominic questionnaire has been extensively validated.³⁰⁻³² Intra-class correlation coefficients between test and retest ranged from 0.71 to 0.81 in 340 community children and test-retest kappa values ranged from 0.44 to 0.69, with most kappa values around 0.60.³¹ Finally, mothers completed the Child Behavior Checklist (CBCL)³³ at 5 years to measure internalising and externalising behavioural problems. The CBCL³³ is a 100-item measure that uses a three-point Likert scale ranging from 0 to 2. The total symptoms score was retained, as well

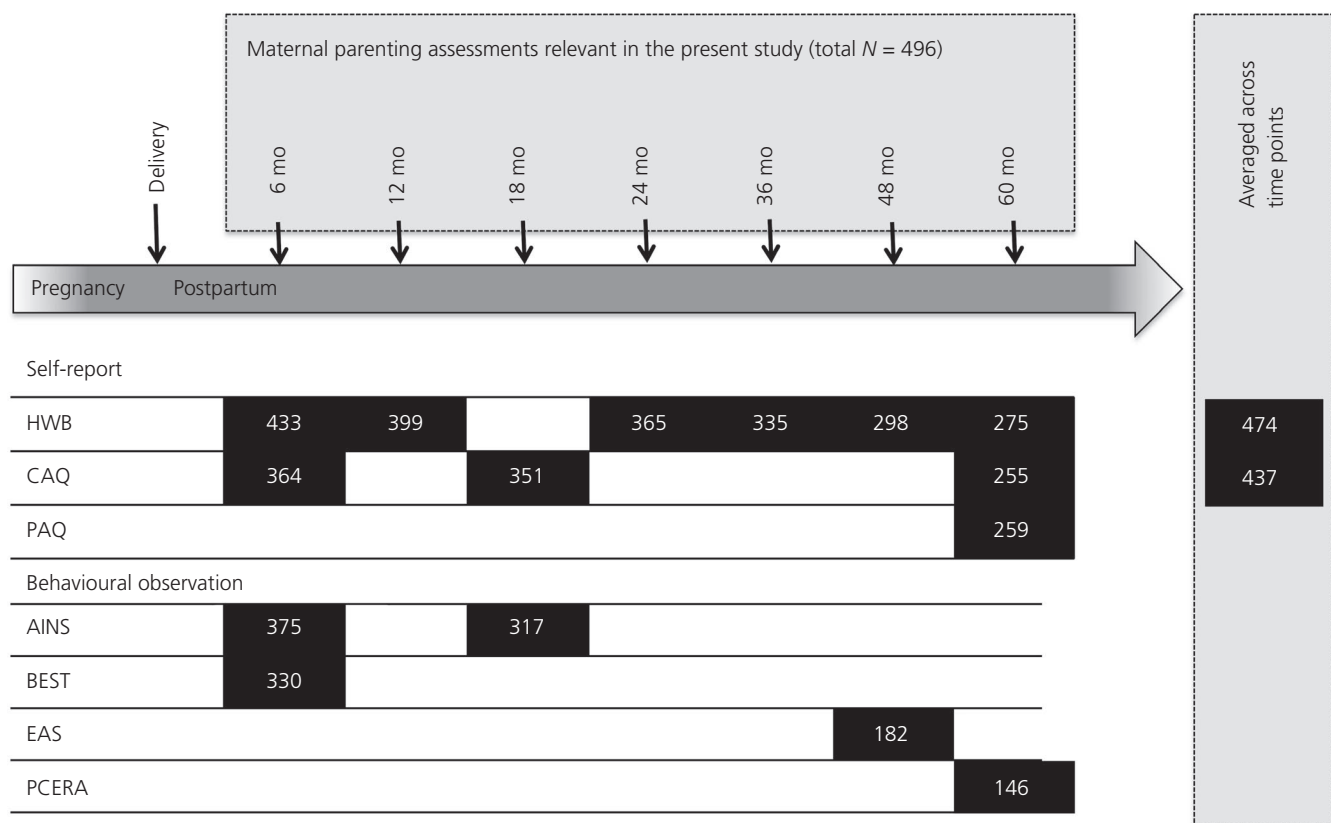


FIGURE 1 Longitudinal study design with the number of participants per instrument for each time point. AINS, Ainsworth Sensitivity Scales; BEST, Behavioral Evaluation Strategies and Taxonomies; CAQ, Childbearing Attitudes Questionnaire; EAS, Etch-A-Sketch; HWB, Health and Wellbeing Questionnaire; PAQ, Parental Authority Questionnaire; PCERA, Parent-Child Early Relational Assessment

as the internalising and externalising problems scores. The internalising and externalising subscales are comprised of 36 and 24 items, respectively. Cronbach's alpha was 0.86 for the internalising symptoms score, 0.90 for externalising symptoms score and 0.94 for total score. High scores indicate more school readiness or more mental health symptoms the Lollipop test, on the Dominic, and the CBCL, respectively.

2.3 | Statistical analysis

All self-report questionnaires and behavioural measures were pre-processed using SPSS, version 20 (IBM Corp., Armonk, NY, USA) (see Supporting information, Appendix S1) to develop a comparable number of scales per applied instrument. For example, 13 CAQ subscales were aggregated to three scores informed by factor analysis. In total, 14 behavioural and 11 self-report measures derived from the nine instruments assessing maternal behaviour, affect and cognition, and motivational aspects of parenting were included (see Supporting information, Table S1). Descriptive statistics for each measure used are provided in the Supporting information (Table S2). All analyses on maternal parenting patterns were performed in R, version 3.3.0 "Supposedly Educational".³⁴

To address our first research goal, we computed pairwise Spearman's rank correlations to explore the correlation between different instruments and across time points. Non-parametric statistics were favoured for this analysis to account for the fact that not all scales were parametrically distributed and to avoid false-positives as a result of outlier values. The heatmap illustrating the strengths of the associations between instrument scales (Figure 2) was drawn using the package "Hmisc".³⁵ As a result of the explorative nature of the analyses, we did not correct for multiple testing.

To test the second research question of whether there are patterns in the parenting data related to distinct components underlying maternal behaviour, we conducted an exploratory factor analysis across all the self-report and behavioural data, using the package "psych".³⁶ Considering the correlation across time points, we averaged all repeated self-report measures to obtain one score per subscale for each instrument across time. Second, participants with more than 25% missing data on the different instruments, mainly as a result of non-availability of behavioural ratings (Figure 1), were excluded from subsequent analyses, leaving a sample size of $n = 197$. Third, we evaluated the suitability of the data for factor analysis by computing Bartlett's test of sphericity and the overall measure of sampling adequacy using the KMO function of the "psych" package.³⁶ Fourth, we examined the number of factors to extract, using multiple criteria as suggested previously,³⁷ including the scree test and parallel test to determine the range of possible factors (see Supporting information, Figure S1). Before running the final factor analysis, we imputed missing data using the `imputePCA` function of the "missMDA" package.³⁸ All factor analyses were run on a Spearman's rank correlation matrix to account for the non-parametric distribution of some of the variables, using the "fa" function of the "psych" package.³⁶ A promax

rotation was applied to the factors, provided that the different constructs were assumed to be correlated. The factoring method was minimum residuals. Factor loadings of ≥ 0.3 were considered potentially meaningful. The interpretation of the final factors was compared with other factor solutions within the range of potential factor numbers.³⁷

Regarding the third research goal, we extracted the factor scores for each mother using a regression-based approach and explored the association between the obtained parenting factor scores with child gender; maternal parity; maternal age; education; family income; maternal symptoms of depression; child total score on the Lollipop School Readiness Test; the three subscales of the child-reports for separation anxiety, major depression, and ADHD as measured on the Dominic at 72 months (subscales on the Dominic selected based on variance in our community sample and their salience in the clinical context); and the maternally reported internalising, externalising and total problems score on the CBCL at 60 months. For these correlation analyses, we Pearson's or Spearman's rank correlation, depending on data characteristics.

3 | RESULTS

3.1 | Research goal 1: Correlation between scores and instruments

We first explored simple correlational patterns across maternal parenting instruments by computing Spearman's rank correlations across all instrument scores and time points (50 variables, including repeated measures). The strength of the associations between instruments is illustrated in a heatmap of the correlation coefficients (Figure 2) and a complete correlation matrix with sample size is provided in the Supporting information (Table S3). Correlation clusters suggest that self-report data were associated more strongly with other self-report data rather than with behavioural measures and vice versa. Correlations between repeated measures of the same self-report scales revealed medium to strong effect sizes ($r = 0.32$ to 0.77). With regard to associations between different self-report questionnaires, Identified- and External-Care Regulation, Parenting Stress, Relationship Satisfaction with the Child, and CAQ Maternal Dysphoria were weakly to strongly correlated ($r = 0.20$ to 0.69). PAQ Authoritative and Authoritarian Parenting Scores showed only weak associations with a few other questionnaire scores. Associations within and between the behavioural measures were less prevalent, with mostly weak to medium effect sizes ($r = 0.11$ to 0.68) (see Supporting information, Table S3). Notably, Sensitivity at 6 and 18 months showed the largest number of associations with other instruments, including BEST measures at 6 months, Etch-A-Sketch at 48 months and PCERA at 60 months. We found only few associations between self-report and behavioural measures and those that reached significance were weak ($r = 0.11$ to 0.23), especially considering that there was no correction for multiple comparisons. Here, the range in effect sizes is given in positive numbers; the direction of the correlation coefficients can be determined from Figure 2 (see also the Supporting information, Table S3).

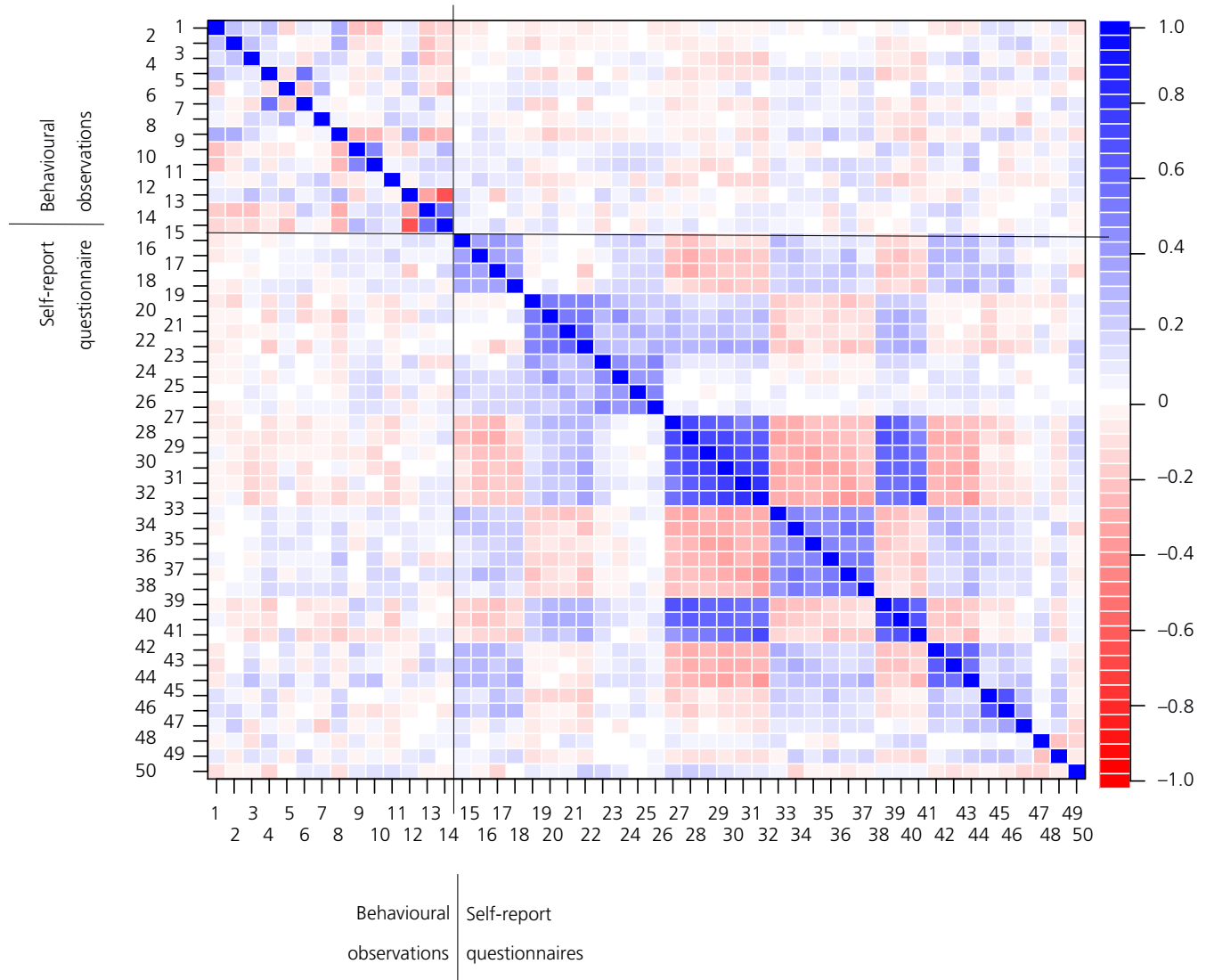


FIGURE 2 Heatmap illustrating the strength of association between the different instrument scores. The grid lines mark the border between behavioural observations and self-report instruments. The more intense colours that are clustering along the heatmap diagonal indicate that scores on a specific instrument were more strongly correlated with other scores on that same instrument not only applied at the same time point, but also across multiple time points. 1, AINS 6M; 2, AINS 18M; 3, BEST 6M Attention; 4, BEST 6M Communication; 5, BEST 6M Instrumental Behavior; 6, BEST 6M Playing; 7, BEST 6M Tactile Interactions; 8, EAS 48M Affirmative; 9, EAS 48M Critical Assessment; 10, EAS 48M Physically Controlling; 11, EAS 48M Verbally Guidance; 12, PCERA 60M Positive Affective Involvement; 13, PCERA 60M Negative Affect and Behavior; 14, PCERA 60M Insensitivity & Intrusiveness; 15, MCR 6M Identified; 16, MCR 12M Identified; 17, MCR 24M Identified; 18, MCR 60M Identified; 19, MCR 6M External; 20, MCR 12M External; 21, MCR 24M External; 22, MCR 60M External; 23, MCR 6M Introjected; 24, MCR 12M Introjected; 25, MCR 24M Introjected; 26, MCR 60M Introjected; 27, Parental Stress 6M; 28, Parental Stress 12M; 29, Parental Stress 24M; 30, Parental Stress 36M; 31, Parental Stress 48M; 32, Parental Stress 60M; 33, Relationship Satisfaction 6M; 34, Relationship Satisfaction 12M; 35, Relationship Satisfaction 24M; 36, Relationship Satisfaction 36M; 37, Relationship Satisfaction 48M; 38, Relationship Satisfaction 60M; 39, CAQ Maternal Dysphoria 6M; 40, CAQ Maternal Dysphoria 18M; 41, CAQ Maternal Dysphoria 60M; 42, CAQ Bonding 6M; 43, CAQ Bonding 18M; 44, CAQ Bonding 60M; 45, CAQ Investment 6M; 46, CAQ Investment 18M; 47, CAQ Investment 60M; 48, PAQ 60M Permissive; 49, PAQ 60M Authoritative; 50, PAQ 60M Authoritarian. AINS, Ainsworth Sensitivity Scales; BEST, Behavioral Evaluation Strategies and Taxonomies; CAQ, Childbearing Attitudes Questionnaire; EAS, Etch-A-Sketch; HWB, Health and Wellbeing Questionnaire; PAQ, Parental Authority Questionnaire; PCERA, Parent-Child Early Relational Assessment

3.2 | Research goal 2: Latent factor analysis of maternal parenting patterns

We explored latent variables underlying the scales on all 11 self-report and 14 behavioural instruments assessing maternal

parenting. Given the strong correlations amongst individual self-report scales across time points, we calculated the mean across all time points for each scale to obtain one single measure per self-report scale, providing a total of 25 variables for the factor analysis. Different instruments had different amounts of missing data,

resulting in different sample sizes per instrument and timepoint (Figure 1). Exclusion of mothers with > 25% missing data produced a sample of $n = 197$. The mothers included in these analyses reported less parental stress at 12 months ($Z = -2.112$; $P = 0.035$) and higher scores on CAQ Bonding at 6 months ($Z = -2.568$; $P = 0.010$), as well as CAQ Investment at 6 months ($Z = -3.272$; $P = 0.001$) and at 18 months ($Z = -2.672$; $P = 0.008$), but higher scores on CAQ Maternal Dysphoria at 60 months ($Z = -2.107$; $P = 0.035$) compared to excluded mothers. There were no differences in any other self-report or behavioural measures, sociodemographic variables or child outcome measures.

We then standardised all scores across instruments. Preliminary analyses showed that our data were appropriate for factor analysis (Kaiser-Meyer-Olkin index = 0.57). Bartlett's test was significantly different from an identity matrix ($\chi^2 = 1267.97$; $df = 300$; $n = 197$; $P < 0.001$) indicating redundancy in the data. The estimated number of factors underlying the data were determined based on the diagnostic plots. Eight factors had an Eigenvalue >1, although only seven passed the parallel analysis criterion, thus giving a range of up to seven factors. The scree plot showed a plateau at four factors. Based on these criteria, we selected four meaningful factors (see Supporting information, Figure S1) that explained 32% of the variance. This small proportion of explained variance suggests that there might be numerous dimensions beyond those extracted here. We repeated the factor analysis after imputation of the up to 25% missing data. The fit based upon the off diagonal values was 0.88 and a root mean square 0.07. The Tucker Lewis index of factoring reliability was 0.74. The factor loadings can be interpreted as the strength of the association between a specific factor and a given measure, and can be positive or negative. The rotated component matrix with factor loadings for each subscale is given in Table 1.

The first factor explained 11% of the variance and consisted of mostly behavioural measures, including BEST Attention, Playing and Instrumental Behavior at 6 months, AINS at 18 months, EAS Affirmative Parenting at 48 months, and the three PCERA scales at 60 months. The loadings indicated that higher scores were related to generally more sensitive parenting. We interpreted this factor as *Supportive Parenting*.

The second factor explained 7% of the variance and was composed of a mixture between self-report and behavioural measures, including CAQ Bonding, CAQ Relationship Satisfaction with the Child, Identified Maternal Care Regulation, CAQ Maternal Dysphoria, and Parenting Stress, as well as EAS Critical Assessment and EAS Physically Controlling Behavior. The direction of the loadings indicated that this factor might assess *Self-Enjoyment Parenting*.

The third factor, explaining 7% of the variance, reflected CAQ Maternal Dysphoria, Parenting Stress, External Care Regulation and Verbal Guidance (negative loading). This factor was thus interpreted as *Overwhelmed Parenting*.

Finally, the last factor also explained 7% of the variance and was composed of BEST Communication, Playing, and Instrumental Behavior (negative loading) at 6 months, AINS Sensitivity at

6 months, EAS Affirmative Parenting, Physically Controlling Behavior and Critical Assessment, and CAQ Investment. The loadings of the scores on the factors suggested that this factor assessed an affective component of parenting and was thus named *Affectionate Parenting*.

All factor scores were extracted using a regression-based approach. Each mother showed a distinct mixture of the different factors contributing to her overall parenting style (see Supporting information, Figure S2), suggesting that each mother has different areas of strength. Although there appears to be a general trend of lower scores on *Supportive*, *Self-Enjoyment* and *Affectionate Parenting*, as well as higher scores on *Overwhelmed Parenting*, this highlights that there are still mothers with high depression scores that show parenting patterns comparable to mothers with low depression scores and vice versa. The correlation between the four factors is shown in Table 2. In sum, our analysis suggests potential underlying patterns based on the self-report and observational instruments reflecting distinct constructs underlying maternal parenting.

3.3 | Research Goal 3: Maternal parenting, maternal characteristics and child outcomes

We then examined the associations of child gender, maternal parity, maternal age, maternal education, family income, and maternal symptoms of depression, with each of the four maternal parenting factor scores. We found that *Self-Enjoyment Parenting* was higher in mothers who had their first child compared to multiparous mothers and older mothers had higher scores for *Affectionate Parenting*. Although higher maternal education correlated with higher scores for *Supportive Parenting* and *Affectionate Parenting*, we did not find any significant associations with child gender or family income category with the parenting factors. Finally, higher average levels of maternal symptoms of depression from 6 to 60 months correlated with all maternal parenting factors in the expected direction (ie, lower *Supportive*, lower *Self-Enjoyment*, higher *Overwhelmed*, lower *Affectionate Parenting*). All correlation coefficients are shown in Table 2.

We also examined the association between the maternal parenting factors and child developmental outcomes. Analysis of these child outcome measures revealed significant specific associations between the four factors of maternal parenting and specific child outcome measures. The *Supportive Parenting* score was positively associated with the performance on the Lollipop school readiness test, and negatively related to the child score for ADHD. *Affectionate Parenting* was related to decreased child reports of symptoms of psychopathology, including separation anxiety, major depressive disorder, and ADHD, as well as CBCL externalising symptoms. Maternal reports on all CBCL scales correlated with *Self-Enjoyment* and *Overwhelmed Parenting*. Again, all correlation coefficients are shown in Table 2.

In sum, maternal education and symptoms of depression in the postpartum showed the strongest associations with the parenting scores. With regard to child outcomes, we found that the four maternal factors were differentially associated with specific measures of child outcomes. Notably, *Supportive Parenting* and *Affectionate Parenting* were both negatively related to child reports of symptoms

TABLE 1 Factor analysis across maternal parenting measures (rotated component matrix)

	Factor 1	Factor 2	Factor 3	Factor 4
Supportive parenting				
PCERA insensitivity, intrusiveness and anxiety	-0.87	0.06	0.04	0.11
PCERA positive affective involvement and verbalisation	0.80	0.12	0.03	-0.08
PCERA parental negative affect and behaviour	-0.72	0.09	-0.04	0.12
EAS affirmative parenting	0.46	0.07	0.01	0.36
BEST attention on child	0.42	0.16	-0.24	-0.11
AINS sensitivity at 18 months	0.37	-0.05	<0.01	0.22
Self-enjoyment parenting				
CAQ bonding	0.01	0.57	-0.22	-0.02
HWB relationship satisfaction with child	0.03	0.55	-0.13	0.19
EAS physically controlling	-0.08	0.52	-0.05	-0.40
HWB identified maternal care regulation	<0.01	0.51	-0.11	0.06
EAS critical assessment	-0.26	0.35	0.10	-0.32
Overwhelmed parenting				
CAQ maternal dysphoria	-0.01	-0.35	0.85	-0.01
HWB parenting stress	-0.05	-0.57	0.68	-0.03
HWB external care regulation	0.08	-0.12	0.40	-0.15
EAS verbal guidance	-0.14	0.04	-0.39	-0.05
Affectionate parenting				
BEST communication	-0.19	0.00	-0.02	0.54
AINS sensitivity at 6 months	0.16	-0.13	-0.04	0.51
CAQ investment	0.01	0.25	0.21	0.49
BEST playing	-0.33	0.04	-0.07	0.44
BEST instrumental behaviour	0.32	0.12	0.11	-0.37
Non-categorised				
BEST tactile interactions	0.10	0.05	-0.25	-0.17
HWB introjected care regulation	0.08	0.12	0.22	-0.09
PAQ permissive parenting	-0.07	0.03	0.28	0.08
PAQ authoritative parenting	0.01	0.13	-0.11	0.27
PAQ authoritarian parenting	0.02	-0.13	-0.10	-0.24

Note: Standardised loadings based upon correlation matrix. Meaningful loadings > 0.3 are indicated in bold. Self-report repeated measures were averaged across time points before inclusion in factor analysis.

Abbreviations: AINS, Ainsworth Sensitivity Scale; BEST, Behavioral Evaluation Strategies and Taxonomies; CAQ, Childbearing Attitudes Questionnaire; CI, confidence interval; EAS, Etch-A-Sketch; HWB, Health and Wellbeing Questionnaire; PAQ, Parental Authority Questionnaire; PCERA, Parent-Child Early Relationship Assessment.

of mental disorders, whereas the *Self-Enjoyment Parenting* and *Overwhelmed Parenting* scores were related only to maternal reports of child outcomes.

4 | DISCUSSION

The present study aimed to comprehensively characterise maternal parenting, using a cohort of Canadian mothers for whom multiple indicators of parenting were measured through self-report questionnaires and behavioural observations in a longitudinal study design. First, we examined associations between scores on different

self-report and behavioural instruments within and across time points. Second, we attempted to identify patterns underlying maternal parenting, using a latent factor analysis approach. Last, we linked these factors to maternal sociodemographic and mood variables, as well as to child outcomes.

In sum, we found that the correlation of subscales measured on the same instruments was generally stronger on the self-reports compared to the behavioural measures, particularly the repeated measures. Notably, scores on Parenting Stress, Maternal Care Regulation, Mother-Child Relationship Satisfaction, and Child Bearing Attitudes Questionnaire showed medium to strong associations not only when measured at the same time point, but also across

time. We found mostly weak to moderate associations for correlations between different scores on the same behavioural instruments at a given time point, whereas there were only few and mostly weak associations between different behavioural observations measured at different time points. The associations between the self-report and the behavioural measures were even weaker, which is in line with previous studies.¹²⁻¹⁵ These findings suggest that the individual measures reflect somewhat distinct components of a highly complex phenotype of maternal parenting.

Using individual measures from 11 self-report and 14 observational measures, we found four interpretable latent factors reflecting *Supportive Parenting*, *Self-Enjoyment Parenting*, *Overwhelmed Parenting* and *Affectionate Parenting*. However, these four factors only accounted for 32% of the observed variance in the data, indicating that parenting is indeed multi-dimensional beyond the factors extracted here, further highlighting the complexity of maternal parenting over time. Subsequent studies should try to validate these factors, ideally in a data set with comparable instruments, aiming to increase the generalisability of the factors. However,

the goal of this data-driven exploratory analysis was to generate novel hypotheses that could guide future research on maternal parenting.

Indeed, it appears that the extracted maternal parenting factors were associated with variables previously shown to relate to variations in maternal care, such as maternal age and education,³⁹ maternal symptoms of depression,⁴⁰ and different child outcome measures.

4.1 | Association between instrument scales

To test intra- and inter-instrument correlations across time, we analysed simple patterns across maternal parenting instruments by computing Spearman's rank correlation across all instrument scores and time points (50 variables, including repeated measures). The two distinct clusters on the heatmap (Figure 2) highlight the discrepancy between self-rating instruments and behavioural observations, which is consistent with previous reports.^{41,42} Several explanations could underlie this phenomenon. First, it might be argued that the strong associations between the different self-report questionnaire

TABLE 2 Correlation of maternal parenting factor scores with maternal variables and child outcomes

	Supportive parenting		Self-Enjoyment parenting		Overwhelmed parenting		Affectionate parenting		
	r	P	r	P	r	P	r	P	n
Between factor correlation									
Supportive parenting									197
Self-directed enjoyment of parenting	0.02	0.832							197
Overwhelmed parenting	-0.11	0.112	-0.62	< 0.001					197
Affectionate parenting	-0.06	0.420	0.10	0.171	-0.23	0.001			197
Sociodemographic and socio-economic factors									
Gender (boys = 0; girls = 1)	0.09	0.231	0.02	0.747	-0.04	0.556	0.01	0.929	197
First time mother (yes = 1; no = 0)	0.04	0.546	0.14	0.046	0.05	0.531	0.01	0.846	197
Age of mother at birth ^a	0.11	0.121	-0.02	0.792	0.01	0.919	0.16	0.023	197
Maternal degree of education ^a	0.23	0.001	0.02	0.829	0.04	0.589	0.20	0.006	192
Income category (LOC low income = 1; high = 0)	-0.01	0.918	0.01	0.850	-0.05	0.493	-0.13	0.100	176
Symptoms of depression									
CESD averaged 6 to 60 months ^a	-0.14	0.046	-0.40	< 0.001	0.62	< 0.001	-0.16	0.023	198
School readiness at 60 months									
Lollipop test total score ^a	0.15	0.043	0.04	0.573	-0.12	0.126	0.03	0.702	174
Child-reported symptoms of mental disorders									
Dominic score separation anxiety ^a	-0.01	0.898	-0.02	0.785	< 0.01	0.971	-0.27	0.001	160
Dominic score major depressive disorder ^a	-0.15	0.068	< 0.01	0.988	-0.09	0.250	-0.21	0.010	158
Dominic score ADHD1	-0.16	0.044	-0.05	0.509	-0.04	0.597	-0.18	0.023	159
Mother-reported behavioural problems ^a									
CBCL score internalising problems ^a	-0.04	0.576	-0.24	0.001	0.38	< 0.001	-0.10	0.206	173
CBCL score externalising problems ^a	-0.11	0.151	-0.27	< 0.001	0.37	< 0.001	-0.15	0.042	173
CBCL total score ^a	-0.08	0.271	-0.27	< 0.001	0.42	< 0.001	-0.14	0.068	173

Abbreviations: ADHD, attention-deficit hyperactivity disorder; CBCL, child behavior checklist; CESD, Center of Epidemiological Studies Depression; LOC, low income category according to Stats Canada.

^aSpearman's rank correlation coefficients.

scales could indicate a more global perception of parenting by the mothers, whereas the behavioural observations are less correlated because these are (i) captured by different observers; (ii) in different situations that might be unnaturalistic and unrepresentative of the everyday behaviour at home¹⁴; and (iii) at a specific time point in development with different child needs and maternal responses.^{8,9} By contrast, the self-report measures may benefit from shared method variance. Second, maternal mood or personality traits might bias self-ratings, whereas this mood bias might not apply to the independent observer-rated behavioural patterns. Finally, this finding might be the result of a socially desirable response bias⁴³ (ie, mothers might try to provide a favourable image of themselves resembling their specific prototype of a “good” mother).

4.2 | Patterns underlying maternal parenting and their association with maternal characteristics and child outcome measures

We identified four factors that we described as *Supportive Parenting*, *Self-Enjoyment Parenting*, *Overwhelmed Parenting* and *Affectionate Parenting* (Table 1). One major factor that associated with all components of parenting was maternal symptoms of depression, which is consistent with previous studies.⁴⁴ This broad effect of depressive symptoms on maternal parenting, even in this non-clinical community sample, highlights the necessity of prevention and intervention programmes targeted at mothers at risk for depression. Furthermore, the finding that depression was also associated with the factors that were more strongly determined by the behavioural measures decreases the possibility of our findings being driven purely by a mood bias in the questionnaires. Moreover, there was no general increase in correlation between self-report and behavioural measures when statistically controlling for depressive symptoms (data not shown).

4.2.1 | Supportive parenting

Supportive Parenting was composed of high Positive Affective Involvement and Verbalisation, low Parental Negative Affect and Behavior, and low Insensitivity, Intrusiveness and Anxiety at 60 months, high Affirmative Parenting on the Etch-A-Sketch at 48 months, increased duration of Attention focused on the child and Instrumental Behavior at 6 months, as well as reduced duration of playing behaviour and, lastly, high Ainsworth ratings at 18 months, but not at 6 months. These measures assess behavioural aspects of maternal sensitive interactions that might reflect a mother's support for the cognitive development of the child. For example, mothers need to flexibly adapt their parenting behaviour during the Ainsworth Sensitivity assessment at 18 months, where the situation changes from a naturalistic interaction to a structured task, and ends with the mother focusing on completing questionnaires (ie, divided attention). This is in contrast to the 6 months Ainsworth assessment, when the mother is simply asked to interact with her infant as she normally would. Likewise, Affirmative Parenting during the

Etch-A-Sketch consists of the mother's supportive and encouraging behaviour of her child. The PCERA is measured at a time when the child starts attending school, when the mother needs to employ scaffolding strategies according to her child's level of development.⁴⁵ The loadings of these variables in combination with the BEST attention score suggests that this factor might reflect more cognitive aspects of maternal care, such as executive functioning (task shifting during 18 months sensitivity task), attention maintenance, and observation, evaluation and reinforcement of the child's actions, which is further highlighted by the correlation with maternal level of education.

In addition, *Supportive Parenting* correlated with school readiness of the child, such that children of mothers engaging in supportive parenting scored higher on this cognitive test at 60 months. This association was paralleled by reduced child self-report of ADHD symptoms, indicating some potentially positive effects of supportive parenting on child executive functions and modelling of appropriate social interactions. At the same time, a child with higher executive functioning could also elicit a more supportive parenting style by the mother, thus explaining this relationship.

4.2.2 | Self-enjoyment parenting

We identified *Self-Enjoyment Parenting* as a second factor in our data. We argue that mothers scoring high on this component liked to identify themselves as mothers and reported high relationship satisfaction with their children. However, these mothers also scored high on the Critical Assessment and the Physically Controlling scales during the Etch-A-Sketch task, which appears to be counterintuitive. We speculate that this factor assessed how much the mother enjoyed her role as a mother or wished to convey her enjoyment, perhaps with consideration for social desirability and performance, because maternal perfectionism was linked not only to higher levels of criticism, but also to higher levels of parenting satisfaction in previous studies.^{46,47} The loading of the EAS subscales suggest that these mothers prioritised reaching the goals of the task (drawing the house) compared to cooperating with their children. The finding that first time mothers scored higher on this component could indicate that they in particular enjoy parenting, although there might be at least some degree of attenuation of parenting enthusiasm with subsequent children. Unsurprisingly, mothers with more severe symptoms of depression may not be able to enjoy their children as much. Finally, there was an association between higher *Maternal Self-Enjoyment Parenting* and lower maternal reports on internalising and externalising symptoms. However, this correlation might have emerged as a result of a mood or social desirability bias in mothers with low or high enjoyment of mothering, respectively.

4.2.3 | Overwhelmed parenting

The *Overwhelmed Parenting* score was interpreted as such because it appears that mothers scoring high on this factor revealed maladaptive care regulation strategies, targeted to avoid negative impression on their social environment (external strategies). Furthermore,

overwhelmed mothers reported high levels of parenting stress and dysphoria, and engaged less in verbal guidance during the Etch-A-Sketch cooperation task. We argue that mothers who apply external motivational strategies could be more susceptible to parenting-related stress because of their concern with external judgment of parental adequacy. Overwhelmed mothers also reported significantly increased levels depression, which might contribute to their high levels of parenting stress and maternal dysphoria.⁴⁴ Mothers who scored high on this component also scored low on the *Self-Enjoyment* factor, indicating that they were less able to enjoy motherhood.

Although suboptimal parenting related to increased maternal stress and symptoms of depression have been discussed as a risk factor for behavioural problems in children, we did not find an association with child cognitive outcomes or with the child reports on their psychopathology. However, more overwhelmed mothers perceived their children as having more internalising and externalising problems at 60 months, suggesting that our results are consistent with these previous reports.^{25,40,44,48} The inverse association of Overwhelmed Parenting with Affectionate Parenting suggests that mothers feeling more overwhelmed as a parent were also less affectionate.

4.2.4 | Affectionate parenting

The *Affectionate Parenting* construct consisted of BEST duration for Communication, Playing and Instrumental Behavior (negative loading), Ainsworth Sensitivity Rating at 6 months, Etch-A-Sketch Affirmative Parenting, Physically Controlling Behavior, and Critical Assessment at 48 months (the two latter scores loaded negatively) and, lastly, CAQ Investment. Hence, the latent construct underlying this factor might reflect an early phenotypic trait of maternal parenting, mainly involving affective components. They appear to be motivated to invest resources, to communicate and play over longer periods of time, and to show less instrumental care. This latter loading is consistent with previous findings showing the discrepancies between affectionate and instrumental care.⁴⁹ Interestingly, this factor did not include the Ainsworth assessment at 18 months, which is a more challenging task for the mother and might thus involve more cognitive aspects of parenting (see above) compared to the affective components.

Mothers with high scores on the *Affectionate Parenting* factor were older and better educated, although the scores were not associated with income in this low-risk sample, which is consistent with previous studies.³⁹ Finally, the *Affectionate Parenting* factor was associated with lower child-reported mental health symptoms³ and less mother-reported externalising problems. These associations could also be explained in a transactional model, where sensitive mothers have more content and less irritable children, who in turn support positive interactions between mother and child.

4.3 | Parenting patterns

One of the few studies classifying maternal parenting behaviours was the meta-analysis by De Wolff and Van Ijzendoorn,¹ who categorised maternal behaviour into four (Sensitivity, Contiguity of Response,

Physical Contact and Cooperation) or five clusters (Synchrony, Mutuality, Emotional Support, Positive Attitude, Stimulation). Although they used a team of experts in the field of attachment research to categorise mostly observed maternal behaviours, we applied a data-driven approach including behavioural observations and self-reports. The clustering of instruments that we obtained in this study might not be directly comparable to the results from De Wolff and Van Ijzendoorn.¹ Thus, we suggest that our findings provide a classification of maternal parenting that is complementary to the expert-derived clustering reported in De Wolff and Van Ijzendoorn.

Similar to our study, Zaslow et al.¹⁷ studied parenting using different methodologies, including self-reports, naturalistic home observation of a mother-child interaction, and a structured observational measure of parenting. They also found that, although the manifest variables were correlated, the correlations across the three methodologies were weak. Similarly, Tarabulsky et al.⁴¹ found a common component from mother- and observer-rated Attachment Q-Sort measures, as well as the residual scores. Although the common variance and the residual scores were all associated with maternal sensitivity, the residual scores for mother and observer followed a divergent pattern of associations with ecological variables, such as infant irritability, parental stress and psychosocial risk related to being an adolescent mother, which parallels our findings. At the same time, Lohaus et al.⁵⁰ identified a unidimensional construct underlying different indicators of maternal sensitivity at 3 and at 12 months, although the stability between the two assessments was low, suggesting different trajectories in maternal parenting.

In sum, our data-driven approach demonstrated that parenting consists of multiple domains, with high inter-individual variation in maternal parenting patterns, as illustrated in the Supporting information (Figure S2). Thus, from a psychosocial perspective, as well as from a data-driven perspective, the simplistic classifications of a “good” or “bad” mother does not hold.

The factors, in combination with their predictive value for child outcomes, might support the planning of interventions targeting at-risk families. To identify children potentially at risk, one must first specify the developmental domain (eg, problems related to emotional, cognitive, or behavioural development), prior to determining what specific aspect of maternal parenting should be assessed. Moreover, interventions should target specific maternal parenting components, again, depending on the child's area of concern. This could be achieved by either measuring different key features in each component, or predictors of a component, aiming to first determine areas of potential parenting problems, or by evaluating a child's areas of concern (eg, problems in school, internalising or externalising behaviour). Upon evaluation of a potential risk area, different intervention strategies could then be applied. For example, mindfulness training might support affectionate parenting,⁵¹ whereas cognitive-behavioural therapy might reduce stress and the feeling of being overwhelmed.^{52,53} Supportive parenting might be encouraged by psychoeducation and direct training of the mother on how to engage in positive interactions with the child.^{53,54} Finally, mothers reporting high levels of depression might benefit from a pharmacological

intervention and/or psychotherapy treatment either in person or web-based video-conferencing with positive changes in multiple domains of parenting.⁵⁵⁻⁵⁷ Parenting interventions that apply multiple strategies might be particularly successful in improving the mother-child relationship and have been associated with changes in maternal brain activity and circuits.⁵³

4.4 | Neuroendocrinology of parenting

From a neuroendocrine and parental brain perspective, we speculate that the described factors of parenting might be related to distinct brain areas, such as the cortex, the mesolimbic system or the pre-optic area,⁴ as well as particular endocrine systems, such as the oxytocinergic, dopaminergic or glucocorticoid system. For example, *Supportive Parenting* might be linked to cortical brain structures involved in executive functions, such as attention, decision-making and planning,⁵⁸ and may involve dopaminergic and oxytocinergic systems.⁵⁹ At the same time, the strong association between depression and the *Self-Enjoyment Parenting* score could indicate an overlapping involvement of the dopaminergic reward pathway, which has been associated with complex maternal behaviours, as well as symptoms of depression, and might thus be an important neurobiological determinant of this particular component of maternal parenting.⁶⁰ Also, the anterior cingulate cortex and amygdala may be involved both in the depressive symptoms and in the self-monitoring of socially desirable responses in the *Self-Enjoyment Parenting* score.⁶¹ Maternal symptoms of depression were also linked with *Overwhelmed Parenting*, which might indicate that feeling stressed and depressed could lead to higher levels of cortisol, which affects multiple brain regions and hormones, including oxytocin- and dopamine-related pathways.⁶²⁻⁶⁴ Finally, based on evidence that the oxytocinergic system is a key driver in affectionate mother-child bonding, and also that oxytocin signalling in the medial pre-optic area is linked to the initiation and maintenance of maternal care,⁶⁵ we argue that oxytocin might be a major neuroendocrine determinant of the *Affectionate Parenting* component. However, these are currently just speculations; the neuroendocrinology and brain processes underlying parenting components must be investigated in future studies.

4.5 | Strengths and limitations

To the best of our knowledge, this is one of the first studies directly and comprehensively examining and characterising maternal parenting using a data-driven approach to analyse self-report and behavioural data. The present study has several strengths. First, we not only included different self-report and observational instruments covering a broad developmental period, but also assessed different aspects of maternal parenting at appropriate time points. Thus, the present study provides one of the more comprehensive pictures of maternal parenting across the first 5 years after birth. Second, we mostly used non-parametric approaches that might yield more reliable results for data sets consisting of multiple instruments and different data distributions with potential outliers. Finally, many of our results are exploratory and thus hypotheses-generating, providing

ground for future research questions. These research questions could include the exploration of predictors for the different factors of maternal parenting, such as early-life experiences, relationship with the partner, social support, socio-economic environment or stress experiences, or the relevance of these factors for additional or more specific child developmental outcomes. Because maternal behaviours might be guided by different hormonal and neuronal systems that act at different stages of maternal care,¹¹ it might be of great value to investigate the biological underpinnings of maternal behaviour, such as brain activity (with special focus on the mesolimbic system, pre-optic area, the amygdala and the cortex⁴), genotype, epigenotype and maternal hormonal levels of candidate systems.

The present study also has several limitations. First, the self-rating measures could be biased by current maternal mood. Indeed, we found that maternal symptoms of depression were correlated with all of the factor scores. Nevertheless, we argue that maternal mood, including subclinical symptoms of depression, is an important determinant of a mother's parenting attitude and parenting skills.²⁵ Moreover, the factors were defined by both observational and self-report measures, excluding the possibility that all instruments were mood-biased. Second, the focus was to characterise maternal behaviour and it was beyond the scope of the present study to closely and extensively investigate predictors of maternal parenting or how maternal parenting factors predict child outcomes. Also, we did not investigate a transactional model in which maternal parenting affects child behaviour, which reciprocally affects maternal parenting. The preliminary analyses aimed to illustrate that the factor scores are meaningful for different areas of child developmental outcomes. Third, we did not include a characterisation of paternal parenting or other caregivers, which was the result of the low compliance of fathers, as well as the reduced amount of data collected on fathers in the MAVAN project. However, parenting by fathers might not only relate to maternal parenting, but also compensate for an adverse maternal parenting style.⁶⁶ Fourth, we did not measure how the children perceived their mothers, which would add an interesting third perspective to maternal parenting. Fifth, the discrepancy between self-report and behavioural observations might be as a result of common-method variance across the different measures of maternal parenting. Sixth, the low amount of variance explained by the four factors might bring into question their relevance. We would argue that the results highlight the complexity of the maternal phenotype with many different aspects, even beyond those described here, and also that our results illustrate how different aspects of maternal parenting might relate to different child outcome measures, which could guide future hypotheses. Finally, the results are not generalisable at the current stage, especially given the relatively small sample size and large number of variables. Additionally, there were many missing data points (Figure 2) as a result of study sample attrition or the unavailability of video material for behavioural observations, or missing questionnaire data. This was an exploratory factor analysis, which strongly depends on the variables and sample characteristics. For example, our sample was of slightly higher than average socio-economic status on measures of both family income and education, with

the latter being associated with *Supportive Parenting* and *Affectionate Parenting*. Moreover, our sample consisted of over 80% Caucasians living in eastern Canadian cities and thus our findings cannot be generalised to other cultures or mothers living outside eastern Canada. Hence, replication in additional cohorts, especially those of lower socio-economic status, as well as those that are less urban or in other cultures, is warranted to increase the generalisability of our findings. Nevertheless, compared to previous studies categorising parenting constructs on theoretical grounds, the present study provides a first data-driven approach to categorise different measures of maternal parenting and how they cohere across time.

5 | CONCLUSIONS

Maternal parenting is a highly complex phenotype with strong variation among mothers. Self-report measures associate mainly with other self-report measures, whereas behavioural data associate with other behavioural data. However, across the two assessment methods of maternal parenting, there was some overlap between instruments, suggesting that different instruments assess related aspects of maternal parenting, at least to some degree. Our findings suggest four interpretable components of maternal parenting, including *Supportive Parenting*, *Self-Enjoyment Parenting*, *Overwhelmed Parenting* and *Affectionate Parenting*.

Taken together, the notion of “bad parenting” is not useful and the complexity of maternal care requires a more nuanced level of assessment and analysis. On the one hand, we advise administering both self-report and behavioural instruments if the goal is to obtain a more complete assessment of maternal parenting. On the other hand, our findings might guide the selection of relevant instruments in studies on the maternal brain and neuroendocrinology, maternal wellbeing, parenting, and child developmental outcomes.

The next steps are to identify what governs these different factors of maternal parenting and to relate them to other measures of child health. Replication of our results in independent cohorts, as well as consideration of the relevant follow-up questions, will be essential for guiding interventions that aim to improve maternal wellbeing and the mother-child relationship.

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CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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