Early Childhood Research Quarterly 66 (2024) 255–268

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

journal homepage: www.elsevier.com/locate/ecresq

Talking, praising and teaching: How parent interaction during a learning task relates to children's early learning

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ARTICLE INFO

Keywords:
Parent-child interaction
Early learning
Socio-emotional functioning
Behavior
Cognitive development

ABSTRACT

The foundational skills that children begin formal schooling with are subject to persistent inequities, and can have long-term academic, occupational and health consequences. Early learning is conceptualised as encompassing social, emotional, behavioral and motor functioning in addition to more traditional formal academic skills. Within a large, diverse, longitudinal child cohort - *Growing Up in New Zealand* - the aims of the current study were to examine: (1) how multiple indicators of children's social, emotional, behavioral, motor and cognitive development relate to one another at age four years prior to beginning formal schooling; and (2) whether parent behavior during an observed writing interaction at age 4 was associated with these early learning factors. Children (n = 4,697) and their primary caregiving parent were visited at home and completed the interactive writing task. Children completed direct assessments of language, executive functioning, self-regulation, writing (name and numbers) and emotion knowledge. The parent reported on the child's language, motor skills and social, emotional and behavioral functioning. Exploratory Factor Analysis indicated four early learning factors: literacy and numeracy skills; oral language and regulation; behavior difficulties; and interpersonal and motor skills. After controlling for multiple covariates, hierarchical regression analyses indicated that parent verbalisations during the writing interaction task predicted small but significant variance in children's early learning across all four factors. The current findings support holistic models of early learning and demonstrate associations with parent verbalisations during learning-based interactions.

1. Talking, praising and teaching: How parent interaction during a writing task relates to children's early learning

In our information-rich society, the need to become literate and numerate at a young age has become emphasised. Basic literacy and numeracy are a universal human right – skills that should be available to every child in the world (Britto, 2012). Children are developing literacy and numeracy skills from early childhood, as a result of their everyday interactions with adults and older siblings in literate environments (McNaughton, 1995; Yelverton & Mashburn, 2018), well before they enter formal schooling and receive explicit instruction in literacy and numeracy. These early literacy and numeracy skills lay the foundation for children's school engagement and achievement (Duncan et al., 2007; Greenwood et al., 2017), so it is critical to understand individual differences in these skills, and how they evolve in early childhood. The current research is focused in particular on development in the latter preschool years just prior to beginning formal schooling.

These foundational skills are often referred to as *school readiness*; here we instead adopt the term *early learning* to acknowledge the importance of these skills during early childhood, not simply after children transition to formal schooling. We also use the term early learning to reflect the importance of the home and education environment for children's learning prior to the commencement of formal schooling. The term school readiness can also imply a threshold or developmental stage that children meet, beyond which they are ready for school, when in fact readiness reflects the family and school's

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https://doi.org/10.1016/j.ecresq.2023.10.001
Received 17 October 2022; Received in revised form 12 September 2023; Accepted 5 October 2023
Available online 9 November 2023

readiness, in addition to an individual child's development (Stipek, 2002; Winter & Kelley, 2008). As an example of the school's readiness for the child, there is meta-analytic evidence that teachers have more positive expectations and direct more positive speech towards European American students compared with Latino/a and African American students (Tenenbaum & Ruck, 2007). These ethnic and gender inequities in teacher perceptions are also found in the New Zealand context (Rubie-Davies & Peterson, 2016).

Contemporary approaches emphasise a multidimensional approach - beyond early literacy and numeracy – to predicting children's later school achievement (Winter & Kelley, 2008). Among the most prominent of these skills are in the oral language and executive functioning domains (Duncan et al., 2007; Forget-Dubois et al., 2009), with socio-emotional and motor domains also theorized to contribute (Duncan et al., 2007; Pagani et al., 2010). In the oral language domain, children's vocabulary knowledge and higher-order narrative skills are critical for their later reading comprehension (Dickinson et al., 2010; NICHD Early Child Care Research Network, 2005; Reese et al., 2010; Suggate et al., 2018). Children's phonological awareness – their ability to detect individual speech sounds – also predicts early print decoding skills (Shanahan & Lonigan, 2010). In the executive functioning domain – which describes a heterogeneous set of cognitive processes involved in regulation and management of behavior (Wasserman & Wasserman, 2013) - children's attention, working memory, and inhibitory control skills are vital for staying on task (Shanahan & Lonigan, 2010). In the socio-emotional domain, children's ability to regulate their behavior and their emotions is critical for positive interactions with others and for ease of learning in a classroom situation (Webster-Stratton et al., 2008). In the physical domain, children's motor skills are recognised as important for early learning. Specifically gross motor skills – involving the body's larger muscles – support children's physical and social competence, which are integral to many learning activities in the school setting; and fine motor skills – involving smaller coordinated muscle movements –predict children's tasks such as writing and drawing which are integral to many of the formal academic tasks in the school setting (see Cameron et al., 2012 for a review).

Much of the existing research focuses on American children (but see Pagani et al., 2010; Wolf et al., 2017) and relatively few studies examine children's early learning across multiple domains. Given the importance of the sociocultural environment for early learning (Lee et al., 2013), it is vital to expand the scope of early learning research to other countries with different early learning contexts (e.g., types of early childhood education and care, the policy landscape, and home learning approaches), to a greater diversity of cultural groups and to consider multiple dimensions of early learning. In particular, while high quality learning interactions have been associated with more positive child outcomes, further research is needed to understand the specific strategies that support child early learning (Winter & Kelley, 2008). Our focus of the study reported here is to examine how parent-child interactions are associated with early learning. Early learning is examined for children who are part of a large inter-disciplinary cohort, *Growing Up in New Zealand*, which has direct measures of child functioning across multiple domains.

2. New Zealand as a site of early learning research

New Zealand is an informative context for the study of children's early learning for several reasons. First, it is a small but diverse population comprising distinct cultural and language groups, which include New Zealand European (70 %) as well as Indigenous Māori that comprises approximately 16.5 % of the total New Zealand population, but a greater proportion of children and young people (27.5% of those under the age of 5 years). The other major ethnic groups are the heterogenous Pacific (8 %) and Asian (15%) populations (Stats NZ, 2018). The most widely spoken language in New Zealand is English. Te Reo Māori, New Zealand's Indigenous language, is an official language, as is New Zealand sign language. An estimated ten percent of New Zealand preschool children speak Te Reo Māori, with Samoan (5 %), Tongan (4 %), Mandarin (3 %) and Hindi (3 %) the next most frequently spoken (Morton et al., 2017).

Second, New Zealand has a national early childhood curriculum – Te Whāriki – that is explicitly play-based and sociocultural in focus, with learning experiences highlighted through reciprocal and responsive relationships for children with people, places, and things; rather than more 'academic' instruction (Ministry of Education, 2017). At 9 months of age, 35 % of children in the current cohort had regular childcare and this increased to 56 % at age 2 years (Morton et al., 2014). For 3- and 4-year old children, in part due to a 20 h subsidised Early Childhood Education (ECE) policy, participation in ECE is nearly universal at around 94 % enrollment in a formal learning environment (Education Counts, 2019). ECE comprises a range of options, from centre-based and half-day preschool (called "kindergarten"), to home-based and Indigenous language immersion settings (see Bird et al., 2016 for more details). All of these ECE types that are subsidized are informed by Te Whāriki. As such, the predominant underlying framework for ECE is play based, even if in practice formal instruction does vary across centres and settings.

Third, the recommended age of entry into primary school is the child's fifth birthday, and most children do begin primary school – and formal reading instruction – on that day or soon after (Morton et al., 2018). Thus, it is easier in New Zealand than in countries with set school entry dates (e.g., at the beginning of the year or beginning of each term) to differentiate between the contribution of children's age and the contribution of formal instruction to their early learning skills. Due to the explicitly non-academic focus of the early childhood curriculum, the individual variation in children's early learning before they begin primary school can be more clearly attributed to informal activities in ECE, and/or – of most relevance to the current research - to formal and informal teaching activities with parents and family members at home. Thus, we argue that New Zealand is an excellent setting in which to assess the role of the home environment in children's early learning skills (Neha et al., 2020).

3. Contributors to early learning in ECE and at home

In the following review, we describe the international research on how parents and ECE teachers support children's early learning in each of these five domains: oral language; literacy/numeracy; executive functioning, regulation and behavior; socio-emotional; and motor development. We situate these findings in the New Zealand context.

3.1. Oral language development

We define oral language development as including vocabulary, narrative, and phonological awareness (understanding of individual speech sounds) skills. Large bodies of correlational research now exist demonstrating that the quantity and quality of adults' speech to young children, especially their turn-taking with toddlers, predicts children's vocabulary development (Hart & Risley, 1995; Gilkerson et al., 2018; Hirsh-Pasek et al. 2015; Rowe, 2012). A great deal of correlational and experimental research has now also isolated specific types of adult-child interactions that are especially facilitative of children's vocabulary and narrative skills, such as shared picture book reading (see Reese, 2019 for a review; Hindman et al., 2014; Senechal & LeFevre, 2002) and decontextualized talk about past and future and about rare words (Cristofaro & Tamis-LeMonda, 2012; Demir et al., 2015; Dickinson & Tabors, 2001; Reese, 1995; Reese et al., 2010).

These same effects are apparent in studies reporting data from New Zealand samples. In smaller scale studies with New Zealand European and Māori families, researchers are finding similar patterns, to those reported in the international literature, for parents' and teachers' book-reading styles (Carroll et al., 2014; Neha et al., 2020; Phillips & McNaughton, 1990; Robertson & Reese, 2017). Research conducted in

New Zealand has also replicated the importance of matching the book-reading style to preschool children's age and language level for optimal vocabulary and narrative development (Reese & Cox, 1999; Riordan et al., 2018).

In novel extensions of international research, New Zealand mothers who were coached to use more open-ended elaborative questions and praise, when talking about the past, had children with advanced narrative skills one year later in comparison to a control group (Reese & Newcombe, 2007). These same features of talk about the past (elaborations and praise) were also correlated with children's early learning in a sample of New Zealand Māori families (Neha et al., 2020), and with children's complex language in a sample of New Zealand early childhood teachers (Reese et al., 2021). Moreover, New Zealand parents' sound talk (i.e., comments on rhyming, sounding out words) during toy play is correlated with children's advanced phonological awareness (Reese et al., 2015).

3.2. Early literacy and numeracy development

Phonemic awareness and letter recognition are considered the main indicators of early literacy in the preschool years, rather than actual reading of words (Bodrova et al., 2000; Petscher et al., 2020; Shanahan & Lonigan, 2010). Similarly, a range of numeracy skills develop during the preschool years that form the foundation for later mathematics development. These numeracy skills include understanding of numbers and counting, concepts of measurement, shape and space, and recognition of patterns (Litkowski et al., 2020).

In contrast to the predictors of oral language development, the practices that support children's early literacy and numeracy skills often involve explicit teaching of letters and numbers. For instance, Senechal and LeFevre (2002) noted that only parents' report of direct teaching of letters and print, and not their reported frequency of shared book-reading, predicted children's later letter recognition and early decoding efforts. However, when parents and teachers are taught to talk explicitly about print in the context of picture book reading, children progress faster in their letter recognition skills (Justice & Ezell, 2000; Justice et al., 2009). Parents' and teachers' direct teaching of numbers and of counting also appears to support young children's growing numeracy skills as shown in correlational and experimental studies (see Elliott & Bachman, 2018 for a review).

Parents' less direct learning activities also support children's early literacy and numeracy skills. Activities identified as especially supportive include playing board games, shopping and preparing food, writing, and talking about decontextualized events (Leyva & Skorb, 2017; Leyva et al., 2012; Reese, 1995; Skibbe et al., 2013; Niklas & Schneider, 2014). All of these activities typically involve counting, writing, and/or talking about metacognitive processes (about letters, numbers, time, thoughts, memories). These activities have been more difficult to capture in research studies but may be equally important to formal teaching for children's literacy and numeracy.

Many of these findings, reported in the international literature, are evident in New Zealand research about children's early literacy and numeracy. Across diverse cultural communities, parents who report explicitly teaching letters and numbers with their children, and who engage in informal conversations about decontextualized events, have children with more advanced literacy and numeracy skills (McNaughton, 1995; Neha et al., 2020). Parents who talk specifically more about print and sounds when reading a rhyming book have children with more advanced letter recognition and phonological awareness skills (Riordan et al., 2018). A parent book-reading intervention focused on word sounds was associated with increases in child talk during book-reading, as well as letter and phoneme knowledge (Riordan, Reese, Das, Carroll, & Schaughency, 2022). Parents who report encouraging their pre-schoolers to count and recognise numbers more frequently have children with better counting skills compared to those who do not report this interaction (Bird et al., 2019).

3.3. Executive functioning, regulation and behavior development

Parents and teachers can support children's growing attention, working memory, and inhibitory control skills by setting clear limits and expectations for children's behavior in a warm and supportive environment (e.g., Webster-Stratton et al., 2008). Specifically, parents and teachers enhance children's behavioral regulation when they set clear limits for children's behavior (Kaehler, Jacobs, & Jones, 2016). Within the New Zealand context, Healey and Healey (2019) conducted a randomised controlled trial where parents of preschool children with attention difficulties were coached in playing games that supported children's executive functioning. Children of parents who completed the play coaching showed equivalent gains in their parent-rated assessments of attention and behavior difficulties to children whose parents participated in a positive parenting programme (Healey & Healey, 2019). International parenting programmes show similar positive effect sizes with improvement in behavior, attention and regulation within the New Zealand context, and these associations have been demonstrated for both Māori and non-Māori families (Fergusson et al., 2009).

3.4. Socio-emotional development

Teachers of early school age children spearheaded recognition of the importance of children's socio-emotional functioning; including a capacity to communicate and resolve conflicts with others and to regulate one's own behaviour (Thompson & Raikes, 2007). Children who experience positive relationships with their peers and teachers in the school setting and have more advanced emotion understanding may be more compliant and engaged in classroom activities and therefore better able to learn (Thompson & Raikes, 2007). Many of the same practices that support children's learning in other domains have been found to also support their socio-emotional development. To support children's understanding of emotion, it appears necessary for parents and teachers to explicitly label and discuss children's emotions, particularly by focusing on the causes and consequences of negative emotions. These conversations appear most effective when they take place after the negative emotion has subsided, and when parents use open-ended questions and praise to elicit children's talk about the past emotion (see Salmon & Reese, 2016). A large proportion of this research has been conducted in New Zealand and Australia (Bird & Reese, 2006; Reese et al., 2007; Taumoepeau & Ruffman, 2006, 2008; van Bergen et al., 2009).

3.5. Motor development

Children's motor development has also been theorized to play a part in their readiness for early learning (Morrison & Hindman, 2012; Pagani et al., 2010; Wolf et al., 2017). Gross motor skills are an important dimension of children's physical well-being (Wolf et al., 2017). Critically, motor difficulties often co-occur with language and behavioral difficulties (Gaines & Missiuna, 2006; Dewey, 2018).

Motor development may facilitate social and emotional development in learning settings (Pica, 2006; Wright et al., 2019). Fine motor skills are typically seen as an important component of readiness for formal schooling (e.g., capacity to hold a pen; Suggate et al., 2016; 2018). Within the New Zealand context for children at school entry, fine motor skills have been associated with prosocial behaviour (Sargisson, Powell, Stanley, & de Candole, 2014). Early gross motor development has been shown to predict school-age cognitive performance, independent of socio-economic status (Piek et al., 2008). Gross motor skills have been associated with child medical difficulties within the New Zealand context (Sargisson et al., 2014). Many contemporary studies of early learning, however, have neglected to measure children's motor development (e.g., Duncan et al., 2007).

4. Inequities in early learning

Inequities in early learning are well documented internationally and within New Zealand. As described above, these reflect the wider ecological systems surrounding the child, including socio-economic disadvantage, parental educational opportunity, systemic racism and the particular school setting(s) in which the child develops (Bronfenbrenner, 1977; Winter & Kelley, 2008). Bilingualism and multilingualism can also be viewed within a socioecological framework, with an individual's language use reflecting interactions with others, the wider learning environment, cultural values and social and policy systems (Titone & Tiv, 2023). Bilingual children are learning more than one language as well as multiple components within each language: oral fluency, reading, writing, and sociocultural aspects of language use. With time, knowledge in one component in one language can support development in other components and another language. However, for bilingual children developing English skills in the school setting, reading and writing are often focused on at the expense of oral language skill (Castro et al., 2011). Socioecological frameworks also highlight gender as constructed through interactions between the individual and their environment (Blackstone, 2003). Boys have historically been perceived as needing more maturational time to be 'ready' for school (Stipek, 2002) and are more likely to be reported as having behavioural concerns (Thompson & Raikes, 2007). Within the *Growing Up in New Zealand* longitudinal cohort, Reese et al. (2018) documented word gaps for New Zealand 2-year-old children as a function of socio-economic status (SES) and child sex that are similar to those reported in the international literature.

5. The present study

The primary aim of this study was to examine how the home learning environment – specifically parent interactions during a writing task - was associated with children's early learning indicators. We used data from a nationally representative, culturally diverse sample, longitudinal study, *Growing Up in New Zealand* (Morton et al., 2012). In order to undertake this analysis we utilised information on development and a parent observation task undertaken at the four-year-old interviews of *Growing Up in New Zealand* where interviewers were trained to observe and rate parents' behavior during a writing activity with their four-year-old child (co-construction of a 'birthday party invitation').

We chose to examine parent-child interactions during a writing task in particular because writing interactions may be especially important in the transition to school. Child writing reflects representational knowledge and an understanding that written symbols communicate meaning (Leyva et al., 2012). During the later preschool years, parent encouragement of writing is a frequent form of home learning. This includes teaching children to write their name, writing during board games, making cards and sending letters and writing or checking off lists (LeFevre et al., 2009; Richgels, 1995). Parental assistance during a writing interaction has been related to child writing skill (Leyva et al., 2012), letter sound knowledge (Neumann et al., 2012) and child reading ability (Aram et al., 2017).

We predicted that parents' teaching techniques (i.e., print talk) during the writing task would be associated with children's literacy and numeracy skills. We also predicted that less teaching-specific aspects of parents' interactions (i.e., their use of open-ended questions and praise) would predict multiple domains of early learning, especially children's oral language and socio-emotional skills.

We also aimed to examine children's early learning with multiple measures across multiple domains. While most contemporary models of early learning or 'school readiness' emphasise the interaction of competency across multiple domains, the extant empirical literature typically includes detailed assessments within specific areas. In this cohort, Neumann et al. (2021) identified specific cognitive factors at different preschool timepoints: at age 9 months children's non-verbal, verbal and motor skills loaded on a single factor; at age 2 years a joint attention and a separate attention and motor factor were identified and at age 4½ years receptive vocabulary and inhibitory control loaded on one factor, with more formal learning skills loading on a second factor. Building on these findings, this study presents a unique opportunity to examine how multiple indicators of children's social, emotional, behavioral, motor and cognitive development relate to one another prior to beginning formal primary schooling at age five years.

Based on existing research we predicted that the factor structure would reflect a more formal literacy/numeracy skill factor as well as a factor involving executive functioning (Duncan et al., 2007). We also predicted that social functioning (prosocial behaviour and a lack of peer problems) would form a factor with emotion knowledge and self-regulation. We predicted that early learning factors would be associated with parental education, child sex and bilingualism. Consistent with what has been described in the international research, we predicted advantages for girls and for children of parents with higher education. Given the evidence for both advantages and disadvantages to bilingual children's early learning, no a priori predictions were made regarding child bilingualism.

6. Methods

6.1. Participants

Women (n = 6,822) were enrolled during their pregnancy into the *Growing Up in New Zealand* study. Pregnant women were eligible if they had an estimated delivery date between 25 April 2009 and 25 March 2010, and resided in a defined geographical region of New Zealand selected for its ethnic, socioeconomic and geographic diversity. The child cohort (n = 6,853) included 11% of the national birth cohort during the recruitment period. The characteristics of the cohort at birth were broadly generalisable to the contemporary New Zealand birth cohort (2007-10) (Morton et al., 2015).

For this study, participants were the 4,697 children and their primary caregiving parent who were part of the *Growing Up in New Zealand* pre-birth longitudinal cohort, and for whom there was complete data for all of the observational and parent-report measures at the four year interviews included here and for all of the *Growing Up in New Zealand* data collection waves. The mean age of mothers (during pregnancy of the cohort child) in our sample was 30.51 years (SD = 5.81). Further socio-demographic characteristics of our sample are shown in Table 1.

6.2. Procedure

Face-to-face data collections occurred during the third trimester of pregnancy (antenatal), and at child ages of 9 months, 2 and 4 ½ years. Data for the current study is primarily drawn from the 4 ½ year data

Table 1
Characteristics of the current sample.

	Mean (Standard deviation)	Number (%)
Maternal age	30.51 years (5.81)	
Highest maternal education		
High school		1282 (27)
Diploma / Trade		1421 (30)
University		1984 (42)
Maternal ethnicity		
European		2849 (61)
Māori		574 (12)
Pacific		552 (12)
Asian		565 (12)
MELAA* and Other		141 (3)
Child sex		
Female		2356 (50)
Male		2341 (50)

* MELAA = Middle Eastern, Latin American or African ethnic group

collection wave, with socio-demographic data from the antenatal timepoint. At age 4 ½ years, children and their parent were visited at home with the interaction assessed by interviewers specifically trained for this purpose. Parent-report data was collected via computer-assisted interviews. Child observation tasks and parent-child interaction data was entered electronically at the time of collection.

6.3. Measures

6.3.1. Parent-child writing interaction: Birthday party invitation

Using a well-established task, parents were asked to help their child make a birthday party invitation (Aram, 2002). Often, parents and children are provided with a blank piece of paper for this task, and children are in their early school years. Because none of the children in our sample had yet started formal schooling, they were provided with an invitation template with lines in English for: *to, date, time* and *place*. Dyads were given approximately 5 minutes to work on the invitation (Luo et al., 2011).

Coding: Typically this task is recorded, and subsequently coded for behaviors of interest. Due to time and logistical constraints of recording a sample of over 5,000 dyads, interviewers were trained to code in-vivo for specific behaviors in time intervals. Interviewers ($n = 30$) attended a training day where they were introduced to the rationale for observing parenting behavior and the specific constructs being coded, which included pre-recorded examples. Interviewers then completed reliability on a set of pre-prepared recordings (of mothers and preschool children completing a similar task) and were required to reach ≥ 80 % reliability with expert coders before going into the field. This procedure was also used for a parent-child interaction task at the 24-month data collection wave (for a full description of the rationale and reliability training procedure, see Reese et al., 2016).

Previous research with the birthday party invitation task has coded for the following maternal interaction constructs (Aram, 2002; Aram & Levin, 2011; Aram et al., 2016): phoneme support; print support; reinforcement; praise and competence; demand (or lack of) for precision; organisation of task; choice or autonomy; and elaboration on the task (i.e., discussion of other related events). It is clearly not feasible for a single interviewer to be able to reliably code all of these constructs concurrently, in vivo. Interviewers were therefore trained to code for the specific observed parent behaviors within a time-sampling approach. Interviewers coded for a single behavior within successive 30-second time periods: open-ended questions, print talk and praise and encouragement (see Fig. 1).

6.4. Early learning indicators from age 4 ½ years

6.4.1. Strengths and difficulties questionnaire (SDQ; Goodman, 1997)

The SDQ is a widely used screening tool for early problem behaviors. The SDQ contains 25 items, rated on a 3-point Likert scale from 0 ‘not true’, 1 ‘somewhat true’ to 2 ‘certainly true’. Five items each correspond to four ‘problem’ subscales (emotion symptoms, conduct problems, hyperactivity and peer problems), and one prosocial behavior subscale. The SDQ is used internationally and has good reported sensitivity and specificity (Warnick, Bracken, & Kasl, 2008). Previous analyses with this cohort have shown the validity of the SDQ for the reporting of behavior of 2-year-old children by both mothers (D’Souza et al., 2017) and fathers (D’Souza et al., 2019). Note, each SDQ subscale usually contains five items, but due to an administrative error only four items of the conduct problems subscale were administered. The ‘often fights with other children and bullies them’ item was missing. Conduct problem subscale scores were therefore prorated based on responses to the four administered items. Cronbach’s alpha’s were moderate (α range = 0.63-0.72), but low for peer problems (α = 0.55) and conduct problems (α = 0.47). However, mean inter-correlation coefficients for each subscale were ≥ 0.20 (Piedmont, 2014).

6.4.2. Abridged peabody picture vocabulary test-third edition (a-PPVT)

The PPVT-III (Dunn & Dunn, 1997) is a widely used measure of receptive language, with 204 possible test items and validated norms from ages 2 to 90 years. For each item, children are presented with four pictures on a single page and asked to point to the picture that corresponds to the spoken word (e.g., “Please point to *ball*”). In an effort to achieve a valid measure of children’s receptive language within a large national cohort study, the Longitudinal Study for Australian Children (LSAC) adapted the PPVT-III for use with their age 4-year data collection. LSAC administered the full PPVT-III to 215 4-year-old children,

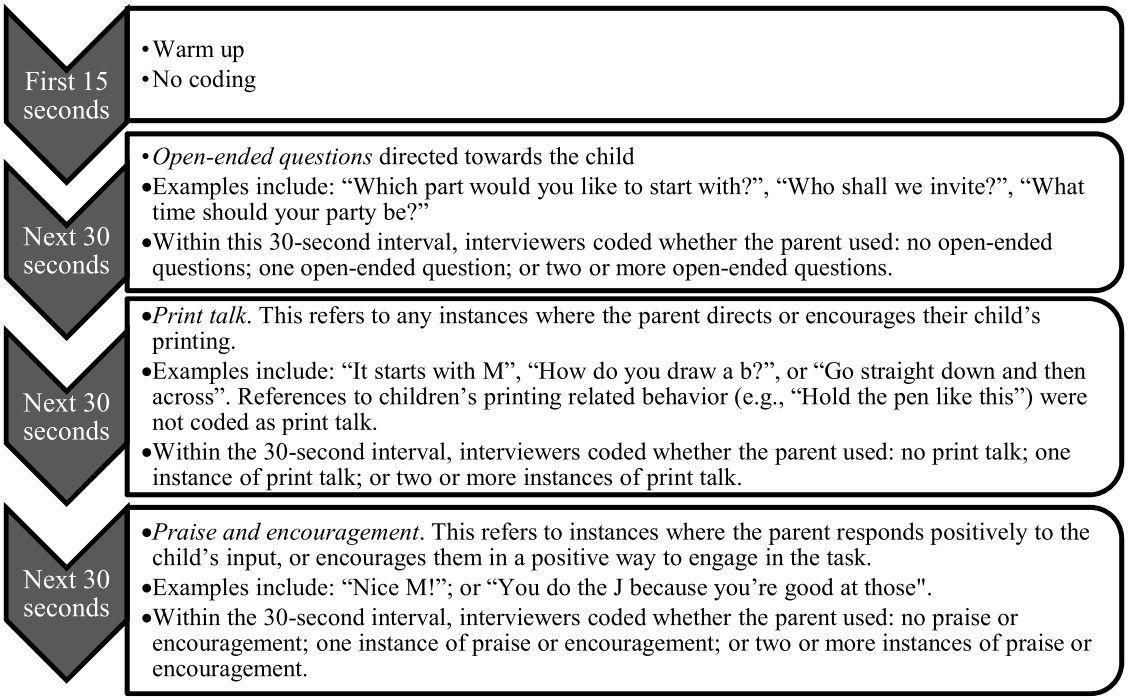

Fig. 1. Interviewer in vivo time-sampling coding for the parent-child writing interaction.

using standard testing procedures. They identified the 40 'best' items for use in a shortened version. These items fit into a one-parameter item response model with the person separation reliability only decreasing from 0.88 for the full PPVT-III to 0.78 for the abridged PPVT-III. The Pearson correlation between the full and abridged versions was 0.93 for all children, and 0.91 for 4-year-old children (Growing Up in Australia, 2019). This 40-item abridged version, together with two test items, was used in the current study. Z-scores on this task are used in subsequent analyses.

6.4.3. Parent rating of oral language (PROL)

The PROL was adapted with permission from the widely used Teacher Rating of Oral Language and Literacy (TROLL; Dickinson et al., 2003) scale. The PROL contains five items tapping children's informal, day-to-day use of language: (1) Which of the following best describes [child's] pattern of asking questions?; (2) How often does [child] try out new words?; (3) Which of the following best describes [child's] ability to communicate questions in a clear and logical way?; (4) How often is [child] understandable when speaking to adults other than you or other family members?; and (5) Which of the following best describes [child's] ability to communicate when s/he is not first understood? Parents rated each item on a 4-point Likert scale, and possible total scores ranged from 0-15. Cronbach's alpha for the PROL scale was 0.61, demonstrating moderate internal consistency (Taber, 2018).

6.4.4. Letter naming fluency

This task is part of the standardised Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminski, 2002), designed to screen for children at risk of reading difficulties during the early years of schooling. Children are presented with a page of upper- and lower-case letters (arranged in random, not alphabetical, order) and asked to name as many letters as they can within one minute. While not a direct test of reading ability, children's early letter knowledge is related to future reading acquisition (Cameron et al., 2020a; Cameron et al., 2020b; Foulin, 2005). Due to variable distribution, letter naming fluency total scores were categorised into four categories based on quartile splits.

6.4.5. Writing: Name and numbers

This task is a component of the "Who Am I?" developmental assessment tool (De Lemos & Doig, 1999). Children were asked to 'write [their] name', and 'write some numbers'. Children were not limited in the specific numbers they could write, or how many. In contrast to the other tasks which were scored or coded in vivo, children's responses were collected and subsequently scored by a trained researcher. Separate scores were given for writing name and writing numbers, with both ranging from 0 to 4. A score of 0 indicated no response or no recognisable numbers/letters from the name. A score of 1 indicated a scribble with no recognisable letters or numbers. A score of 2 indicated some recognisable letters / at least 1 number. A scores of 3 indicated a recognisable name but with errors (e.g., letters very poorly formed, name written in reverse); more than one number and numbers only. A score of 4 indicated a recognisable name, with letters generally clear/several numbers clear.

6.4.6. Counting: Forwards and backwards

Children were asked to count up from 1 to 10, and to then count down from 10 to 1. Responses were recorded and a score of one given for each number in the correct position, with possible total scores ranging from 0–20.

6.4.7. Emotion labelling

Children were presented with emotion face cards. This task was adapted with permission from Denham's (1986) Affective Knowledge Task. To avoid ceiling effects two additional emotions (surprise and disgust) were added to the original four emotion faces (happy, sad, angry, scared). These in random order: happy, surprised, sad, angry, scared and disgust. Due to time and practical constraints, emotions were depicted on simple cartoon faces rather than puppets. With each face, interviewers asked "How does s/he feel?" using a neutral tone. Children received a score of 0 or an incorrect response, 1 for a partially correct response (e.g., any negative emotion/feeling for sad, angry, scared or disgust) and a 2 for a correct response (e.g., scared, afraid, terrified, fearful or frightened for the scared face). Possible total scores therefore ranged from 0-12.

6.4.8. Gift self-regulation task

Children were told "I have a surprise to show you, but I don't want you to see it. I want to wrap it first. Please turn around so you won't see it. Please don't look or peek while I wrap it. I'll tell you when I'm done." Interviewers then turned away by 90 degrees and noisily pretended to wrap the (already wrapped) gift. This process was timed for 60 s. Interviewers recorded: the time of first peek; how many times the child peeked; and whether the child had not peeked at all during the 60 s. Note, the gift was given to the child after completion of this task. In order to consider responses as a single ordinal variable, children were categorised into four groups: peeking within first 20 s (12 %); peeking within 21–40 s (9 %); peeking within 41–60 s (7 %); or no peeking (72 %).

6.4.9. Hand-clap inhibitory control task

The Developmental NEuroPSYchological assessment (NEPSY) contains a range of tasks designed to tap executive functioning in young children aged 3-12 years (Korkman, 1988). One of the inhibition and control tasks of the NEPSY requires children to knock on the table when the examiner taps, and to tap when the examiner knocks. Our task was a hand-clap version of this knock/tap task (Buckley et al., 2020). The interviewer introduced the task by explaining "Now for this game, when I clap one time, you clap two times. And when I clap two times, you clap one time, ok?" This was followed by up to six teaching trials, and the child only continuing when the last practice trial was correct. Sixteen test trials were then completed (half 2-clap and half 1-clap in a randomly assigned order), with possible total scores ranging from 0-16. Standardised z-scores on this task were used in subsequent analyses.

6.4.10. Gross motor skills

Parents reported on their child's performance across eleven developing gross motor skills on a 5-point Likert scale from "never" (0) to "always" (4). These items were developed for this study, based on developmental literature of preschool motor development (Cools et al., 2009; Iivonen & Sääkslahti, 2014). The eleven motor skills were: bend over without falling; walk in a straight line; walk backwards; walk up and down stairs alternating feet; run easily; balance on one foot for ten seconds; hop on one foot for three hops; climb well; kick a ball; catch a ball thrown from approximately one metre away; pedal a tricycle or bicycle. Cronbach's alpha for the motor skills scale was 0.79, demonstrating adequate internal consistency. Due to variable distribution, motor skills total scores were split into four quarters, with each representing 25 % of the data.

6.5. Socio-demographic measures

As described in Table 1, mothers reported on their self-prioritised ethnicity during pregnancy, and responses were categorised into European, Pacific Peoples, Māori, Asian or MELAA (Middle Eastern, Latin American, African) and Other. At the enrollment interview during pregnancy, mothers also reported on their highest education and this was categorised as no secondary, secondary, diploma / trade or university qualifications. Child sex at birth was confirmed via linkage with hospital birth records. Mothers' age in years was collected at the antenatal timepoint. Child age (in days) at the time of the 54-month data collection was calculated.

6.6. Data analysis

Exploratory factor analysis using Principal Axis Factoring was conducted to examine whether children's functioning across fifteen measures in preschool development reflected underlying early learning factors. These measures mapped to the following key early learning constructs (please note, these refer to conceptual constructs not empirically derived factors):

- Oral language: receptive (a-PPVT) and informal (PROL).
- Literacy: writing name; letter-naming fluency (DIBELs).
- Numeracy: counting; writing numbers.
- Socio-emotional and behavioral: emotion labelling (AKT); prosocial behavior and emotion, conduct, hyperactivity and peer problems (SDQ).
- Motor skills: gross motor development questions.
- Regulation: inhibitory control (hand-clap task), gift-wrap self-regulation.

Four separate hierarchical linear regression models were then developed to examine associations between maternal verbal behavior during the writing interaction and early learning. Each regression model had a separate early learning factor as the dependent variable. Independent variables were entered in a hierarchical approach based on developmental progression. Maternal socio-demographic variables (ethnicity, education and age) were entered at Step 1. Child birth variables (sex and age) were entered at Step 2. Child bilingualism was then entered at Step 3 as this reflects an early postnatal environmental factor. Finally, the three maternal verbalisation variables during the writing task (open-ended questions, print talk and praise) were entered at Step 4. All analyses were conducted using IBM SPSS Statistics 23 and used an alpha level $< .05$.

7. Results

Means, standard deviations and ranges of raw scores for potential early learning indicators are shown in Table 2. While factor analysis is relatively robust to skewness and kurtosis, no variables had values exceeding -1/+1.

7.1. Early learning factor analysis

In order to examine how multiple indicators of early learning relate to one another, an exploratory factor analysis (principal axis factoring) was conducted using the 15 variables described above. Based on an examination of the scree plot and eigenvalues greater than 1, a four-factor model was selected. With inter-factor correlations $> .20$, oblique rotation is recommended (Schmitt, 2011). Due to the large sample size, promax rotation was selected. Values less than 0.3 were suppressed (Field, 2018). Note, with this suppression value the gift wrap self-regulation task did not load on any of the factors. The pattern matrix is shown in Table 3. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.80 (with > 0.6 required). Bartlett's Test of sphericity (chi square = 9955.94) was significant ($p < .0001$).

7.2. Associations of early learning factors with maternal behavior during the writing interaction

Four hierarchical linear regressions were examined, with each of the four early learning factors as dependent variables. These regressions tested the primary aim of understanding how maternal behaviour during the writing interactions related to children's early learning. Maternal variables (ethnicity, education and age) were entered first, followed by child birth variables (sex and age), then child bilinguialism and then the three parent interaction behaviors (open-ended questions, print talk and praise) at the last step. Results are shown in Tables 4 and 5.

Table 2
Descriptive statistics for early learning indicator scores at age four years.

Early Learning Indicator	Mean score	Standard Deviation	Range
a-PPVT ($n = 5377$)	0.00	1.00	-1.80 – 1.95
Hand clap inhibitory control ($n = 5534$)	0.00	1.00	-2.22 – 0.96
Write name ($n = 5634$)	2.84	1.12	0-4
Write numbers ($n = 5634$)	2.24	1.07	0-4
Emotion labelling ($n = 5606$)	7.91	2.19	0-12
SDQ Emotion problems ($n = 6148$)	1.98	1.78	0-10
SDQ Conduct problems ($n = 6147$)	3.58	1.35	0-10
SDQ Hyperactivity ($n = 6150$)	4.53	1.64	0-10
SDQ Peer problems ($n = 6148$)	4.83	1.26	0-10
SDQ Pro-sociality ($n = 6147$)	7.76	1.80	0-10
Gift wrap self-regulation ($n = 5692$)	51.49	17.71	1-61
PROL ($n = 6084$)	12.47	2.02	4-15
Motor skills ($n = 5316$)	39.42	4.38	0-44
Letter naming fluency ($n = 5480$)	8.38	10.52	0-69
Counting ($n = 5634$)	12.66	5.89	0-20

Note: a-PPVT = abridged Peabody Picture Vocabulary Test; SDQ = Strengths and Difficulties Questionnaire; PROL = Parent Rating of Oral Language

The overall model explained 15.1 % of the variance in factor one (literacy and numeracy skills). Maternal factors explained 10.1 % of the variance, with an additional 3.2 % explained by child factors, no variance explained by bilingualism, and 2.0 % by parent behavior during the interaction task.

The overall model explained 23.0 % of the variance in factor two (oral language and regulation). Maternal factors explained 18.4 % of the variance, with an additional 1.2 % explained by child factors, 1 % explained by bilingualism and 2.7 % by parent behavior during the interaction task.

The overall model explained 21.1 % of the variance in factor three (behavior difficulties). Maternal factors explained 20.5 % of the variance, with an additional 0.1 % explained by child factors, 0.3 % explained by child bilingualism, and an additional 0.4 % by parent behavior during the interaction task. Only maternal praise was a significant predictor in this model.

The overall model explained 4.71 % of the variance in factor four (interpersonal and motor skills). Maternal factors explained 2.3 % of the variance, with an additional 1.6 % explained by child factors, no additional variance was explained by child bilingualism. An additional 1.1 % of the variance was explained by parent behavior during the interaction task. Print talk, praise and open-ended questions were all significant predictors in this model.

Maternal ethnicity was significantly associated with all four learning factors. Child bilingualism was a significant predictor of oral language and regulation skills and behavior difficulties, but not literacy and numeracy or interpersonal and motor skills. Maternal education was associated with children's literacy and numeracy, oral language and regulation skills and behavior difficulties, but not with interpersonal and motor skills. Compared with boys, girls displayed higher literacy and numeracy skills, oral language and regulation skills, and interpersonal and motor skills.

Table 3
The four early learning factors from the pattern matrix with factor loadings.

	Factor one: Literacy and numeracy skills	Factor two: Oral language and regulation	Factor three: Behavior difficulties	Factor four: Interpersonal and motor skills
Hand clap: inhibitory control		.46		
a-PPVT: receptive language		.63		
Emotion labelling		.48		
SDQ: emotion problems			.67	
SDQ: conduct problems			.45	
SDQ: hyperactivity			.47	
SDQ: peer problems			.47	
SDQ: pro-sociality				.56
Letter naming fluency	.63			
Motor skills				.36
PROL: informal language use		.32		.42
Write name	.58			
Write numbers	.71			
Counting	.46			

Note: a-PPVT = abridged Peabody Picture Vocabulary Test; SDQ = Strengths and Difficulties Questionnaire; PROL = Parent Rating of Oral Language

Table 4
Hierarchical regression analyses examining associations of parent interaction with two early learning factors: Literacy and numeracy skills and oral language and regulation skills.

	Factor one: Literacy and numeracy skills				Factor two: Oral language and regulation skills			
Step predictors	Adjusted R^2 change	Beta	SE	Beta (standardised)	Adjusted R^2 change	Beta	SE	Beta (standardised)
Step 1: Maternal factors	.101****				.184****			
Maternal ethnicity								
Māori versus European		-.368	.040	-.141****		-.384	.036	-.154****
Pacific versus European		-.346	.043	-.128****		-.647	.039	-.251****
Asian versus European		.390	.043	.145****		-.213	.040	-.083****
Other versus European		.110	.072	.021		-.118	.065	-.024
Maternal education								
High school versus University		-.285	.032	-.147****		-.312	.029	-.169****
Dip/Trade versus University		-.220	.029	-.117****		-.221	.027	-.124****
Mother age		.002	.002	.014		.008	.002	.060****
Step 2: Child factors	.032****				.012****			
Girl versus Boy		.248	.024	.144****		.133	.022	.081****
Child age		.058	.008	.104****		.042	.007	.078****
Step 3: Child Bilingual	.000				.010****			
2+ versus 1 language spoken		-.033	.031	-.018		-.199	.028	-.112****
Step 4: Parent-child invite task	.020****				.027****			
Open ended questions		.031	.015	.028*		.040	.014	.038****
Print talk		.098	.014	.101****		.059	.013	.064****
Praise		.070	.016	.065****		.127	.015	.123****

Note: coefficients are reported for each independent variable from the final equation for each dependent variable
SE standard error
***$p < .001$, **$p < .01$
**** $p < .0001$,

8. Discussion

The findings from this study support and extend current knowledge about how multiple components of children's early learning relate to one another, and how parent practices are associated with children's early learning. The four early learning factors identified: literacy and numeracy skills; oral language and regulation skills; behavior difficulties; and interpersonal and motor skills, all support broader contemporary views: where school readiness is seen as a combination of more formally learned behaviors, social and emotional competence, and developmental maturity (including motor and attention abilities). The findings from this study also suggest that, after controlling for a range of child and socio-demographic factors, parents' use of open-ended questions, print talk and praise were related to children's early learning: uniquely explaining 2-3 % of the variance in children's literacy and numeracy (factor one) and oral language and regulation (factor two).

8.1. Parent-child writing interaction

Mothers' use of open-ended questions, print talk and praise related in meaningful ways to children's early learning. All were significant predictors of children's literacy and numeracy skills, oral language and regulation and interpersonal skills. There was some evidence of specificity: more open-ended questions and praise, but not print talk, predicted fewer behavior difficulties. We expected that print talk would relate to literacy and numeracy skill, however in addition to this, open-ended questions and praise were also significant predictors of the factor reflecting more formal literacy and numeracy skills. Together, these findings reflect the importance of positive, supportive, enquiring parent-child interactions for children's early learning. These findings are in line with emerging intervention research that suggests these interactions may confer social, emotional and behavioral benefits for the child beyond specific literacy and numeracy skills (Weisleder et al., 2019).

Table 5
Hierarchical regression analyses examining associations of parent interaction with two early learning factors: Behavior difficulties and interpersonal and motor skills.

	Factor three: Behavior difficulties				Factor four: Interpersonal and motor skills			
Step predictors	R^2 change	B	SE	Beta (standardised)	R^2 change	B	SE	Beta (standardised)
Step 1: Maternal factors	.205****				.023****			
Maternal ethnicity								
Māori versus European		.310	.035	.128****		-.135	.034	-.061****
Pacific versus European		.715	.038	.286****		-.309	.036	-.135****
Asian versus European		.262	.039	.105****		-.086	.034	-.038*
Other versus European		.135	.064	.029*		.032	.064	.007
Maternal education								
High school versus University		.196	.029	.109****		-.070	.029	-.042*
Dip/Trade versus University		.159	.026	.091****		-.028	.026	-.017
Mother age		-.020	.002	-.149****		-.001	.002	-.006
Step 2: Child factors	.001*				.016****			
Girl vs Boy		.039	.021	.024		.156	.021	.108****
Child age		.012	.007	.024		.030	.007	.063****
Step 3: Child Bilingual	.003****				.000			
2+ vs 1 language spoken		.108	.027	.063****		.011	.027	.007
Step 4: Parent-child task	.004****				.011****			
Open ended questions		-.017	.014	-.017		.015	.014	.016
Print talk		-.001	.013	-.001		.038	.013	.046**
Praise		-.061	.015	-.061****		.071	.023	.069****

Note: coefficients are reported for each IV from the final equation for each DV
***$p < .001$, **$p < .01$, $p < .05$
**** $p < .0001$,

8.2. Early learning factors

In line with existing literature, more formal literacy and numeracy skills emerged as a distinct factor (Neumann et al., 2021). While many models of school readiness link oral language with more formal literacy skills (Britto, 2012), it was noteworthy that our data show a separation here: with oral language skill (receptive language, emotion labelling and informal language use) loading onto factor two with inhibitory control. It may be that factor one reflects the production, or expression, of literacy and numeracy skills; whereas factor two reflects the broader socio-emotional and language components that underlie early learning. Further research including a measure of expressive as well as receptive language may help to clarify this. Regardless, these findings highlight the integral role of children's oral language skills in early learning. This is particularly important given that children's language difficulties just prior to school entry are a better predictor of poor school readiness than persistent language difficulties throughout early childhood (Justice et al., 2009).

Overall, factor two (oral language and regulation) appears to reflect the long-held conceptions of teachers about what constitutes preparedness for school: with a focus on language and regulation rather than formal learning (Linder et al., 2013). These findings also reflect a conceptualisation of regulation as closely linked with social and emotional wellbeing, rather than more cognitive (i.e., organisation, goal-direction) or temperament / attention explanations (Ursache et al., 2012). It may be that children with more advanced language skills are better able to use self-talk to regulate their own emotions, behaviour and responses (Ursache et al., 2012). Similarly, more regulated children may elicit more complex linguistic interactions from adults (Eisenberg et al., 2005). It may also be that this factor loading reflects underlying parental emotion socialization – parents with a rich vocabulary, who discuss emotions and provide support or coaching for their child to regulate their own emotional responses (Ornaghi et al., 2019). It was surprising that the gift wrap task did not load onto factor two (or any of the factors). It is worth noting that the factor analysis was set to suppress values below 0.3 and that children's gift wrap self-regulation scores had a loading just below this. The gift wrap task reflects delayed gratification, an aspect of 'hot cognition' which involves both cognition and emotion processing. It may be that the reward itself was not emotionally activating enough to reflect individual differences in this construct or that children's responding also reflected some unmeasured variable, such as conscientiousness (Duckworth et al., 2013). Regardless, the variables loading on factor two do reflect the inter-relation of cognitive abilities such as executive function with children's socio-emotional functioning: rather than acting as two separate influences on children's later academic achievement, children's social and emotional skills are seen as critical for understanding how cognitive ability impacts later academic achievement (Blair & Raver, 2015). Multiple mechanisms may explain this relationship. For example, children with greater socio-emotional competence may be better able to set goals and problem-solve, understand others' perspectives, form better friendships, feel more connected to teachers and the school community, and may receive more positive feedback from peers and teachers (Denham & Brown, 2010; Panayiotou et al., 2019).

It is perhaps surprising that all behavior difficulties as measured by the SDQ loaded onto a separate factor. For example, we might expect that SDQ hyperactivity-inattention would load negatively onto factor two alongside the hand clap inhibitory control measure. It may be that behavior difficulties as captured by a clinical screening tool measure something qualitatively distinct to high versus low regulation within the typically developing population (Swanson et al., 2012, Polderman et al., 2007). Alternatively, this may partially be an artefact of the timing of measurement given the New Zealand context. Developmental maturation models indicate age 6 years as an optimal age to begin schooling: when the prefrontal cortex is sufficiently developed to support top-down regulation of attention and emotion to support learning in the classroom (Blair & Raver, 2015). Measurements for the current study were taken at age 4½ years as New Zealand has a universal school starting age from 5 years. It may be that over the 18 months following the timing of these analyses for the children, neurodevelopment impacts more life course stability indicators of attention, emotion, and behavior. By age six years, behavior difficulties may be more closely linked with other indicators of emotion, language, and attention.

The loading of both interpersonal (SDQ prosociality and PROL informal language) and motor skills onto a single factor (factor four) was also somewhat surprising. Certainly atypical disruptions in gross motor development are known to be associated with deficits in other aspects of development, for example through a shared underlying neurobiological mechanism. However, there is also evidence that motor, social and language development are closely related in typically developing children. Leonard and Hill (2014) conducted a systematic review and identified associations for infants and school age children. Children with

less developed motor skills may engage in less active social play, limiting opportunities for group social engagement. This may in turn impact children's 'social standing' which may further impact the range and depth of social and linguistic interactions.

Maternal factors (including self-prioritized ethnicity, completed education, and age at pregnancy) accounted for the largest proportion of variance in children's early learning across all four factors: 10–20 % of the variance in factors one, two and three. These findings may reflect socio-economic and ethnic inequities in early learning outcomes (Hart & Risley, 1995; Schady, Galiani, & Souza, 2006). The current findings suggest that these inequities continue to exist in children's literacy, numeracy, oral language and regulation and behavioral problems prior to beginning formal school. While the current data does not speak to mechanisms, younger parents are more likely to have experienced disruption to their own education which may impact the home learning environment, financial resources and access to other supports (Wall--Wieler et al., 2019). Impacts of colonisation and immigration may impact early learning ethnicity inequities through adverse experiences, limited resources, parent and family stress and reduced support for parents to engage in supportive, responsive interactions and create structure and set helpful limits (Shaw et al., 2021).

These findings are particularly concerning given that although New Zealand has a high uptake in subsidised early childhood education and a strong policy focus on achieving ethnic equity in wellbeing outcomes, including in the education sector, there are known ethnic inequities in access to culturally inclusive and responsive early childhood educational environments (Bird et al., 2016). Targeting these disparities will require broader policy interventions, particularly given equitable access to high-quality education is recognised as a critical 'route out of poverty' (Britto, 2012). When interpreting these inequities, however, it is important to note that lower or higher factor scores do not necessarily reflect a flatter or steeper learning trajectory, and may in fact reflect priorities or values for families or cultures at this specific developmental stage. Measures used may also lack cross-cultural validity. For example, factor three (behavior difficulties) reflects the four difficulties subscales of the SDQ. Concerns have been raised within the New Zealand context about the validity of this tool for Māori, Pacific and Asian children and children of recent immigrants. Specifically, that the wording of the questions and response options, and the problem focus, do not consider children within a broader context, from multiple perspectives (Kersten et al., 2014).

Associations of child sex and bilingualism with early learning factors warrant further discussion. In line with existing literature, girls displayed an advantage over boys for most aspects of early learning (Kent & Pitsia, 2018). Our findings on associations of bilingualism with early learning appear less consistent with existing literature. Research suggests that children bilingual in English and an Asian language have more advanced cognitive and social skills in their first year of school, with no differences in physical and motor skills (Guhn, Milbrath, & Hertzman, 2016). A clear advantage for bilingual children in executive functioning and attentional control was also shown, with more successful later academic outcomes. Bilingualism has therefore been posited as a potential protective factor for children growing up in low socio-economic environments (Guhn et al., 2016). In contrast, bilingualism in our sample was associated with lower oral language and regulation skills (factor two) and greater behavior difficulties (factor three). It may be that the inclusion of the PPVT receptive language scores (reflecting English language proficiency) in factor two obscured a positive association of bilingualism with regulation. A single measure of language skill is unlikely to capture the unique linguistic abilities conferred by bilingualism (e.g., narrative cohesion and story-telling; Hoff, 2013). While many bilingual children may understandably start school with lower English language skills, the cognitive advantages of this trajectory may be seen later in development (Hoff, 2013, 2021).

8.3. Strengths and limitations

The current data from age 4½ years cannot speak to how children's early preschool learning translates into subsequent school performance. As noted by Britto (2012), 'school readiness' encompasses not only children's readiness for school, but also family readiness (e.g., parents' attitudes and involvement) and the school's readiness (e.g., school factors that support transition). Similarly, individual differences in early learning identified in our data represent an important, but single, data point before children begin school. School readiness skills are considered to be cumulative in that there exists a hierarchy of achievement based on mastering earlier goals, i.e., children build on earlier learned skills and behaviors. In this sense, readiness combines learning and development because achieving simpler skills allows for the acquisition of higher and more complex skills (Bowman and Burns, 2001). Children entering primary school, for example, need to have a working vocabulary in order to understand words read. In other words, learning achievement in school is the continuation of a process of acquiring skills from birth: advanced skills build upon the mastery of former skills (Britto, 2012). Even within the relatively fortunate New Zealand context, schools differ in terms of classroom size and crowding, teacher experience, and resources (e.g., school breakfasts and lunches, discretionary funds, access to specialist teachers). Further research is needed to understand how the early learning factors identified here interact with schools' readiness for children and children's later academic outcomes.

A strength of this study is that most constructs were measured based on direct assessment with children, with the exception of the SDQ and children's motor abilities, which were based on maternal report. This is important, particularly when considering the relative influence of maternal socio-demographic factors such as education which may contribute to shared measurement variance on maternal report. While future research could include direct measurement of children's gross and fine motor skills (e.g., the Peabody Developmental Motor Scale, 2nd Edition, PDMS-2; Folio & Fewell, 2000), it would be very complex and labour intensive to measure children's behavior directly without parent or teacher report in such a large sample.

A notable limitation is that most constructs (with the exception of oral language) were measured with one indicator. Moreover, not all constructs considered important to early learning were measured. For example, fine motor skill, while correlated with gross motor, is likely to contribute in unique ways to children's early learning. Because of the large sample size and need to use tasks that interviewers could score and code in vivo, the hand-clap (inhibitory control), gift-wrap (self-regulation) and birthday party invitation (parent-child interaction quality) tasks were adapted for the current study. There may be components of these tasks that are important to children's early learning that could not be captured. For example, the richness and diversity of parental vocabulary is a consistent indicator of the home learning environment and is associated with children's later academic outcomes (Leffel & Suskind, 2013; Reese et al., 2010), but could not be reliably assessed in vivo by interviewers and *Growing Up* - a child-centred, inter-disciplinary, longitudinal study – was not designed to measure parent behavior at this level of detail. In addition, our reliance on interviewer coding of parent-child interaction may have underestimated the size of the association with early learning. For example, recent meta-analyses suggest moderate associations between parent-child book-reading and children's oral language (Fitton et al., 2018; Noble et al., 2019), compared with the small but significant associations found here. The time sampling approach reduced resource burden (i.e., recording and subsequent coding of interactions). However this has inherent limitations. For example, some dyads may take more time to warm up to the task and therefore may have engaged in open-ended questions, print talk or praise and encouragement after the time window for that particular code had passed.

Finally, it is important to note that the current data was collected in

2013-2014. Te Whāriki – New Zealand's early childhood curriculum – was revised in 2017. The revision emphasises enhanced linkages with Māori models and immersion education, encourages teachers to be intentional, and refines learning outcomes within the domains of well-being, belonging, contribution, communication and exploration; however Te Whāriki maintains its strong play-based framework (McLachlan, 2017). COVID-19 has impacted school and ECE attendance and learning in New Zealand as it has globally, and appears to have perpetuated existing inequities (Flack et al., 2020). Future research examining learning trajectories will need to consider this cohort effect.

8.4. Implications

The findings reported from this study have important theoretical and policy implications. There is overall support for contemporary models of children's early learning. Children's socio-emotional, language and self-regulatory development is interrelated, and is distinct from children's formal literacy and numeracy skills. The quality of mother-child interactions was a consistent predictor of children's developmental competencies across domains, highlighting the importance of continuing to support the early home learning environment, and of support specifically for parents. Of concern, however, socio-demographic inequities were evident across all four of the early learning factors. These inequities are largely the result of differential access to the economic, cultural and social environments known to support child development, and disproportionate cumulative disadvantage, which in the New Zealand context includes settler colonialism, exposure to racism and systems failures predominantly experienced by Māori and Pacific communities. Although not examined in the current study, early indicators of learning such as those measured here are related to later school achievement (La Paro & Pianta, 2000; Duncan et al., 2007), and are therefore an important determinant of potential later life success. This highlights a need to continue to focus on proximal supports for children but also to look beyond the home learning and even beyond educational settings to ensure that broader inequities in the wider socioeconomic environment for children do not impact every child's right to education.

CRediT authorship contribution statement

Amy Bird: Conceptualization, Formal analysis, Writing – original draft. **Elaine Reese:** Conceptualization, Data curation, Investigation, Writing – original draft. **Elizabeth Schaughency:** Conceptualization, Data curation, Formal analysis, Writing – original draft. **Karen Waldie:** Conceptualization, Data curation, Investigation, Writing – review & editing. **Polly Atatoa-Carr:** Conceptualization, Data curation, Investigation, Writing – review & editing. **Susan Morton:** Conceptualization, Methodology, Funding acquisition, Writing – review & editing. **Cameron Grant:** Conceptualization, Methodology, Funding acquisition, Writing – review & editing.

Data availability

The data that has been used is confidential.

Funding

Growing Up in New Zealand has been funded by New Zealand government ministries including the Ministries of Social Development, Health, Education, Justice and Pacific Island Affairs; the former Ministries of Science Innovation and of Women's Affairs; the former Department of Labour; the Department of Corrections; Te Puni Kokiri; New Zealand Police; as well as by The University of Auckland and Auckland UniServices Limited.

Acknowledgments

The authors would like to acknowledge the families who have been part of *Growing Up in New Zealand*, who give their time and share their experiences so generously. The authors would also like to acknowledge the members of the wider *Growing Up* research and operations teams, policy partners, and funders of the study.

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