Sira Määttä

Developmental pathways of language development:

A longitudinal predictive study from prelinguistic stage to outcome at school entry

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INSTITUUTTI

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ABSTRACT

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This research focused on the pathways of development during the prelinguistic stage and from prelinguistic development to later language ability. The first goal was to follow and describe the development of several prelinguistic communication skills during the first two years of life (Studies I and II). The second goal was to examine the predictive relations between this development and language ability and difficulties, as well as memory, up to school age (Studies I, II, and III). The third goal evaluated the feasibility of parental screening in identifying children at risk for language and communication difficulties (Studies I, II, and III). Prelinguistic skills were followed with a parental screener administered at three month intervals from age 6 to 24 months (seven measurements, n = 508, 203–330 by age). The same children were followed from ages 2 to 8 years (five measurements, n = 102–296). Both variable- and person-oriented approaches were applied. Development across several prelinguistic skills emerged as a rather continuous and stable characteristic of individual differences. Individuals differed widely in development, and six clearly distinguishable developmental trajectories were identified. Prelinguistic development was consistently related to parental and psychometric measures of later language ability and performance in working memory measures up to age 8. Growth across several prelinguistic skills was the best predictor of later language ability. The most prominent feature of developmental risk was the accumulation of early difficulties, especially if symbolic and social abilities were included. The connection between prelinguistic development and later verbal working memory was particularly strong. The findings suggest that a notable proportion of children who show multiple at-risk features of development already before their second birthday continue to show poor language and communication skills along with limitations in working memory in their later development. The findings support the rationale for early screening and indicate that features of early development that predict later development can be identified using parent reports. The key implications to screening are that assessment should cover several prelinguistic communication skills and that repeated surveillance tapping the growth of child's skills should be favored instead of one-time screening.

Keywords: prelinguistic communication skills, early predictors, developmental trajectories, language difficulties, working memory, parent-report, screening, developmental surveillance

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Tämä tutkimus kohdistui kielen ja kommunikaation kehityskulkuihin esikielellisessä vaiheessa sekä yhteyksiin esikielellisen kehityksen ja myöhempien kielellisten taitojen välillä. Ensimmäinen tavoite oli seurata ja kuvata useiden esikielellisten kommunikaatiotaitojen kehitystä kahden ensimmäisen ikävuoden aikana (osatutkimukset I ja II). Toisena tavoitteena oli tutkia tämän varhaiskehityksen ennustavuutta suhteessa myöhempiin kielellisiin taitoihin ja vaikeuksiin sekä muistitaitoihin kouluikään saakka (osatutkimukset I, II ja III). Kolmas tavoite oli arvioida varhaisen vanhempien avulla toteutettavan seulonnan soveltuvuutta ja luotettavuutta kielen ja kommunikaation kehitykseen liittyvien riskien tunnistamisessa (osatutkimukset I, II ja III). Esikielellisiä kommunikaatiotaitoja seurattiin vanhemmille suunnatulla seulontalomakkeella kolmen kuukauden välein 6–24 kk:n iässä (seitsemän mittausta, n = 508, 203–330 kussakin ikävaiheessa). Seurantatutkimukset toteutettiin lasten ollessa 2–8 vuoden ikäisiä (viisi seurantapistettä, n = 102–296). Aineiston analyyseissä käytettiin sekä muuttuja- että henkilösuuntautuneita lähestymistapoja. Kun useiden esikielellisten kommunikaatiotaitojen kehitystä tarkasteltiin yhtäaikaisesti, yksilölliset erot näyttäytyivät suhteellisen jatkuvina ja pysyvinä. Kehityksessä oli havaittavissa suuria yksilöllisiä eroja ja aineistosta tunnistettiin kuusi selkeästi toisistaan eroavaa kehityskulkua. Esikielellisten taitojen kehitys oli järjestelmällisesti yhteydessä sekä vanhempien raportoimiin että psykometrisin testein arvioituihin kielellisiin taitoihin sekä suoriutumiseen työmuistitehtävissä kahdeksaan ikävuoteen saakka. Esikielellisten taitojen kokonaiskehitys ennusti parhaiten myöhempiä kielellisiä taitoja. Selkein kehityksellinen riskipiirre oli useiden vaikeuksien ilmeneminen varhaiskehityksen aikana erityisesti, jos vaikeudet liittyivät varhaisiin symbolisiin ja sosiaalisiin taitoihin. Erityisen vahva ennustava yhteys löytyi esikielellisten taitojen kehityksen ja myöhemmän työmuistisuoriutumisen väliltä. Tulosten perusteella näyttäisi siltä, että huomattavalla osalla lapsista, joiden kehityksessä on havaittavissa useita riskipiirteitä jo ennen kahta ikävuotta, kielen ja kommunikaation taidot ovat heikot ja työmuisti rajoittunut myös myöhemmissä ikävaiheissa. Tulokset osoittavat, että varhainen seulonta on perusteltua ja että myöhempää kehitystä ennustavia varhaisia kehityspiirteitä voidaan luotettavasti tunnistaa vanhempien antaman lomaketiedon pohjalta. Seulonnan näkökulmasta olennaisinta näyttäisi olevan, että arviointi kattaa esikielelliset taidot monipuolisesti ja tuottaa tietoa myös taitojen kehityksestä, eli kehitystä tulisi seurata toistuvasti yksittäisen arvioinnin sijaan.

Avainsanat: esikielelliset kommunikaatiotaidot, varhainen ennustaminen, kehityskulut, kielelliset vaikeudet, työmuisti, vanhemmat informantteina, seulonta, kehityksen seuranta

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I Määttä, S., Laakso, M.-L., Ahonen, T., Tolvanen, A., Westerholm, J., & Aro, T. (2016). Continuity from prelinguistic communication to later language ability: A follow-up study from infancy to school age. *Journal of Speech, Language, and Hearing Research, 59,* 1357–1372. Available online: http://jslhr.pubs.asha.org /article.aspx?articleid=2578594

II Määttä, S., Laakso, M.-L., Tolvanen, A., Ahonen, T., & Aro, T. (2012). Developmental trajectories of early communication skills. *Journal of Speech, Language, and Hearing Research, 55*, 1083–1096. Available online: http://jslhr.pubs.asha.org/article.aspx?articleid=1782652

III Määttä, S., Laakso, M.-L., Tolvanen, A., Ahonen, T., & Aro, T. (2014). Children with differing developmental trajectories of prelinguistic communication skills: Language and working memory at age 5. *Journal of Speech, Language, and Hearing Research,* 57, 1026–1039. Available online: http://jslhr.pubs.asha.org/article.aspx?articleid=1831283

Taking into account the instructions given and comments made by the co-authors, the author of the thesis applied previously collected data, conducted the analyses and wrote the reports of the three individual articles as the first author. She also actively participated in the planning of the design and realization of the data collection during the last stage of the follow-up study.

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1 INTRODUCTION

Learning to participate proficiently in social encounters and to use speech and language to communicate are primary developmental tasks for young children. Communication and language difficulties are among the most common early developmental difficulties and often the earliest indicators of developmental deficits of any kind. These difficulties have also been shown to relate to academic and social outcomes across the lifespan (Hulme & Snowling, 2009; Taanila, Murray, Jokelainen, Isohanni, & Rantakallio, 2007). Law, Boyle, Harris, Harkness, and Nye (2000a) concluded, in their review of the prevalence and natural history of language delay, that there is strong evidence for "potentially long-term sequelae of early language delay both in its own right and as a flag for other comorbid conditions" (p.191). An important first step in the effective prevention of further developmental and socio-emotional problems is the early and accurate identification of children with early communication and language delays.

Estimates of the prevalence of language difficulties range from 2% to 19% for early language delay (Law, Boyle, Harris, Harkness, & Nye, 2000b; Nelson, Nygren, Walker, & Panoscha, 2006), and from 2% to 10% for language impairment in kindergarten age (3–6% in Hulme & Snowling, 2009; 2–10% in Law et al., 2000b; 7% in Tomblin et al., 1997). The rather large variability of the estimates likely result from differences in the sampling procedure, the age of the assessed children, and the criteria used to designate impaired language. Nevertheless, it is clear that a considerable percentage of children are affected by language impairment, and a still larger percentage by milder language and communication difficulties.

Children with early language difficulties show substantial variation in outcomes. Depending on the age at which the difficulties have been identified, the reported percentages of persistence range from around 40% to 50% for toddler-aged children with early language delay, and 50% to 90% for kindergarten-aged children who exhibit language difficulties (e.g., Dale, McMillan, Hayiou-Thomas, & Plomin, 2014; Hulme & Snowling, 2009). However, even children whose expressive language delay appears to have been resolved by school-age

continue to perform at the low end of the normal distribution (Dale et al., 2014) and have been reported to be at an increased risk for later mild difficulties (Hulme & Snowling, 2009; Rutter, 2008). In addition, early language difficulties frequently act as precursors of school-age academic, social, behavioral, and psychiatric problems (e.g., Beitchman, Wilson, Brownlie, Walters, Inglis, Lancee, 1996; Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Brinton & Fujiki, 1999; Noterdaeme & Amorosa, 1999), which have been shown to persist into, or, in some cases, even increase in, adulthood (e.g., Arkkila, Räsänen, Roine, & Vilkman, 2008; Clegg, Hollis, Mawhood, & Rutter, 2005; Howlin, Mawhood, & Rutter, 2000; Mawhood, Howlin, & Rutter, 2000).

These findings, considered in light of the notion that early intervention likely leads to better outcomes in at-risk children (Beeghly, 2006; Carscadden et al., 2010; Guralnick, 1997; Ramey, Campbell, & Ramey, 1999; Warren, 2000), imply that there is a need for early and accurate identification of children with emergent communication and language difficulties. Early identification of at-risk children enables clinicians to provide support as close to the genesis of the problem as possible, to take advantage of the critical period for brain development, and to prevent minor impairments from becoming permanent (Bruce, Kornfält, Radeborg, Hansson & Nettelbladt, 2003; Pool & Hourcade, 2011; Warren, 2000; Webb, Jones, Kelly, & Dawson, 2014).

However, with the current knowledge of early predictors of communication and language and current practices of screening, the health care system is not able to optimally identify at-risk children. Research is therefore needed to more accurately identify the key risk factors that contribute to the emergence of language difficulties, to better depict the developmental trajectories of at-risk children, and more thoroughly understand the implications that early development has for later outcomes. In addition, effort should be made to improve screening procedures that are feasible and readily applicable in basic health care settings.

The aim of this research was to scrutinize and untangle some of these questions by studying the development of language and communication longitudinally, starting from the prelinguistic period with the follow-ups extending up to the first grade (mean age 7 years 9 months, 7;9). The development of prelinguistic communication skills was examined repeatedly during the first two years of life and the connections of this development to later language outcome studied at various ages and in various domains of communication and language, applying both variable- and person-oriented approaches.

1.1 A continuum from prelinguistic communication to later language

The emergence of language is an important developmental milestone for children. However, even before this takes place, children participate actively in so-

cial encounters and are able to effectively use several means of nonverbal communication. The term prelinguistic communication is used to refer to the communicative abilities children have before they start using language as their primary means of communication (Watt, Wetherby, & Shumway, 2003; Wetherby, Warren, & Reichle, 1998). The prelinguistic period spans intentional preverbal communication and the transition to the first words (Watt et al., 2006). The first two years of life is an important period in the development of these early communication skills.

Children's prelinguistic communication ability is thought to form a continuum with later, more language-based, communication (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bruner, 1983). For example, gestures have been shown to develop hand in hand with language skills. In other words, several early language milestones have been attested to have gestural correlates that either precede or co-occur with the advances of language skills (e.g., Bates & Dick, 2002; Iverson, Hall, Nickel, & Wozniak, 2007; Tomasello, Carpenter, & Liszkowski, 2007). The development of symbolic play has also been found to follow a sequence that parallels communication development (McCune, 1995; Toth, Munson, Meltzoff, & Dawson, 2006). These findings suggest the possibility of a common underlying base in cognitive development for the use of symbols (Bates et al., 1979; McCune, 1995; Kaiser & Roberts, 2011). That is, linguistic and nonlinguistic symbols might have shared origins, an idea already proposed by Piaget (1971), according to whom this origin might be sensorimotor in nature.

On the other hand, Tomasello (2000) and Tomasello et al. (2007) provide a more social explanation of the joint origin of preverbal and verbal communication, that of shared intentionality. The transactional model of communication development and the social pragmatic theory of language acquisition propose that language skills emerge from a child's nonverbal understanding of the world and social intentions (Tomasello, 2001; Tomasello et al., 2007). The infant's growing will, intent, and ability to communicate is thought to develop within the social context, with adults providing the scaffolding of meaning and communication in early development (Bruner, 1983; Vygotsky, 1978). Parent-child interaction, especially joint engagement between communicative partners, is seen as foundational to emerging communication (Adamson, Bakeman, & Deckner, 2004; Adamson, Bakeman, Deckner, & Romski, 2009; Siller & Sigman, 2008). The child's ability to engage in and contribute to joint attention, in turn, is an important indicator of early social communication abilities and has been found to predict the development of spoken language (e.g., Carpenter, Nagell, & Tomasello, 1998; Laakso, Poikkeus, Katajamäki, & Lyytinen, 1999; Wu & Gros-Louis, 2014). According to Adamson et al. (2009) the transition from prelinguistic to linguistic communication is marked by the use of symbols within the context of joint attention.

Thus, early socio-cognitive and prelinguistic communication skills are seen as building blocks for later language development, while social environment creates the context in which children learn, expand and develop their emerging skills. These skills are not thought to map one-on-one with later lan-

guage skills, but rather to converge, during development, onto later developmental milestones that correlate with the emergence of language (Bates et al., 1979; Bates, 2004). Bates (2004) has suggested that language ability emerges from the interactions of many early cognitive processes. Early socio-cognitive skills, such as speech sound perception and production, object recognition and categorization, imitation, joint reference, and intentionality act as prerequisites for language (Bates, Thal, Finlay, & Clancy, 2002) and may be both necessary and, along with opportunities for social interaction, sufficient for language development to occur (Bates, 2004). Comparably, outlining a dimensional view of language ability, Rescorla (2002, 2005, 2009, 2013) argues that language should be regarded as an ability spectrum that builds up from several distinct yet interrelated skills that subserve language. This notion is supported by the findings of marked intercorrelations between different language and communication measures (Rescorla, 2009). Rescorla (2009) compares this early language endowment to that of intelligence and suggests that individual differences are, to some extent, constitutionally based.

1.2 Defining language difficulty, delay and impairment – a spectrum of language ability

The dimensional view of language ability (Rescorla, 2002, 2005, 2009, 2013) claims that language ability should be regarded as a continuum rather than a dichotomy of impaired versus normal. Children can vary widely along this continuum, from seriously impaired to extremely gifted, and their rank order, irrespective of their level of performance, is partly determined by the endowment they are born with (Rescorla, 2002, 2005, 2009). Thus, the dimensional view asserts that children with language difficulties are not qualitatively different from typically developing children but that their differences in language ability arise from differential endowment of the skills subserving language (Rescorla, 2009). That is, children with language difficulties represent the tail of a normal distribution of language ability (Leonard, 1991, 2013; Rescorla, 2013). The weaker their early endowment of language is, the further the children are situated on the left tail of the distribution.

Several researchers have suggested that the differences between individuals in language performance are stable over time (Bornstein, Hahn, Putnick, Suwalsky, 2013; Bornstein & Putnick, 2012; Fenson et al., 1994; Rescorla, 2009; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998; Thal, Bates, Goodman & Jahn-Samilo, 1997; Tomblin, Zhang, Buckwalter, & O'Brien, 2003). The differential endowment, suggested by the dimensional view (Rescola, 2013), could partially account for this stability. One prediction stemming from this line of thought is that children with early language delay, that is, with a weaker early endowment, can be expected to show persistent language weaknesses. This view has received support from studies that have indicated that early delays are

related to the level of later language proficiency (Rescorla, 2009). Research has consistently shown that although the majority of children with a history of early language delay perform within the normal range by kindergarten age, their performance, as a group, is weaker than that of typically developing children across a range of standardized language tests in both kindergarten (Girolametto, Wiigs, Smyth, Weitzman, & Pearce, 2001; Moyle, Ellis Weismer, Linstrom, & Evans, 2007; Roos & Ellis Weismer, 2008) and school age (Armstrong, Marchman, & Owen, 2007; Rescorla, 2002, 2005, 2009, 2013; Rice, Taylor, & Zubrick, 2008). In addition, it seems that children whose oral language delay seems to resolve by early school age might continue to be at increased risk for later mild language deficits and academic difficulties (e.g., Hulme & Snowling, 2009; Rescorla, 2013; Rutter, 2008).

Moreover, it is important to remember that not all children with early language and communication delays catch up; instead, some face extensive difficulties in language and communication (e.g., Dale, Price, Bishop, & Plomin, 2003). It is possible that the children with the weakest early endowment are those who are later diagnosed with impairments in language or social communication (Rescorla, 2009), such as Specific Language Impairment (SLI) or Autism Spectrum Disorders (ASD). An important question for clinical work is how to differentiate between normal variation and early language difficulties that require intervention. That is, if language ability is regarded as a continuum, which point along this continuum would indicate language development compromised severely enough to warrant intervention? Although the difficulties that some children show are not necessarily significant enough to be classified as clinical impairment, these subtle subclinical weaknesses might have a significant impact on later academic performance, and thus merit early identification (Lyytinen, Eklund, & Lyytinen, 2005; Rescorla, 2009; Roos & Ellis Weismer, 2008).

In this research the terms *language difficulties* and *compromised language skills* are used to refer to the full variety of weaker language skills, ranging from mild to severe. The term *delay* is used to refer to children with (early) slowness in language and communication development, and *impairment* to refer to clinically significant language weaknesses not tied to a specific diagnostic label (see Figure 1; see also discussion of specific labels in Reilly, Bishop, & Tomblin, 2014). In line with the idea of a continuum, terms such as *late talkers* and *SLI* are considered to be labels that, based on predefined criterion, are afforded to different points along this continuum (Rescorla, 2009).

1.2.1 Children with language impairment – heterogeneity of difficulties

The assumption that language endowment forms a continuum which builds up from many skills subserving language implies the potential for a marked heterogeneity of symptoms in language difficulties (Dollaghan, 2004). According to Rescorla (2009, 2013), the subskills that comprise language may include auditory perception and processing, word retrieval, verbal working memory, motor planning, phonological discrimination, and grammatical rule learning. Weak

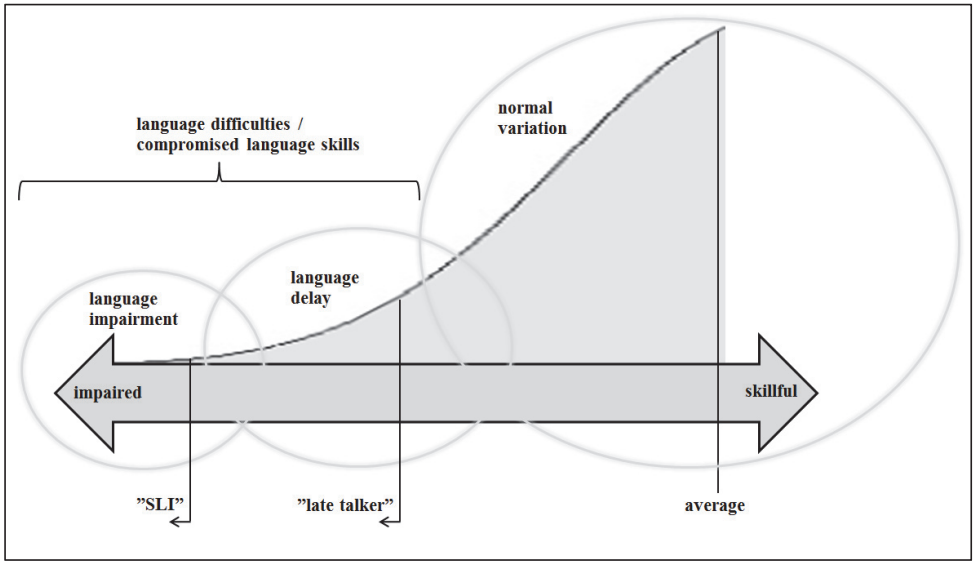

FIGURE 1 Language ability as a continuum

language ability can arise from weaknesses in any of these skills, and thus manifest differently across individuals (Rescorla, 2013). Indeed, children with language difficulties have been shown to exhibit highly varied skill profiles, a finding consistent across languages (Leonard, 2014; for Finnish, see Asikainen, 2005).

As a group, children with language impairment have been shown to have weaker skills compared with typically developing peers in several aspects of language. These include, among others, receptive and expressive vocabulary (Gray, Plante, Vance, & Henrichsen, 1999; Hick, Botting, & Conti-Ramsden, 2005; Rice & Hoffman, 2015), naming (Messer & Dockrell, 2006), semantic fluency (Weckerly, Wulfeck, & Reilly, 2001), rapid naming (Katz, Curtiss, & Tallal, 1992), mean length of utterance (Hewitt, Scheffner Hammer, Yont, & Tomblin, 2005; Rice et al., 2010), grammatical skills, syntax and, in particular, morphosyntax (Rice et al., 2008), and verbal working memory (Montgomery, Magimairaj, & Finney, 2010). However, not all children with language impairment show difficulties in all these aspects of language, and some have been found to show age-appropriate overall performance in standardized language tests, although their difficulties in language use in everyday situations are indisputable (Asikainen, 2005; Conti-Ramsden, Cruchley, & Botting, 1997; Rescorla, 2002). For example, in the studies of Asikainen (2005) and Conti-Ramsden and colleagues (1997) a small minority of children with clinically identified language impairment did not show deficiencies in any of the measured language tasks.

Efforts have been made to characterize the patterns of individual differences (i.e., distinguish different subgroups within children with language impairments) but none of the existing groupings has received consistent empirical support (for reviews, see Leonard, 2014; Tomblin, Zhang, Weiss, Catts, & Ellis

Weismer, 2004). Results have varied according to the sets of tests administered, and research has yet to reach a consensus regarding the attributes according to which these children should be classified. On the grounds of current research, it seems that the attributes of such a classification should be quantitative rather than qualitative. For example, Dollaghan (2004, 2011), applying a taxonomic method of analysis, found that language impairments seemed to be distributed in a dimensional rather than categorical fashion. In line with this, Tomblin et al. (2004) concluded that instead of different qualitative subtypes, children varied mainly by the severity of their impairment, pragmatic skills being the only exception. In similar vein, based on twin studies of language impairment, Bishop (2006) has argued that instead of discrete subtypes, research should be looking for "dimensions of impairment".

In addition to interindividual differences, weak early endowment may manifest differently over time within the same group of children (Rescorla, 2013). According to Rescorla (2013), when a group of late talkers were followed longitudinally from toddler age to adolescence the nature of the late talkers' "most substantial impairment changed over time, paralleling the language acquisition process" (p. 234). That is, children with early expressive language delay may catch up in several language skills, such as vocabulary and grammar, while still showing weaknesses in the ability to use complex, higher-order language skills. Similar findings have been obtained by Conti-Ramsden et al. (1997; Conti-Ramsden, & Botting, 1999), who reported a follow-up study on six linguistic subgroups and found that despite the stability in the exhibited patterns of difficulties, individual children varied from pattern to pattern over time. In addition, the difficulties presented a more varied picture with increasing age, including non-verbal ability and academic skills (Conti-Ramsden, Botting, Simkin, & Knox, 2001). Thus, it seems that language impairment is a dynamic difficulty with patterns of relative strengths and weaknesses within individuals changing over time and development (Conti-Ramsden & Botting, 1999).

1.2.2 Risk markers for language impairment

The large heterogeneity in the outcomes of children with language difficulties has led researchers to search for possible key difficulties, that is, risk markers that may help to distinguish the children at risk for the most persistent and substantial language impairments (Conti-Ramsden & Hesketh, 2003). A risk marker can be conceptualized in three ways: 1) a strong interpretation of a risk marker suggests that a marker represents both a clear symptom and a particular cause; 2) a weaker interpretation suggests that a marker represents the clearest symptom with no assumptions of specific causality; and 3) the mildest interpretation suggests that a marker represents one of the symptoms but does not assume specific causality or suggest that the symptom alone identifies the impairment (Conti-Ramsden & Hesketh, 2003). All three interpretations have been used in the research on risk markers (e.g., Bishop, North, & Donlan, 1996; Conti-Ramsden & Hesketh, 2003; Rice & Wexler, 1996), but researchers have yet to reach a consensus on the issue.

The two main approaches in the search for clinical markers for language impairment have traditionally been research based on processing considerations and research based on linguistic frameworks (Conti-Ramsden & Hesketh, 2003). From the processing point of view, one factor that has been rather consistently shown to relate to language ability and difficulties is working memory (e.g., Coady & Evans, 2008; Conti-Ramsden & Hesketh, 2003; Engel de Abreu, Gathercole, & Martin, 2011; Petruccelli, Bavin, and Bretherton, 2012; Rescorla, 2013; Vance, 2008). Working memory capacity has been shown to be associated with various aspects of language, such as new word learning, mean length of utterance, complex sentence comprehension, comprehension of narratives, and performance on standardized language tests (for a review, see Montgomery et al., 2010).

Working memory is a complex concept and has been conceptualized in several ways (for a review, see Miyake & Shah, 1999). One commonly used conceptualization is the working memory model of Baddeley (2003, 2012; originally presented in Baddeley and Hitch, 1974). This model distinguishes between short-term memory and more complex working memory. Both short-term and working memory involve temporary storage of material, but the difference lies in whether or not concurrent processing activity is required. Short–term memory tasks impose minimal processing demands, whereas working memory tasks engage the participant in significant processing activity. Baddeley's working memory model consists of two separate subcomponents for the immediate short-term retention of unprocessed information: the phonological loop for verbal material, and the visuospatial sketchpad for visuospatial short-term storage. It also includes two working memory components: the central executive, which is responsible for attentional control, and the episodic buffer, which supports the integration of representations from the working memory, long-term memory, and language processing systems (Baddeley, 2003, 2012).

Children with language difficulties have been shown to have deficits in several components of working memory, that is, in verbal short-term memory, in verbal working memory, and for some, in visuospatial short-term storage (e.g., Alt, 2011; Archibald & Gathercole, 2006). Among the tasks of working memory, nonword repetition (NWR) and sentence repetition (SR) have been suggested to be clinical markers of SLI (Bishop et al., 1996; Conti-Ramsden & Hesketh, 2003; Vance, 2008). These tasks have been shown to differentiate between children with language impairment and age-matched or language-matched children with typical development (Archibald & Joanisse, 2009; Conti-Ramsden, 2003; Conti-Ramsden & Hesketh, 2003). It has also been suggested that working memory deficits, as indicated by weak performance in the NWR or SR tasks, might serve as indicators of residual language difficulties even when the initial language difficulties have resolved (Conti-Ramsden, Botting, & Faragher, 2001; Thal, Miller, Carlson, & Vega, 2005).

In addition to NWR and SR, a third risk marker of language impairment, generated from the linguistic framework, has been suggested to be weak morphosyntactic skills, especially grammatical tense marking (e.g., Rice, Tomblin,

Hoffman, Richman, & Marquis, 2004; Rice & Wexler, 1996). For example, in a study by Rice et al. (2008) children with slow development in early expressive language demonstrated significantly weaker skills in syntax and morphosyntax in the context of age-appropriate performance on a global measure of language. However, there are doubts whether this risk marker has the same usefulness in languages other than English. It has been suggested that instead of grammatical tense marking, process-dependent tasks, such as NWR, may have greater validity across different languages, especially when languages that have a rich inflectional morphology are taken into account (Conti-Ramsden, 2003).

1.3 Predicting later language

Research has indicated that individual differences in several socio-cognitive, prelinguistic communication and early language skills predict later language development (e.g., Kaiser & Roberts, 2011; McCathren, Warren, & Yoder, 1996; Smith, 1998 Wetherby & Prizant, 2002). These skills include social engagement (Adamson et al., 2009), gaze following (Brooks & Meltzoff, 2008), and other forms of joint attention (Beuker, Rommelse, Donders, & Buitelaar, 2013; Laakso et al., 1999), gestures (Bates & Dick, 2002; Colonnesi, Stams, Koster, & Noom, 2010), deferred imitation (i.e., recall memory, Heimann et al., 2006), symbolic play (Bruce et al., 2003; Lyytinen, Poikkeus, Laakso, Eklund, & Lyytinen, 2001), early vocalizations (cooing, babbling, rate of consonantal babble; McCathren, Yoder, & Warren, 1999; Oller, Eilers, Neal, & Cobo-Lewis, 1998; Whitehurst, Smith, Fischel, Arnold & Lonigan, 1991), auditory language skills (such as speech segmentation; Newman, Ratner, Jusczyk, Jusczyk, & Dow, 2006), language comprehension (Smith, 1998), and vocabulary size (Lee, 2011; Marchman & Fernald, 2008).

While limitations in the identified skills place children more or less at risk for later language difficulties, these risks do not seem to operate in an absolute but rather in a probabilistic fashion (Fernald & Marchman, 2012; Thal & Katich, 1996). That is, no single socio-cognitive or prelinguistic skill has been found to consistently lead to later language difficulties. Thus, a reliable and accurate means of identifying children at-risk for persistent language difficulties continues to be lacking. One important confounding factor is the large variability in the research frames and methodologies of the predictive studies. The studies vary according to which prelinguistic skills have been measured, whether the study has focused on a single predictor or a combination of predictors, at which point in development these skills have been measured, whether prelinguistic skill development has been followed longitudinally, and which outcome measures have been used in the follow-up.

The majority of the predictive studies have concentrated on only one or very few prelinguistic predictors measured at a single point in time. Thus, despite the rather extensive literature on predictors of communication and language development, several questions remain that warrant further attention.

First, it has not been established which socio-cognitive and prelinguistic skills are the most relevant in identifying children at risk for developing persistent language difficulties (e.g., Law et al., 2000b). Second, it is still not possible to ascertain whether it is a *specific skill*, or a combination of skills at a *specific age,* or the *overall level* of early skills that is predictive of later language ability. In addition, few studies have examined the development of prelinguistic communication skills over time. It is possible that individual differences in the *pace of development* might better reflect children's later language learning potential (Rowe, Raudenbush, & Goldin-Meadow, 2012) or that *specific developmental patterns over time and several measures* might indicate greater risk for language difficulties (Darrah, Hodge, Magill-Evans, & Kembhavi, 2003). Thus, more research is needed to establish a more convergent understanding of the developmental processes in language and communication development and individual differences in those processes.

1.3.1 Development of prelinguistic skills

During the early stages of communication and language development children show a great deal of individual variation. That is, there are differences both *between* individuals in their rate of development (Bates, Dale, & Thal, 1995; Darrah et al., 2003; Fenson et al., 1994; Fenson et al., 2000; Thal et al., 1997) and *within* individuals between the different components of early communication and language and even within single language domains over time (Bates et al., 1995; Darrah et al., 2003; van Geert & van Dijk, 2002). Interindividual variation means that children may reach developmental milestones at different ages. For example, the typical age range has been reported to be 4 to 10 months for the onset of canonical babbling, 6 to 12 months for the emergence of joint attention, 8 to 10 months for the onset of word comprehension, and 8 to 16 months for first words (e.g., Bates et al., 1995; Bates & Dick, 2002; Karousou & López-Ornat, 2013; Morales et al., 2000; Oller et al., 1998).

Intraindividual variation means that a child's development may proceed at different rates in different aspects of communication and language. However, despite possible differences in the level of different concurrent skills, that is, an uneven profile of skills, it seems that prelinguistic skills are tightly connected. Studies that have considered the development of more than one prelinguistic skill simultaneously have reported significant correlations both concurrently and over time between measures of different early socio-cognitive skills, indicating a great deal of shared variance (e.g., Laakso et al., 1999; Watt et al., 2006). These findings imply that these skills do not follow completely separate developmental trajectories, but rather interact and co-develop, as suggested by the theories of both Bates (2004) and Rescorla (2009, 2013).

Despite substantial variation, findings of consistency in the relative standing of individuals in a group over time, that is, stability of language development, have also been reported (e.g., Bornstein et al., 2013; Bornstein & Putnick, 2012; Fenson et al., 1994; Hohm, Jennen-Steinmetz, Schmidt, & Laucht, 2007; Reilly et al., 2006; Thal et al., 1997). According to Bornstein and Putnick (2012)

and Bornstein et al. (2013), when multiple domains, measures, and sources are used across age, the individual differences in child language seem to be rather stable. This suggestion is in line with the assumptions of the dimensional view, that when language is seen as a whole comprising of several interrelated skills, the rank ordering of children displays stability even when variations exist in the subskills.

Although the developmental sequences of separate prelinguistic skills have been rather elaborately tracked (e.g., see Bates & Dick, 2002, for gestures; Carpenter et al., 1998, for joint attention; and McCune, 1995, for symbolic play), the stability of prelinguistic communication across several skills has been less intensively studied. The results remain inconclusive and vary depending on whether group level or individual level stability is examined. For example, Reilly and colleagues (2006) found that the best predictor of children's prelinguistic ability at 12 months of age, measured with a screener including several prelinguistic skills, was their performance in the same measure four months earlier, suggesting group-level stability across several skills. Similarly, Wetherby, Allen, Cleary, Kublin, and Goldstein (2002) have reported strong correlations between successive measurements of several prelinguistic skills at ages 13 and 20 months (r = .85–.91). Watt and colleagues (2006) also found significant longitudinal correlations both between corresponding scores and across different skills for joint attention, gestures, inventory of consonants, inventory of words, and language comprehension between ages 14 and 20 months. On the other hand, Darrah and colleagues (2003) found, in their study of stability of communication scores in children aged 13 to 21 months, that although the correlations between successive measurements were high (around .50), 40% of infants demonstrated unstable communication scores over time (i.e., change in percentile ranks). They concluded that typical development does not seem to be linear or to occur at a constant rate, and that fluctuations in an individual infant's scores may not necessarily be indicative of developmental deviance (Darrah et al., 2003).

1.3.2 What predicts later language ability?

Although research has established links between several early socio-cognitive and prelinguistic skills and later language ability, none of the predictors identified thus far have proven to have consistent predictive value. One potential explanation for this might be the large variability of predictors and outcome measures used between different studies. Indications that different prelinguistic communication skills may contribute distinctively to subsequent language development have been reported (Wetherby et al, 2002; Wetherby, Goldstein, Cleary, Allen, & Kublin, 2003). For example, Wetherby et al. (2002; Wetherby, Brosnan-Maddox, Peace, & Newton, 2008; Watt et al., 2006) found specific associations between early social and symbolic skills and later receptive language, early expressive skills and later expressive language, and early social skills and later ASD. Thus, it seems that the predictive relations might vary according to which skills are being used as predictors and what is being predicted, and be

affected by, for example, how fine-grained the outcome measures are (i.e., separate language variables, receptive vs. expressive language, or aggregated measures of general language ability).

It has also been suggested that the age at which these skills are assessed might affect the way they relate to later abilities (Bates & Dick, 2002; Heimann et al., 2006; Morales et al., 2000 Thal & Tobias, 1994; Watt et al., 2006). For example, it has been shown that the relationship between gesture and speech changes over time (e.g., Bates & Dick, 2002; Longobardi, Rossi-Arnaud, & Spataro, 2012). In the early stages of development, use of gestures positively correlate with emerging naming skills, whereas towards the end of the second year this might change into a negative correlation reflecting the overreliance of gestures over words in some children with language delays (Bates & Dick, 2002). Similar results have been obtained for joint attention (Morales et al., 2000). Thus, it seems that the predictive power of a certain skill might vary depending on whether the skill is just emerging or already more established (Brooks & Meltzoff, 2008; Rescorla, 2013; Rose, Feldman, Jankowski, & Van Rossem, 2008).

Another possibility for the lack of consistency in prediction is that no single prelinguistic skill is crucial for later language development. Early socio-cognitive and prelinguistic skills are not thought to map one-on-one with later language skills, but rather their interaction during development is thought to lay the foundation for later language ability (Bates, 2004; Rescorla, 2013). This is supported by the significant intercorrelations found on the one hand between different measures of socio-cognitive and prelinguistic skills (e.g., Laakso et al., 1999; Watt et al., 2006), and on the other between several early and later measures of language (Rescorla, 2013). It is possible that the predictive power lies in the interaction and co-development of these early skills.

Thus, in order to understand development and predictive relations, early socio-cognitive and communication skills should be studied together. Unfortunately, few predictive studies have addressed several of the prelinguistic predictors simultaneously. And even fewer studies have considered both the predictive power of the overall development of several prelinguistic skills and the possible unique contributions these skills have over and above that of the overall level. The few studies that have done so, have reported conflicting results. In some studies, when other prelinguistic communication skills have been controlled for, the unique predictive power of a single skill has been diminished (Lyytinen et al., 2001; Salley, Panneton, & Colombo, 2013), whereas in others (Bruce et al., 2003; Watt et al., 2006; Wetherby et al., 2002, 2003), specific relations have also been found. For example, Watt et al. (2006) found specific predictive connections between gestures and receptive language and joint attention and expressive language during the first half of the second year, between inventory of consonants and expressive language during the latter half of the second year, and between early language comprehension and receptive and expressive language throughout the second year.

However, Wetherby et al. (2002; Watt et al., 2006) found significant correlations between the different prelinguistic skills they studied, suggesting a large

amount of shared variance. The proportion of shared variance between the assessed skills was large relative to the unique contribution of the predicted variance, which led the authors to conclude that judgments about the relative importance of any particular skill in predicting language outcome should be guarded. They suggested that in order to strengthen the predictive value of prelinguistic skills, a combination of measures should be used (Wetherby et al., 2002). Similar conclusions have been reached in other studies that have included a rather comprehensive set of prelinguistic measures. These studies suggest that the accumulation of language-related risk factors increases the probability of later language difficulties (Darrah et al., 2003; Ellis & Thal, 2008; Law et al., 2000a; Lyytinen et al., 2001; Paul & Roth, 2011; Rescorla, 2009; Thal et al., 1997; Thal & Katich, 1996; Wetherby et al., 2002).

These findings suggest that an approach including several domains of early language and communication, rather than one examining the predictive power of a single skill, would be more suitable in trying to predict later language outcomes (e.g., Darrah et al., 2003; Law et al., 2000a; Lyytinen et al., 2001; Thal et al., 1997; Thal & Katich, 1996; Wetherby et al., 2002). The findings are also in line with the assumption of the dimensional view of language ability that weaker overall endowment leads to a weaker outcome later on (Rescorla, 2009, 2013). This is not to say that a single delay, especially if severe, would not count as a true risk, but it is likely that deficits in a single language domain would lead to different developmental outcomes than those associated with multiple deficits (Hulme & Snowling, 2009). Accordingly, Bishop (2006) has argued that a deficit in a single domain is rarely enough to seriously compromise language. She suggests that it is likely that there are multiple routes to effective language development and that more than one route has to be blocked for language ability to be compromised.

In addition to the overall level of early skills, which has been shown to be a major predictor of communication and language status later on (e.g., Bornstein & Putnick, 2012; Reilly et al., 2006, 2007), it has been suggested that the pace of development has a bearing on later language ability. According to Rowe et al. (2012), the pace of development might be more predictive of later language than the level at any certain age as "the rates of growth likely contain more information about the child's language acquisition potential than their ability at one point in time" (p. 510). For example, studies that have followed vocabulary development (Rescorla, Mirak, & Singh, 2000; Rowe et al. 2012) and early precursors of literacy (Lyytinen et al., 2006) have found that children with a slower pace or a declining trend of development compared to peers show weaker language skills later on. However, studies on the development of prelinguistic skills from this point of view continue to be lacking. In addition to just augmenting existing skills, growth in prelinguistic development also depends on the acquisition of new skills (Reilly et al., 2006), and thus measures that are able to capture this kind of growth could prove worthwhile in the study of the early stages of communication development.

1.3.3 In search of individual developmental trajectories - a person-oriented framework in the study of child language

The studies discussed so far focus more or less on prediction at the group level. That is, they seek to clarify which aspects of early development predict weaker language performance later on, and in what way children with language difficulties as a group differ from children with unproblematic language development. However, as Darrah et al. (2003) have pointed out, despite group-level stability (correlations as high as .50 between successive measurements of prelinguistic skills have been reported), the developmental profiles of individual children show significant variation. For the purposes of clinical practice, the ability to predict the developmental trajectories of individuals is of the utmost importance. The methodological options of the person-oriented framework might serve this goal.

The person-oriented approach emphasizes the individuality of development by positing that development is partly specific and unique to the individual (Sterba & Bauer, 2010). However, it also assumes that there is lawfulness in development that can be described by typical developmental patterns, which are often limited in number (Bergman, Magnusson, & El-Khouri, 2003; Bergman & Trost, 2006; Sterba & Bauer, 2010; von Eye & Bogat, 2006). Thus, the person-oriented approach suggests the possibility of distinct subgroups that show different patterns of development within a population. According to the person-oriented approach, the key to understanding developmental processes, and individual differences in those processes, is to search for these typical patterns of development, (i.e., developmental trajectories of individuals; Bergman et al., 2003; Bergman & Trost, 2006).

The theoretical foundation of the person-oriented approach lies in the holistic-interactionist framework (see Bergman et al., 2003 for an overview). In developmental psychology, adopting this perspective means conceiving developmental processes as systems comprising various interacting factors, and hence studying development as an integrated whole rather than as a collection of separate variables (Sterba & Bauer, 2010). The interacting factors form developmental patterns that have a meaning over and above the separate variables and thus these patterns can be a fruitful target of research (Bergman & Andersson, 2010; Bergman et al., 2003; Sterba & Bauer, 2010). Following these principles, instead of describing separate variables and group-level phenomena by means of static linear models, the focus of research is on patterns of information, individual development and the mechanisms of change (i.e., processes of development as dynamic systems; Bergman & Andersson, 2010). Thus, the person-oriented approach is not just a theoretical framework, but also has consequences for methodological issues, for example by stating that generalizations on an individual level cannot be obtained by using data aggregated over individuals (e.g., von Eye & Bogat, 2006). In person-oriented research the patterns formed by the values of variables are treated as the basic analytical unit and are often analyzed by applying some type of pattern-oriented approach (Bergman & Trost, 2006)

So far, research on child communication and language development has mainly been conducted from a variable-oriented perspective. However, in order to gain a convergent understanding of the developmental processes in early communication and language development, multiple domains of communication and language should be considered simultaneously. If language emerges from the interactions of many early cognitive and communication processes, as suggested by Bates (2004) and Rescorla (2013), these processes should be studied together and their development considered as a system over time. While the use of longitudinal designs and the person-oriented approach (either alone or in combination with variable-oriented analyses) in research of language development has been recommended (Hoff, 2006; Laursen & Hoff, 2006), little research using these approaches has been attempted in the field of prelinguistic communication and early language development.

In addition, more research is needed to understand individual differences in the processes of language development. The person-oriented approach facilitates the identification of distinct subgroups, that is, typical patterns of development (Laursen & Hoff, 2006; von Eye & Bogat, 2006). Examining these typical patterns over time and over different skills may yield interesting information on the rate and synchrony of language development (Conti-Ramsden et al., 1997; Darrah et al., 2003; Ellis Weismer, Murray-Branch, & Miller, 1994; Hoff, 2006). It is possible, for example, that children with a specific skills profile or a particular pattern of development over time are at greater risk for later language difficulties (Darrah et al., 2003; Lyytinen et al., 2006; Smith, 1998; Rescorla, Mirak, & Singh, 2000; Wetherby & Prizant, 2002).

Thus far, the majority of the research on subgroups has focused on finding different types of impairments within the group of children with SLI (e.g., Tomblin et al., 2004). In addition, this research has almost exclusively been limited to children of preschool age or older. In the earliest attempts to identify subgroups of children, a group of children with slow expressive language development (so-called late talkers), initially identified at ages between 18 and 32 months, were followed (see Rescorla & Dale, 2013 for a detailed discussion on late talkers). Based on retrospective analyses, these children have been divided into those with persistent difficulties and those whose difficulties seemed to resolve; the former group have been variously found to have weaker early receptive language and weaker gesture and symbolic skills (Rescorla & Dale, 2013). A few studies, using retrospective data, have attempted to identify more specific developmental trajectories of language development in children aged 2 to 5 years (Law, Rush, Anandan, Cox, & Wood, 2012; Peyre et al., 2014). These studies explored the risk factors associated with the identified trajectories and found that declining development and resilient development were in part predicted by different factors. So far, the only study attempting to identify subgroups of children with slow expressive language development based on a combination of concurrent putative predictors is that by Desmarais, Sylvestre, Meyer, Bairati, and Rouleau (2010). As well as the child's inventory of words, their study also took into account language comprehension, communication

skills, grammatical abilities, symbolic play, and cognitive development, and suggested that it is possible to identify groups of children who vary along a continuum of early language and communication abilities. However, information about whether these subgroups had differential outcomes later on is not yet available.

Studies on the co-development of several early language skills or prelinguistic communication skills in a nonclinical sample of infants continue to be very scarce. Those that have attempted to distinguish between transient and persistent language difficulties have reported that early communication and language delays lead to poorer language proficiency at the group level; at the individual level, however, accurate identification of at-risk children has not yet been accomplished (Dale et al., 2003; Ukoumunne et al., 2011). However, monitoring early communication and language development using multifaceted and repeated assessments might enable the identification of typical patterns of development that could lead to normal, compromised, or clinically impaired language skills.

1.4 Screening for language difficulties

The primary goal of screening is the early identification of language and communication difficulties, or risk for these difficulties, to enable the targeting of appropriate support (Carscadden et al., 2010; Pool & Hourcade, 2011; Stott, Merricks, Bolton, & Goodyer, 2002). Relevant questions in screening for early language and communication skills are when, by whom, and how the screening should be performed (Bruce et al., 2003). The few systematic reviews related to screening for speech and language difficulties published so far (Kasper et al., 2011; Law et al., 2000b; Nelson et al., 2006) have all expressed a need for further studies. For example, in their review, Nelson and colleagues (2006) concluded that several aspects of screening remain inadequately studied, and thus it is difficult to determine optimal methods such as which instruments to use, at what age to screen, and what frequency of screening is the most useful. The reviews so far have found a wide age range across studies (preschool age in Kasper et al., 2011; 0;7–6;5 years in Law et al., 2000b; 0–5 years in Nelson et al., 2006), and screening methods that mainly target the evaluation of expressive and receptive language. Thus, research systematically taking into account a variety of prelinguistic screening methods and the effectiveness of screening at the prelinguistic stage is largely nonexistent.

1.4.1 Feasibility of screening methods

Extensive research has been conducted on the continuity of several separate cognitive and communication skills from early infancy to later childhood (see section 2.3). However, most of these studies have not considered the feasibility of the methods used from the point of view of screening. So far, the majority of

these studies have adopted an experimental or observational approach, which as such, does not provide a means of assessment readily applicable in basic health care. Systematic psychometric testing, laboratory procedures, or home observations of infants by professionals is neither practical nor realistic in the basic health care system. The development of feasible procedures and methods of screening for use by the basic health care system in order to identify children at risk for later communication and language difficulties is therefore essential (see Warren, 2000).

Parent report measures of current communication and language skills have been shown to be reliable and valid, and to correlate with concurrent and subsequent behavioral measures (Feldman et al., 2005; Laakso et al., 1999; Rescorla & Alley, 2001). They have also been shown to be rather sensitive indicators of poor social-communication development (Ben-Sasson, Habib, & Tirosh, 2014) and language delays in young children (Heilmann, Ellis Weismer, Evans, & Hollar, 2005), although their ability to predict persistent language delay remains debatable (Law & Roy, 2008; Thal, O'Hanlon, Clemmons, & Fralin, 1999; Wetherby et al., 2003). In most cases, the sensitivity of the tests has been poorer than their specificity (Carscadden et al., 2010; De Koning et al., 2004; Dale et al., 2003; Law et al., 2000b; Law & Roy, 2008; Nelson et al., 2006; Feldman et al., 2005; Westerlund, Berglund, & Eriksson, 2006); that is to say, it is easier to identify children who do not have language problems than those who do.

On the question of the timing of screening, encouraging results have been obtained from examining the associations between parental reports obtained after 24 months of age and later communication skills and language ability (e.g., Pesco & O'Neill, 2012; Stott et al., 2002). For younger children, parent report measures have been shown to be robust indicators of concurrent language ability (e.g., Carscadden et al., 2010), although the predictive values have not reached acceptable levels. This has led many authors to conclude that screening under the age of 24 months may be too early (Dale et al., 2003; Feldman et al., 2005; Pesco & O'Neill, 2012; Westerlund et al., 2006). However, the majority of screening studies have focused on oral communication, the number of spoken words being the most common (and often the sole) indicator in efforts to identify at-risk children.

The measurement of skills assumed to be prerequisites for oral language, such as social communication, gestures, joint attention and symbolic abilities, might prove more successful before the age of 24 months (e.g., Ben-Sasson et al., 2014; Bruce et al., 2003; Wetherby et al., 2003). It has been shown that, compared to typically developing peers, children who later present with developmental difficulties show significantly weaker early communication skills already during the first two years of life (Veness, Prior, Eadie, Bavin, & Reilly, 2014). However, differential diagnosis between language difficulties, developmental delay, and ASD based on social communication skills might be difficult at this early age (Camarata, 2014; Veness et al., 2014; Wetherby et al., 2008). The application of a broadband screener that has the potential to identify a wide range of children who may benefit from early treatment might, however, be a feasible first

step, after which more specific methods could be used to focus the screening procedure (e.g., Barbaro, Ridgway, & Dissanayake, 2011; Pierce et al., 2011).

In a review of the feasibility of speech and language screening in older children, Law et al. (2000b) stated that a number of screening tests are adequate but that evidence warranting universal screening remains lacking. This led them to conclude that alternative methods of early identification should be explored. One possibility is systematic developmental surveillance of early communication skills instead of a one-time screening (Barbaro et al., 2011; Ben-Sasson et al, 2014; Darrah, et al., 2003). Developmental surveillance refers to an "ongoing and systematic collection of data relevant to the identification of a disorder over time" (Baird et al., 2001, p.468) implemented within a parent-professional partnership. The benefit of this type of screening is that it is able to take developmental change, that is, growth over time, into account.

It has also been suggested that in order to increase predictive validity, initial parental screening should be followed by a professional evaluation of the identified at-risk children (Ben-Sasson et al., 2014; Boyle, Gillham, & Smith, 1996; Bruce et al., 2003; Dale et al., 2003; Law et al., 2000b Miller et al., 2011; Wetherby et al., 2002). However, as Westerlund et al. (2006) point out, the functionality of such a two-stage procedure is dependent on the sensitivity of the initial screening measure. Thus, the initial screening procedures should be further developed to obtain higher rates of sensitivity even at the cost of lower specificity or a high amount of false positives, which then could be focused on in the second stage of screening (Stott et al., 2002; Westerlund et al., 2006).

1.4.2 The Infant-Toddler Checklist as a broadband screener for language and communication

Research is needed to evaluate whether repeated use of a parent-report screener would be a feasible way to depict early communication skill development, and whether this kind of assessment would be able to capture the features of early development that are essential for later language development. Currently, one of the most comprehensive parent-report screening tools for prelinguistic and early language skills (for a review of methods, see Crais, 2011) is the Infant-Toddler Checklist (ITC) of the Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP, Wetherby & Prizant, 2002). The ITC is a short parental screener that addresses several relevant aspects of prelinguistic communication development divided into three composites: social (emotion and eye gaze, communication, gestures), speech (sounds and words), and symbolic (understanding and object use). The questionnaire was developed as a broadband screening tool for the purposes of initial screening and surveillance of the development of communication and symbolic abilities between ages 6 to 24 months.

The ITC has been shown to be able to detect developmental growth and produce relatively stable rankings of children over short periods of time (Reilly et al., 2006; Wetherby et al., 2002). However, indications of instability in ITC rankings both between and within individuals have also been reported (Darrah

et al., 2003), which argues for the use of the ITC as a tool for repeated surveillance rather than as a one-off screener. It has also been suggested that the ITC serves as an ideal first pass developmental screen, as it is able to detect a wide range of communication-related disorders, such as global developmental delay, general language delay, and ASD (Pierce et al., 2011; Veness et al., 2011). However, studies using the ITC longitudinally to depict development are few in number, and studies that have extended their follow-up period beyond the toddler years even fewer (for exceptions see, Darrah et al., 2003; Reilly et al., 2006; Veness et al., 2011, 2014).

The concurrent and predictive validity of the ITC for both receptive and expressive language have been shown to be good up to the age of 3 years (Watt et al., 2006; Wetherby et al., 2002, 2003), and concurrent and longitudinal connections between the ITC and communication delays, including ASD, have been reported (Miller et al., 2011; Pierce et al., 2011; Veness et al., 2011; Wetherby et al., 2008). Based on concurrent face-to-face evaluation and follow-up testing of language skills, the sensitivity of the ITC has been reported to be 81% to 89% and its specificity 70% to 79% for children aged 12 to 24 months at the initial screening (Wetherby et al., 2003). The numbers of false positives and overreferrals are reported to be higher than false negatives and underreferrals (Pierce et al., 2011; Wetherby et al., 2003), which further suggests that the ITC could be a good candidate for the first step of a screening procedure.

1.5 Aims of the research

This research focused on the development of prelinguistic communication skills during the first two years of life and the developmental links between this early development and subsequent language ability up to school age. The longitudinal data set comprised seven repeated measurements of prelinguistic skills between 6 and 24 months, and five follow-up measurements of language and memory between the ages 2 and 8 years. The research had three main goals: 1) to depict the development and co-development of several early prelinguistic communication skills; 2) to study the links between this early development and later language ability and difficulties, as well as working memory; and 3) to explore the feasibility of early parental screening in identifying children at risk for later language and communication difficulties.

The first goal was addressed in Studies I and II. Study I approached the question from a variable-oriented framework by studying the development and interaction of several prelinguistic skills between ages 6 and 18 months using group-level statistics. Specifically, it was asked whether different prelinguistic skills show overlap or skill- and age-specificity in their development over time. The stability of individual differences in development during the prelinguistic period was also studied. Study II was conducted using a person-oriented approach, with the primary aim of identifying distinct typical developmental trajectories of prelinguistic skills between ages 12 and 21 months.

The second goal was addressed in all three studies. Study I explored which aspects of early development, such as the overall development of several prelinguistic skills and skill- and age-specific variation, best predicted later language ability on a group level between 2 and 8 years of age. Study II explored the associations between the different developmental trajectories and language-related difficulties at age 4 years 7 months (4;7), and Study III expanded this to include language difficulties and working memory capacity at age 5 years 3 months (5;3). The aim was to find out whether some of these trajectories indicate developmental risks for later language difficulties.

All three studies also addressed the third goal pertaining to the ability of a parental screener to monitor development and to highlight the features of prelinguistic development critical for the identification of children at risk for language difficulties. Specifically, Study I focused on whether there was continuity and stability from the early parent-report screener to later language ability measured using multiple methods and sources, whereas Studies II and III explored the predictive value of the screener on a more individual level by considering the values of sensitivity and specificity.

2 METHOD

2.1 Participants

The data collection was carried out between 2003 and 2011 as part of two research projects, Esikko (Firstling) and Tomera (Brisk), conducted in collaboration between the University of Jyväskylä and the Niilo Mäki Institute. The purpose of the project Esikko was to implement a user-friendly assessment tool for systematic surveillance of the development of prelinguistic communication skills under the age of two years for the use of basic health care providers. The participants were recruited through child health care clinics in the city of Jyväskylä, Central Finland. All the clinics in the area (population base close to 100,000, and age cohort of about 900 at the time) volunteered to participate in the study. Child health care clinics provide free services that focus on health promotion, risk assessment, and disease prevention, and are regularly attended by over 95% of Finnish parents and their children from birth to school age (for a more detailed description of pre- and postnatal care for families in Finland, see Callister, Lauri, & Vehviläinen-Julkunen, 2000). All families with a child between 6 and 24 months were invited to join the study, and in total 508 children (50.2% boys, 49.8% girls) and their families participated. The project Tomera followed the development of these same children until the spring term of first grade. The focus of the project was to study the children's language and communication, social and self-regulation skills in order to provide means for early identification and intervention.

The participants studied for this research represent subsets of this community-based longitudinal sample. Table 1 lists the number of participants in Studies I–III, and Table 2 the demographic characteristics of the original sample along with the subsamples used in the research. Demographic data related to birth and family were collected for the original sample at the time of recruitment and were available for 472–494 children.

TABLE 1 Number and age of the participants in Studies I–III

	Prelinguistic data		Follow-up data	
	n	Age (months)	n	Age (years;months)
Study I	427	6–18	91–253	2;0–8;4
Study II	271	12–21	187	4;7
Study III	271	12–21	91	5;3

The sample of children and families was reasonably representative of the Finnish population (Official Statistics of Finland, 2013; Vuori & Gissler, 2004). All the participating children spoke Finnish as their native language. Twenty-one children (4.3%) had been born preterm (i.e., gestational age less than 37 weeks; 5.7% in general population in 2003). Mean birth weight was 3.5 kg (SD = 0.6, range 1.1–5.4; population mean 3.5 kg). Mothers' mean age was 29.8 years (SD = 5.4; mean age of giving birth in general population 30.0), and fathers' mean age 32.1 years (SD = 6.3) at the initial assessment. Parental education was classified using a seven-point scale ranging from basic level (0 = no vocational education) to advanced educational training (6 = higher-level university degree). Mean educational level was 3.8 (SD = 1.9) for mothers, and 3.5 (SD = 1.9) for fathers. The distribution of the level of family education in the sample roughly followed the distribution of education in the general population: 7% of mothers and 6% of fathers (general population 6%) had no vocational education, 58% of mothers and 66% of fathers (general population 64%) had at least some vocational qualification, and 35% of mothers and 29% of fathers (general population 29%) had a master's or higher university degree.

There were small but significant differences in demographics between the children with follow-up data at age 5;3 and first grade (n = 100–102 and 266–272) and those without (n = 372–394 and 206–227). The participants, compared to nonparticipants, in the last two follow-ups had slightly older and more educated mothers (mother's age: 30.9 vs. 29.6, $p = .031$, $\eta_p^2 = .009$ at 5;3; 30.4 vs. 29.2, $p = .014$, $\eta_p^2 = .012$ in first grade; mother's education: 4.1 vs. 3.7, $p = .050$, $\eta_p^2 = .008$ at 5;3; 4.1 vs. 3.5, $p = .001$, $\eta_p^2 = .023$ in first grade). However, the effect sizes were small and only maternal education in the sample in first grade remained significant after correcting for multiple comparisons (Bonferroni correction). These results are in line with previous longitudinal studies of language, where attrition has tended to be lower among children with older and more educated mothers (e.g., Henrichs et al., 2011; Reilly et al., 2010). No other significant differences between the subsamples were found.

2.2 Procedure

The early questionnaire data were collected repeatedly every three months until the children were 24 months of age. Thus, the early questionnaire form was filled in a maximum of seven times: at ages 6, 9, 12, 15, 18, 21, and 24 months of

TABLE 2 Demographic information for the original sample, the sample in the early LGC model (Study I), the sample in the ECD model (Studies II and III), and the follow-up subsamples

	Original sample	Study I: Early LGC model	Studies II and III: ECD model	Follow-up 2 years	Follow-up 3 years	Follow up 4;7	Follow-up 5;3	Follow-up first grade
n	508	427	271	104	112	296	102	273
Males/females, %	50.2/49.8	50.8/49.2	54.2/45.8	54.8/45.2	57.1/42.9	51.0/49.0	52.0/48.0	50.9/49.1
Preterm birth (< 37 wk), n (%)	21 (4.3)	20 (4.9)	11 (4.1)	6 (5.8)	7 (6.3)	10 (3.4)	4 (3.9)	9 (3.3)
Birth weight, M (SD), kg	3.5 (0.6)	3.5 (0.6)	3.5 (0.5)	3.6 (0.6)	3.6 (0.6)	3.6 (0.5)	3.5 (0.6)	3.6 (0.5)
Birth order, first born, n (%)	267 (56.6)	216 (54.8)	139 (55.4)	49 (50.0)	51 (48.6)	161 (58.5)	50 (51.0)	141 (55.3)
Single parents[a], n (%)	19 (3.9)	15 (3.6)	7 (2.7)	2 (2)	3 (2.7)	8 (2.8)	0 (0)	5 (1.9)
Parental education[a], M (SD)								
Mother	3.8 (1.9)	3.8 (1.9)	4.0 (1.9)	4.1 (1.8)	4.1 (1.9)	3.9 (2.0)	4.1 (2.0)	4.1 (1.9)
Father	3.5 (1.9)	3.6 (1.8)	3.7 (1.8)	3.5 (1.8)	3.8 (1.7)	3.6 (1.9)	3.8 (1.8)	3.6 (1.8)
Parental age[a] M (SD), y								
Mother	29.8 (5.4)	29.7 (5.4)	30.3 (5.2)	30.4 (5.1)	30.6 (5.2)	30.2 (5.3)	30.9 (5.2)	30.4 (5.2)
Father	32.1 (6.3)	32.0 (6.4)	32.6 (6.5)	32.5 (6.0)	32.7 (5.7)	32.4 (6.1)	32.5 (5.8)	32.4 (6.3)

Note. Coverage of the demographic data varied between 472–494 in the original sample, 394–416 in the early LGC model sample, 251–271 in the ECD model, 98–104 at 2 years, 105–111 at 3 years, 275–291 at age 4;7, 98–102 at age 5;3, and 219–235 in the first grade. The percentages are calculated from the available data. LGC = latent growth curve; ECD = early communication development.

[a] At time of initial recruitment.

age (see Table 3 for sample sizes by age). The total number of forms filled in by parents depended on their child's age at the time of recruitment and on how many of the subsequent forms they completed. For the majority of the sample (67.9%) data were available from at least three measurement points.

Subgroups of the original participants were followed after the early questionnaire data collection phase at ages 2, and 3 years (parent report and individual assessment), 4;7 (parent report), and 5;3 years (individual assessment), and in the spring term of the first grade (age range 7;2–8;4, parent report). At age 2 years, a subset of 143 families was invited to fill in a questionnaire on the vocabulary development of the children. Of these families 104 (72.7%) returned the questionnaire. At the age of 3 years, the same families were re-invited to attend an individual assessment of their child's vocabulary and 112 (78.3%) agreed to participate. When the children had reached age 4;7, all of the originally participating families were contacted again. The families were sent a questionnaire to assess their child's language and communication skills. Of the 508 families, 473 were reached, and 296 (62.6%) returned the questionnaire. At age 5;3, a subsample of 102 children were met for individual assessment of language and working memory. The final follow-up was conducted during the spring term of first grade (mean age in months = 93.3, SD = 3.9, range 86–103). All the originally participating families were contacted and sent a questionnaire on their child's language and communication skills. Of these families, 453 were reached, and 273 (60.3%) returned the questionnaire. More detailed descriptions of attrition along with the rationale for the selection of the subsamples are given in the original papers.

2.3 Measures

The assessment phases and measures used are presented in Table 3. Parents completed questionnaires every three months between ages 6 and 24 months and at the follow-ups at ages 2 years and 4;7, and first grade. Face-to-face assessments were administered at ages 3 years and 5;3. More detailed descriptions of the measures are given in the original papers.

Early communication measure

Early communication skills were measured with the Finnish version of the Infant-Toddler Checklist (ITC) of the Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP, Laakso, Poikkeus, & Eklund, 2011; Wetherby & Prizant, 2002). The ITC is a parent-report screening tool comprising 24 questions designed to measure relevant prelinguistic milestones of early communication and language development in children aged 6 to 24 months. The questions are organized into three composites that cover several areas of communication development: The *social composite* consists of 13 questions on emotion and use of eye gaze, communication, and gestures. The *speech composite* comprises five questions that survey sounds and words. The *symbolic*

TABLE 3 Assessment phases and measures used in Studies I – III

Age	*n*	Source	Measure	Components	Studies		
					I	II	III
6 months	229	Parent report	Communication and Symbolic Behavior Scales – Infant Toddler Checklist (ITC)	Social, Speech, and Symbolic	x		
9 months	203				x		
12 months	322				x	x	x
15 months	305				x	x	x
18 months	279				x	x	x
21 months	273					x	x
24 months	330						
2 years	104	Parent report	MacArthur-Bates Communicative Development Inventories – Words and Sentences Inventory	Vocabulary	x		
				Inflections	x		
				Maximum sentence length	x		
3 years	112	Individual assessment	Boston Naming Test	Expressive vocabulary	x		
			Peabody Picture Vocabulary Test-Revised	Receptive vocabulary	x		
4;7	296	Parent report	Five to Fifteen (FTF) – Language subscales	Comprehension	x	x	
				Expressive	x	x	
				Communication	x	x	
5;3	102	Individual assessment	WPPSI-R – Similarities	Verbal reasoning	x		x
			Peabody Picture Vocabulary Test-Revised	Receptive vocabulary	x		x
			Korpilahti Auditory Sentence Comprehension	Receptive grammar	x		x
			NEPSY-II – Verbal Fluency	Verbal productivity	x		x
			Rapid Automatized naming	Naming speed			x
			WISC-III – Digit Span	Working memory	x		x
			NEPSY – Repetition of Nonsense Words	Working memory	x		x
			NEPSY-II – Sentence Repetition	Working memory	x		x
			Corsi Block Task	Working memory			x
1st grade	273	Parent report	Children's Communication Checklist - II	Language: Speech, Syntax, Semantics, Coherence	x		
				Communication: Inappropriate initiation, Stereotyped language, Use of context, Non-verbal communication	x		

composite contains six questions related to understanding and object use. The ratings are either on a three-point scale (0 = not yet, 1 = sometimes, 2 = often) or on scales that describe a series of numbers or ranges scoring 0 to 4 points, resulting in a possible maximum score of 26 for the social composite, 14 for the speech composite, and 17 for the symbolic composite.

Follow-up measures

Measures at 2 years

Early expressive vocabulary was assessed with the Finnish version of the MacArthur-Bates Communicative Development Inventories Words and Sentences (MCDI; Fenson et al., 1994; Lyytinen, 1999). The questionnaire includes a predefined vocabulary checklist of 595 words, a 16-item checklist of common inflections, and asks parents to write verbatim the three longest sentences their child has produced.

Measures at 3 years

Children's single-word receptive vocabulary was assessed with the Peabody Picture Vocabulary Test – Revised (PPVT-R; Dunn & Dunn, 1981). The test consists of 166 words each accompanied by four line drawings from which the child selects the one compatible with the word.

Single-word expressive vocabulary was assessed with Boston naming (Kaplan, Goodglass, & Weintraub, 1983) in which the child is shown 60 pictures one at a time and asked to name them.

Measures at 4;7

Children's language-related difficulties were assessed using the questionnaire Five to Fifteen (FTF; Kadesjö et al., 2004). The language domain of the FTF comprises 21 questions divided into three subscales that cover comprehension (five questions), expressive language (13 questions), and communication skills (three questions). Ratings are made on a three-point scale (0 = does not apply, 1 = applies sometimes or to some extent, 2 = definitely applies). As the FTF is a symptom questionnaire based on parent report, the results are regarded as representative of parental concerns as opposed to clinically evaluated difficulties. The 90th percentile cutoff recommended by the original authors (Korkman, Jaakkola, Ahlroth, Pesonen, & Turunen, 2004) was used to indicate a heightened risk for developmental difficulties.

Measures at 5;3

Language. The language tasks were selected to cover various dimensions of language in both the receptive and expressive domains, as suggested by Conti-Ramsden and Durkin (2012). Compromised language skills were defined as performance at or below -1 SD in at least two of the language measures.

The Similarities (SI) subtest of the Wechsler Preschool and Primary Scale of Intelligence – Revised (WPPSI-R; Wechsler, 1995) was used to assess verbal abstract reasoning and conceptualization abilities. The test consists of 20 items

divided into three types of tasks where children choose compatible pictures, complete sentences and explain how two things are alike.

Single-word receptive vocabulary was assessed with a shortened 30-item version of the Peabody Picture Vocabulary Test – Revised (PPVT-R; Dunn & Dunn, 1981). The items were selected based on the data of another Finnish study, the Jyväskylä Longitudinal Study of Dyslexia (see Lyytinen et al., 2004; Lyytinen et al., 2006).

The Korpilahti Auditory Sentence Comprehension test (SC; Korpilahti, 1996) was used as a measure of receptive grammar. The test assesses the ability to process semantic and syntactic information in sentences of increasing complexity. The child is read 30 sentences and asked to choose a compatible picture from three options.

The Verbal Fluency (VF) subtest of NEPSY-II (Korkman, Kirk, & Kemp, 2008) was used to assess verbal fluency and vocabulary through the ability to generate words within specific semantic categories (animals, foods) in 60 seconds.

Speed and accuracy of naming was assessed with the task of Rapid Automatized Naming (Ahonen, Tuovinen, & Leppäsaari, 2003; see also Denckla & Cutting, 1999). The task features an array of 50 pictures (car, house, fish, pen, and ball) that alternate in random order. The child is asked to name them as fast as possible without errors.

Working memory. The working memory tasks were selected to measure different subsystems of Baddeley's (2003, 2012) model of working memory following the conceptualizations of Archibald and Gathercole (2006) and Petruccelli and colleagues (2012).

The Digit Span subtest (DS) of the Wechsler Intelligence Scale for Children – Third edition (WISC-III; Wechsler, 1999) comprises two parts. In the first part, the child repeats a dictated series of digits verbatim (forward part, DSf), and in the second part the child repeats the series backwards (backward part, DSb). The series begins with two digits and increases in length with two trials at each length. The DSf is regarded as tapping the phonological loop (i.e. auditory short-term memory) and the DSb as tapping both the phonological loop and the central executive (e.g., Vance, 2008).

Nonword repetition (NWR) ability was assessed with the Repetition of Nonsense Words test of NEPSY (Korkman, Kirk, & Kemp, 1997) in which the child is asked to repeat verbatim 16 nonwords that increase in length from one to six syllables. The nonwords conform to the phonotactic rules of Finnish but are low in word likeness and phonotactic frequency. The test is regarded as tapping the phonological loop along with many language-related processes such as speech perception, phonological encoding and assembly, and articulation (Coady & Evans, 2008).

The Corsi Block Task (CB; Corsi, 1972) was used to assess visual short-term memory (i.e., the visuospatial sketchpad). In this task, the examiner taps a sequence of identical spatially separated blocks, the length of the sequence ranging from two up to nine blocks, and the child repeats the action.

The Sentence Repetition (SR) test of NEPSY-II (Korkman et al., 2008) comprises 17 sentences of increasing complexity and length. The sentences are read to the child, who is then asked to recall each verbatim immediately after its presentation. The task requires the integration of phonological information from temporary memory stores with lexical and semantic information from long-term memory systems, and is thus considered to be a suitable task for measuring the episodic buffer, which is responsible for storing chunks of such integrated information (Alloway & Gathercole, 2005; Baddeley, 2000; Boyle, Lindell, & Kidd, 2013).

Measures in first grade

The Finnish version of the Children's Communication Checklist-II (CCC-2; Bishop, 2003; 2014; Norbury, Nash, Baird, & Bishop, 2004) was used to assess children's language and communication difficulties. This parent-report questionnaire includes four subscales evaluating language-related abilities (speech, syntax, semantics, coherence) and four subscales focusing on pragmatics (inappropriate initiations, stereotyped language, use of context, nonverbal communication). Each scale comprises 5 questions on difficulties, and 2 question on strengths that are rated by frequency on a four-point scale (0 = less than once a week; 3 = several times a day/always).

2.4 Statistical analyses

Both variable-oriented and person-oriented approaches were used in the analyses reported here. Analyses were performed using Mplus statistical package 5.1 (Muthén & Muthén, 1998–2007) and 7 (Muthén & Muthén, 1998–2010), and IBM SPSS Statistics for Windows, versions 19.0.0.1, 20.0.0.2, and 23.0.0.0. Table 4 presents an overview of the research aims along with specific questions and analysis methods by study (I–III). The analyses were chosen based on the assumption that the early skills co-develop and are connected to later development. Correlations within and between the three ITC composites over time are shown in Appendix 1 and between the ITC composites and the follow-up measurements in Appendix 2. As was expected due to the sequential nature of the data, all the successive measurements within the three ITC composites correlated significantly with each other. There were also significant correlations between the three ITC composites within and between different ages, indicating that the three areas of development are interconnected and thus, the examination of their co-development seemed justified. The significant correlations between the ITC composites and the follow-up measures, in turn, suggested that there is a connection between early communication development and later language ability and difficulties.

In Study I, Latent Growth Curve modeling (LGC) was used to analyze the repeated measures of early communication skills. The aim was to model development in each composite of the ITC (social, speech, and symbolic) and to

TABLE 4 Overview of the research questions and methods of analysis by research aims and Studies I-III

	Aims of the research		Specific Research Questions by Study	Data analyses
1.	to describe the development of several early prelinguistic communication skills	I:	How is the development of prelinguistic communication skills described by repeat assessments at ages 6 to 18 months with respect to: a) the stability of individual differences over time? b) developmental overlap and specificity between different skills?	Latent Growth Curve modeling (LGC)
		II:	Can meaningful individual developmental trajectories be found by studying the development of prelinguistic communication skills longitudinally between ages 12 and 21 months?	Latent Profile Analysis (LPA)
2.	to examine the predictive relations between prelinguistic development and later language ability and difficulties and working memory	I:	Which aspects of prelinguistic communication skill development best predict language ability at ages 2 to 8 years?	Regression analysis
		II:	What associations are there between early trajectories and later language difficulties reported by parents at age 4;7 years? Is it possible to identify risk trajectories?	Crosstabulation Chi-square test
		III:	Is there continuity between prelinguistic communication skill development (i.e., early developmental trajectories) and individually assessed language outcomes at age 5;3 years at both the group and individual levels?	ANOVAs with post hoc (Kruskall-Wallis test) Crosstabulation, chi-square test
			Do children with different early developmental trajectories show differences in kindergarten-age working memory capacity?	ANOVAs with post hoc (Kruskall-Wallis test)
3.	to evaluate the feasibility of early parental screening in identifying children at risk for later language and communication difficulties	I-III:	No specific research questions stated in the original studies. Study I focused on continuity and stability between the development of prelinguistic skills assessed by the early parent-report screener and later language ability measured using multiple methods and sources. Studies II and III explored the predictive value of the screener by examining the values of sensitivity and specificity.	Descriptive statistics Sensitivity and specificity analyses

describe the commonalities of development across these composites by using second-order factors. The associations between early communication skill development and later language ability were explored by running separate regression analyses between the second-order factors of the LGC model and the measurements at each follow-up stage. Specific pathways were built on the basis of the model modification indices in order to test skill- and age-specific connections.

In Study II, Latent Profile Analysis (LPA) was used to explore typical patterns of development when following several prelinguistic skills longitudinally, that is, the three composites of the ITC over four consecutive time points. The theoretical basis for the analysis was the person-oriented approach, which posits three criteria for research (von Eye & Bogat, 2006): 1) it is assumed that the sample is comprised of several populations (i.e., subgroups) that differ in parameters (means and variances) and functional characteristics; 2) attempts are made to establish external validity for the subgroups; and 3) the subgroups either have an a priori meaning or are interpretable based on substantive theory. Thus the aim of the analysis was to find latent subgroups of early communication development (ECD) that differ from one another in the mean values of the observed variables, that are theoretically meaningful, and that might have meaningful connections to later language development. The external and predictive validity of the ECD groups was examined by exploring whether the extracted subgroups differed in their gender distribution or in their follow-up outcomes at age 4;7. These further analyses were performed with cross-tabulations and chi-square tests using Monte Carlo simulations and exact tests.

In Study III, the ECD groups were compared in their language and working memory abilities at age 5;3 by performing analyses of variance (ANOVAs) with a post hoc test using the least significant difference method. The results were confirmed using the nonparametric Kruskall-Wallis test, as owing to the large heterogeneity in group sizes and variances, and the rather small size of some of the groups. The individual level analyses were conducted by means of cross-tabulation and chi-square test using exact tests. Effect sizes were estimated by partial eta squared (Cohen, 1992) for the ANOVAs, and Cramér's V (Cramér, 1946) for the chi-square tests.

2.4.1 Latent growth curve modeling

The analysis method used in Study I was a type of second-order multivariate Latent Growth Curve modeling (LGC, Bollen & Curran, 2006; factor-of-curves, Duncan, Duncan, & Strycker, 2006; McArdle, 1988). This type of modeling is used to determine if development in one behavior co-varies with development in other behaviors. According to Duncan and colleagues (2006, p. 63), multivariate LGC provides a "more dynamic view of the correlates of change, as development in one variable can be associated with development in another variable". In the factor-of-curves model it is examined whether a second-order factor structure adequately describes the covariances among lower order developmental functions (Duncan et al., 2006).

The estimation method was maximum likelihood with robust standard errors (MLR), which allows for the processing of skewed variables (Muthén & Muthén, 1998–2010). The missing data function enables the use of all available observations in the data in estimating the parameters of the models. This estimation method corresponds to the full-information maximum likelihood (FIML) method which does not require the same number of items, observations, or variables for every individual, as the log-likelihoods are written for each individual based on the individual's observed data (e.g., Enders, 2010; Graham & Coffman, 2012). FIML preserves key relationships among variables, better estimates the variability in the data, and improves the accuracy of parameter estimates, yielding more valid results, and thus its use is recommended over other methods, such as listwise deletion (see, Enders, 2010; Jeličić, Phelps, & Lerner, 2009). In addition, listwise deletion, pairwise deletion and mean substitution require that missing values are missing completely at random (MCAR). FIML assumes that missing values are missing at random, which is less stringent condition.

Mplus provides several fit indices that can be used to evaluate the goodness-of-fit of the model. These include the chi-square test, Comparative Fit Index (CFI), Tucker-Lewin Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Error of Approximation (SRMR) (Muthén & Muthén, 1998-2010). According to Hu and Bentler (1999), the values of chi-square test $p > .05$, CFI $\geq .95$, TLI $\geq .95$, RMSEA $< .06$, and SRMR $< .08$ indicate good model fit. However, these values should not be used as definitive cut-off criteria but rather as guidelines for evaluating the model fit, as Marsh, Hau, and Wen (2004) have critically pointed out. It has also been suggested that the chi-square value is sensitive to large sample sizes (Miles & Shevlin, 2007) and thus chi-square values should be interpreted with caution. In addition to fit indices, model modification indices and substantial theory can be utilized in specifying the model.

LGC was used in Study I to explore the co-development of social, speech, and symbolic skills during the prelinguistic period and the stability of individual differences over time. The growth curves were first applied simultaneously to the social, speech, and symbolic composites. The initial level of each composite (i.e., the level), the average rate of growth (i.e., the slope), and individual variation in the initial level and growth were estimated. These first-order factors described individual differences within each ITC composite. Then, to describe the features of development shared among the three ITC composites (i.e., to model the correlation structure between the first-order factors), second-order common factors (overall level and growth) were added. The model was further improved using the model modification indices. Three age-specific factors were added to explain the residual covariance at ages 9, 12, and 15 months. A more detailed description of the different steps of the analysis is given in the original paper.

2.4.2 Latent profile analysis

Latent profile analysis (LPA) is a type of finite mixture analysis (Muthén, 2001). The model is estimated using the missing data function (Muthén & Muthén, 1998–2007). The use of the MLR estimation method allows for the use of slightly skewed variables (Muthén & Muthén, 1998–2007). The modeling is based on the idea that the observed data can represent different subpopulations (i.e., latent classes) and that these classes can be identified and their parameters estimated (Muthén & Shedden, 1999; Muthén, 2001). In LPA, a latent class has a common mean trajectory and individuals' deviation from this mean is expected to consist of random residuals that are normally distributed (Nagin, 2005).

The number of latent classes is decided based on statistical criteria, alongside theoretical considerations. In order to the model to be reliable and to avoid local solutions, the model has to be estimated with several different starting values (Muthén & Muthén, 1998–2007). The statistical fit information is calculated for each model (1-class, … k-class) and the models can be compared on the basis of this information. The criteria used in this study were the Bayesian Information Criterion (BIC; Schwartz, 1978) and the parametric Bootstrapped Likelihood Ratio Test (BLRT; Muthén & Muthén, 1998-2007), as these two criteria have been found to be the most consistent in identifying the best-fitting solution in simulation studies (Nylund, Asparouhov, & Muthén, 2007; Tolvanen, 2007). The BIC is a fit index that evaluates model fit with regard to the number of parameters that are estimated by imposing a penalty for increasing the number of parameters. The lower the value of the BIC, the better the model fits the data. The BLRT estimates the k and k-1 class solutions for a previously defined number of replications of simulated data, and compares these solutions. A *p*-value lower than .05 suggests that the k latent classes fit the data better than the k-1 classes.

The statistical quality of the classification, that is, how well the model classifies individuals into subgroups (i.e., how distinctive the latent groups are), can be evaluated using the estimates of Entropy and Average Latent Class Posterior Probabilities (AvePP; Muthén & Muthén, 1998-2007). The values of these two indicators vary between 0 and 1. The higher the values, the clearer the solution and the more distinct the latent groups are from one another. An AvePP greater than .70 has been suggested to indicate that the solution is interpretable using the mean trajectories (Nagin, 2005).

LPA was used in Study II to extract individual developmental trajectories. The model estimation proceeded stepwise starting from the one-class solution and continued until the nine-class solution. The solutions were assessed for 1) reliability and stability, by examining the set of different starting values by which each solution was obtained; to avoid local solutions, the model has to be produced with several different starting values; 2) goodness-of-fit, by using BIC and BLRT; 3) statistical quality (i.e., distinctiveness), by examining the Entropy and AvePP values; and 4) their interpretability with respect to substantive theory. A more detailed description of the analysis is given in the original paper.

3 OVERVIEW OF THE ORIGINAL STUDIES

3.1 Study I

Continuity from prelinguistic communication to later language ability: A follow-up study from infancy to school age

This longitudinal prospective study examined the development and continuity of communication and language in 427 Finnish children from the prelinguistic stage to school age. First, the study addressed how prelinguistic communication skills develop during the first two years of life. Prelinguistic communication was followed repeatedly between 6–18 months of age with a multifaceted parental screener that covers several relevant areas of prelinguistic development, organized into three composites (social, speech, and symbolic). The development within and between the composites over time was modelled using latent growth curve modelling (LGC). Of interest was whether development in these three areas would show mainly shared features or also skill- and age-specific variance. Second, it was examined which aspects of prelinguistic communication skill development (common, that is, shared level or pace of development or skill- or age-specific factors) best predict later language and communication abilities. Follow-ups were conducted at ages 2 years (n = 104), 3 years (n = 112), 4;7 (n = 253), 5;3 (n = 102) and in first grade (mean age 7;9, n = 236). Various areas of language and communication were assessed using multiple measures and multiple sources of information.

Prelinguistic development across several skills emerged as a rather continuous and stable characteristic of individual differences during the first two years of life. All three composites (social, speech, and symbolic) showed marked growth and large inter-individual differences throughout the assessment period. However, the relative standings of individuals over time were rather consistent within the composites. The LGC model also suggested that there is a large amount of shared variance across the composites. That is, individuals tend to have a similar ranking relative to others and the rate of devel-

opment tends to be similar across the three composites. In addition to the notable commonalities, there was also significant skill- and age-specific variation in development.

The results also suggested continuity from prelinguistic development to later language ability. The common level and growth of prelinguistic communication skills were significant predictors of language ability between ages 2 to 7;9 years. The pace of development across multiple early skills, in particular, contributed to later language ability, with faster pace leading to better language skills. That is, the children who had a faster rate of growth in early communication skills during the period from 6 to 18 months showed better vocabulary skills at ages 2 and 3 years, had fewer parent reported concerns about language and communication development at age 4;7 and in first grade, and showed better language and verbal working memory skills at age 5;3. The percentage explained by the common level and growth factors of the LGC model varied from 10.5 to 53.3%, with the strongest predictive relation found between the growth of early skills and later verbal working memory capacities. No reliable skill- or age-specific connections were found.

Overall, the results indicate that the progression of development of prelinguistic communication skills shows similarities across several skills, and that individual differences in these skills are fairly stable throughout early development. The results also indicate that the individual variations in early language endowment show consistency that extends far beyond the toddler years, and thus support a developmental continuum from prelinguistic to linguistic ability (Bruner, 1983), and the dimensional view of language ability (Rescorla, 2009, 2013). The results also show that the link between early and later communication skills is not purely specific to language skills, but also reflects other underlying cognitive skills, such as memory. With regard to screening procedures, the results advocate developmental surveillance of several early communication skills by showing that the combined pace of development of various early communication skills better predict later language outcome than any specific skill at any given age alone.

3.2 Study II

Developmental trajectories of early communication skills

This study examined developmental trajectories of prelinguistic skills and their connections to later parent-reported language difficulties. First, following the premises of the person-oriented framework (Bergman et al., 2003; Bergman & Trost, 2006), developmental trajectories, that is, typical patterns or subgroups of prelinguistic development between ages 12 and 21 months across three relevant prelinguistic domains (social, speech, symbolic) were identified using latent profile analysis (LPA, n = 271). Second, the identified groups' outcomes measured with a parent-report three years later were compared in order to find out

whether certain trajectories reflect possible developmental risks for later language difficulties (n = 187).

The LPA results showed six different early communication development (ECD) groups that were clearly separate statistically and interpretable in accordance with substantive theory (see Figure 2.). The development of skills within a single domain over time was relatively stable in the majority of the groups, and the groups generally retained their order relative to each other. There were differences between the groups both in the overall level of development (i.e., all three composites on the same level; groups 1 A, Average, 2 AA, Above average and 6 BD, Broad difficulties), and in the shape of the developmental pattern (i.e., differences in the level between the three skill domains; groups 3 A+So, Average with fluctuating social skills, 4 BA+Sy, Below average with symbolic difficulties, and 5 ED, Expressive difficulties).

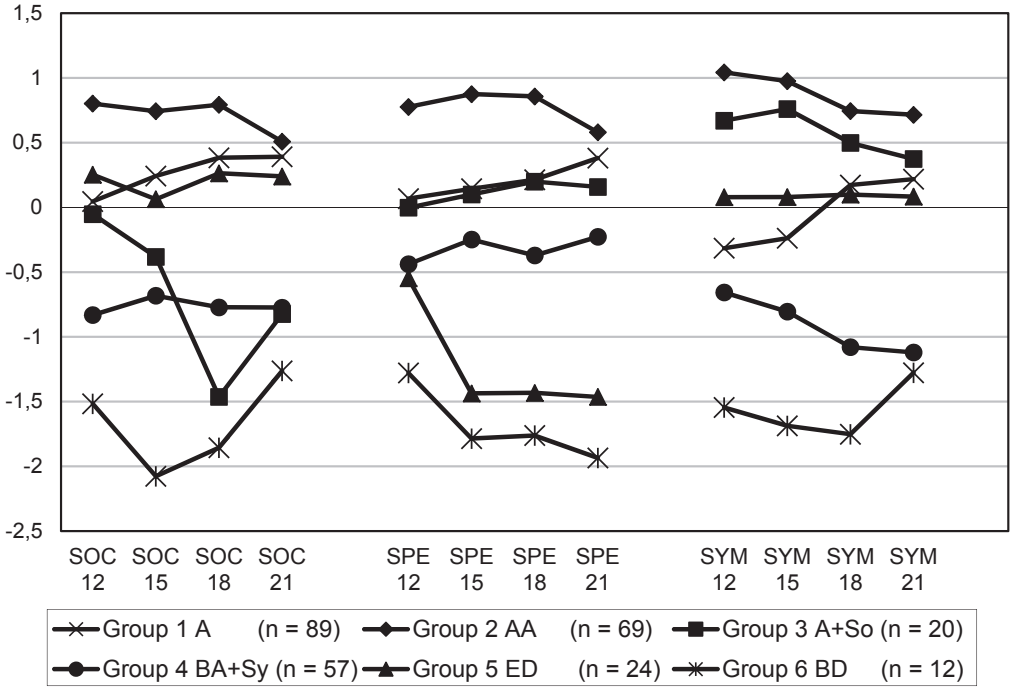

FIGURE 2 The profiles of the Early Communication Development (ECD) groups. Profiles are based on standardized estimated means. ITC = Infant-Toddler Checklist; SOC = Social composite of the ITC; SPE = Speech composite of the ITC; SYM = Symbolic composite of the ITC; A = Average; AA = Above average; A+So = Average with fluctuating social skills; BA+Sy = Below average with symbolic difficulties; ED = Expressive difficulties; BD = Broad difficulties.

The six ECD groups showed meaningful longitudinal connections to later parent-reported concerns over language difficulties three years later, at age 4;7. The outcome measure was a symptom questionnaire, which includes questions

about receptive, expressive, and communication skills. The 90th percentile cutoff used in this study indicates a heightened risk for developmental difficulties. Using crosstabulation, significant differences between the outcomes of the different ECD groups emerged. A tendency toward slow early communication development leading to an increased rate of parent-reported concerns about language development was detected. Based on lower than average performance in early development and on the follow-up parent-report, three groups were identified as showing at-risk features, each showing a different combination of weaknesses: Group 4 BA+Sy showed slow development in symbolic skills and, to some extent, in social skills; Group 5 ED fell behind their peers in early speech skills; and Group 6 BD showed slow development in all three domains of prelinguistic communication. All in all, close to 80% of the children whose parents reported any language-related concerns at follow-up belonged to one of these three at-risk groups. However, the large percentage of false positives (i.e., the number of children belonging to an at-risk group and not having language difficulties later on in development) indicated that, on the individual level, the specificity of prediction was rather low. The results were more clear-cut for groups 1 A, 2 AA, and 3 A+So, which were considered to represent varieties of typical development. Average or above average early performance seemed to be reliable indicator of unproblematic language development later on. For these three groups combined, parents reported language-related concerns for only 3% of the children.

Overall, the findings suggest that the majority of children who show difficulties in their language development can be identified already early in the second year of their lives. In addition to expressive language, which has received notable research attention, slowness in social and symbolic skill development appeared as predictors of later language difficulties. In addition, it was found that an at-risk profile in early development was not consistently the one showing the most severe initial difficulties or consistently below-average scores. Thus, the results imply that early screening should involve several prelinguistic skills and screening should be carried out repeatedly during early development.

3.3 Study III

Children with differing developmental trajectories of prelinguistic communication skills: Language and working memory at age 5

This study investigated the continuity of at-risk development from the prelinguistic stage to kindergarten-age language and working memory performance. Following our earlier work, which outlined six early communication development (ECD) trajectories between ages 12 and 21 months (Study II), the children's later development in language and working memory was examined by psychometric assessment at age 5;3 (n = 91). It was examined whether the children in the three groups previously identified as being at risk for language dif-

ficulties (groups 4 BA+Sy, 5 ED, and 6 BD) would show weaker language skills at kindergarten age both at the group and individual level compared to the children from the typically developing groups (1 A, 2 AA, and 3 A+So). Given the prominent role of working memory in language processing (e.g. Engel de Abreu et al., 2011; Montgomery et al., 2010) the capacity of working memory was also compared between the different ECD groups.

At the group level, no significant differences in performance in the language measures (Similarities, PPVT, Sentence comprehension, and Word fluency – semantics) were detected. Two of the at-risk groups, groups 4 BA+Sy and 6 BD, consistently showed the lowest means in all measures, but these differences did not reach significance, possibly due to small group sizes and large individual variation within the groups. For the purposes of the individual-level analyses, the children were divided into two groups (compromised language skills – no difficulties) based on their follow-up performance (performance at or below -1 SD in at least two of the language measures; n = 13) or a parent-report of a diagnosis of language impairment (n = 1). A statistically significant association was observed between the ECD groups and difficulty status at follow-up. The majority (11/14, 78.6%) of the children with compromised language skills came from the two at-risk groups 4 BA+Sy and 6 BD. Thus, the children who showed below-average performance in more than one area of prelinguistic development also more often showed compromised language skills at follow-up. No typical pattern of language difficulties emerged among these children, but rather, they showed highly varied deficiencies in both their language and working memory ability.

Groups 4 BA+Sy and 6 BD also showed the lowest performance in the working memory tasks. The group differences were significant in Digit Span total, Digit Span forward, and Sentence Repetition whereas in Nonword Repetition, Corsi Block task, and Digit Span backwards the analysis failed to reach significance. However, the trend of the group differences was similar in all tasks, with these two at-risk groups showing the lowest scores.

Overall, the results suggest that compared to peers with unproblematic early communication development or with single early difficulties, children whose early communication development is slow in several areas of communication skills fare worse in their later language and working memory development. The study emphasizes the significance of social communication and early symbolic abilities, rather than early expressive language, when contemplating prelinguistic predictors of language development under the age of 2 years. The study also highlights the developmental interaction between language and memory functions and suggests that early precursors of working memory should be taken into account in early screening.

4 DISCUSSION

The present research focused on the development of prelinguistic communication skills and the predictive relations of this development to later language ability. The first goal was to examine the development and interaction of several prelinguistic communication skills during the first two years of life (Studies I and II). Second, the predictive links from this early development to later language ability and difficulties were investigated between ages two to eight years (Studies I, II, and III). Third, the feasibility and potentiality of early parental screening in identifying children at risk for later language and communication difficulties was evaluated (Studies I, II, and III). Table 5 lists the main results.

The findings suggest that when multiple prelinguistic skills are assessed simultaneously and repeatedly during the first two years of life, early communication ability manifests as a rather continuous and stable characteristic of individual differences. At the group level, a great deal of shared variance was observed in the development of different prelinguistic skills, indicating that development often proceeds in a similar fashion in these early communication skills. However, wide individual variation, and clearly distinguishable developmental trajectories that differed both in their level and pattern of performance was also found. The development of prelinguistic skills was consistently related to psychometric measures of later language and working memory and parental ratings of language and communication up to eight years of age. At the group level, shared features in the growth of several prelinguistic skills were by far the best predictors of later language ability. When comparing the performance of the individual trajectory groups, slowness in several areas of development, in social and symbolic skills in particular, seemed to indicate a higher risk for later difficulties. The connection between prelinguistic development and later verbal working memory was particularly strong in both the group-level and individual-level analyses. On the whole, these findings indicate that features of early prelinguistic development that have a bearing on and predict later development can be identified using parental reports. The results support the rationale of early developmental surveillance, although more research is needed to improve the accuracy of prediction at the individual level.

TABLE 5 Overview of the main results by research aims and Studies I–III

	Aims of the research		Main results by Study
1.	to describe the development of several early prelinguistic communication skills	I:	a) Despite large individual variation, early communication ability manifested as a rather continuous and stable characteristic of individual differences between age 6 and 18 months b) The development of different prelinguistic skills showed a great deal of shared variance. Significant skill- and age-specific variation was also present.
		II:	Six distinct developmental trajectories differing in both the level and pattern of performance were found.
2.	to examine the predictive relations between prelinguistic development and later language ability and difficulties, and working memory	I:	Early communication development explained a significant amount of the variance in later language, communication, and verbal working memory performance across ages 2 to 8 years. Shared features in the growth of several prelinguistic skills were the best predictors of later language ability.
		II:	Three trajectories were identified as showing at-risk features of development. Trajectories that showed slowness in several areas of development, especially in social and symbolic skills in particular, indicated higher risk for later difficulties.
		III:	No significant differences in performance in the psychometric language tasks were found at the group level at age 5;3 between the different trajectories; however, at the individual level, two of the at-risk groups contained significantly more children with later language difficulties. The same two at-risk groups also showed significantly poorer working memory.
3.	to evaluate the feasibility of early parental screening in identifying children at risk for later language and communication difficulties	I-III:	Features of early prelinguistic development that predict later development can be identified using parent reports. The majority of children with later difficulties can already be identified before their second birthday. However, the proportion of false positives is high. The results support the rationale for screening, although the accuracy of prediction on the individual level is not yet adequate.

Note. See Table 4 for specific research questions.

4.1 The development of prelinguistic communication skills

The first goal in the present research was to depict the development of prelinguistic communication skills when several relevant early skills were studied simultaneously (Studies I and II). The question was addressed by applying both variable-oriented (ages 6 to 18 months; Study I) and person-oriented (ages 12 to 21 months; Study II) approaches. The children's prelinguistic skills were measured at three-month intervals using the ITC parental questionnaire. The ITC consists of three composites of early language and communication skills that measure social communication skills such as eye gaze, gestures, and emotions (social composite), early vocalizations and first words (speech), and early receptive language and constructive and symbolic play skills (symbolic).

The results showed marked growth, as well as stability and continuity, in the development of prelinguistic skills during the first two years of life both within and between different skills (Study I). The period between 9 and 18 months of age is marked by both quantitative and qualitative developmental changes in social communication skills (e.g., Tomasello, 1995). This was also evident in this research, as shown by the growth in raw scores in all three areas of early communication skills development (social, speech, and symbolic) across the study periods of 6 to 18 months (Study I) and 12 to 21 months (Study II). As can be expected during a period of intensive development, large interindividual variability was found in the development of these early skills, as shown by the overlap in the scores between different ages. That is, already at the age of 6 months, the highest performing infants scored almost as high as the lowest performing infants at ages 15 and 18 months (Study I). The results confirm previous research findings (e.g., Bates et al., 1995; Fenson et al., 1994, 2000; Darrah et al., 2003; Thal et al., 1997) of wide individual variation in development (Study I), and suggest that this individuality might be better depicted by delineating distinct developmental trajectories (Study II).

Study I explored development at the group level using a variable-oriented methodology. Despite clear developmental changes (i.e., fast growth in group average skills) and large interindividual variation during this period, development showed itself to be continuous and stable. Successive measurements in each composite showed a moderate to high correlation ($r = .34–.79$), which suggests continuity in individual differences in these skills over age. Furthermore, the relative standings of individuals in their development within a composite were rather consistent, as indicated by the significant loadings of the measurements at each age on the skill-specific level and growth factors. As was expected based on previous findings (e.g., Laakso et al., 1999; Watt et al., 2006), a large amount of shared variance was also observed in the development of early social, speech, and symbolic skills. This was shown by the large correlations between the level factors of the different composites, the growth factors of the different composites, and the significant loadings of these factors on the combined (common) level and growth factors. Thus, individuals tended to have a

similar ranking relative to others across the three skill composites. That is, individuals performing high in one composite were likely to perform high in the other two as well. Moreover, the relative pace of development was similar across the three composites. In other words, individuals who showed slow development in one skill composite also tended to be slow in the other two.

The connection was strongest between social and symbolic skills, suggesting that development in these two composites follow, for the most part, the same trajectories. According to Tomasello (1995, 2000) the developmental synchrony found between skills such as joint attention, social referencing, gestural communication, imitative learning, and intentional communication is strong evidence of an underlying commonality, which he suggests to be the infant's emergent understanding of other persons as intentional agents. He further suggests that this understanding of intentionality and concomitant motivation to manipulate their own and others' attention forms the context for speech development. The findings of this research seem to accord with this view. Although the connection of the speech composite with the other two composites was not as strong as the connection between the social and symbolic composites, a significant amount of the variance of the speech composite was explained by the common factors. This might reflect a shared context for learning whereas the significant residuals might indicate the presence of more specific developmental factors, such as speech motor control or phonological development (e.g., Nip, Green, & Marx, 2011; Oller, Eilers, Neal, & Schwartz, 1999), that have unique effects on speech development. In addition, the weaker connection could also be due to the timing of the measurement. The study period (6–18 months) coincides with the very beginning of speech development when, for the majority of children, these skills are just emerging.

All in all, in Study I, early communication ability emerged as a rather continuous and stable characteristic of individual differences when multiple early communication skills were assessed simultaneously and repeatedly. These findings of stability are in line with previous research on early communication skills (e.g., Reilly et al., 2006; Watt et al., 2006). However, the shared features of the different early communication skills (i.e., the common level and growth factors) did not explain all of the variation in early communication development. That is, notable skill- and age-specific variation was observed, as shown by the significant residual variances of the skill-specific factors and the emergence of age-specific factors. Thus, despite good model fit, a large proportion of individual variation was left unexplained by the group-level analyses.

The aim of Study II was to explore individual variation in development by searching for typical individual trajectories of development between ages 12 and 21 months. The theoretical basis for the study was the application of a holistic-interactionist framework and a person-oriented approach (e.g., Bergman et al., 2003; Sterba & Bauer, 2010). That is, development was studied as an integrated whole, instead of as separate variables, and the interest was in the patterns that were formed when several of the factors involved were studied together. Using Latent Profile Analysis (LPA) six different developmental trajec-

tories (i.e., early communication development groups; ECD) were identified. These trajectories were clearly distinguishable from each other statistically, and interpretable on the basis of substantive theory. In accordance with the findings of stability in the group-level analyses, the different trajectory groups retained their order relative to one another across ages 12 to 21 months despite fluctuations in development in some groups. The children with the weakest skills at 21 months had shown slower development compared to peers already nine months earlier, indicating that the possible risk status of some children was recognizable already as early as 12 months of age.

Some of the ECD groups resembled the results of the group-level analyses of Study I. That is, development in these groups was relatively stable both within a single composite and across the three composites. These groups differed from each other in their overall level of development, ranging from slightly above average (AA) to average (A) and below average (BD). However, groups showing clear differences between the level and pace of development between the different composites were also found. In the "Average with fluctuating social skills" group (A+So) development in the social composite differed from the overall average level. In the "Below average with symbolic difficulties" group (BA+Sy) the score for the symbolic composite was somewhat lower and indicated delay compared to the otherwise stable, slightly below average, performance in the other two composites. In the "Expressive difficulties" group (ED), in turn, development in the speech composite indicated delay, whereas social and symbolic skills developed typically.

These results testify to individuality in development and suggest that, in addition to group-level analyses, the use of individually oriented studies is well-grounded as a means to better understand development. In addition, the results suggest that it is meaningful to look at several of the factors involved (i.e., multiple domains of communication and language) simultaneously, a view inherent in the person-oriented research paradigm. The person-oriented framework is also in accordance with the premises of the dimensional view of language ability (Rescorla, 2013), as it takes into account several language subserving skills simultaneously. Thus, the different ECD groups could be assumed to represent typical patterns of differential endowment. It is possible that differences in the level of skills between individuals as well as different combinations of strengths and difficulties have a specific bearing on later developmental outcomes, a topic we turn to in the next section.

4.2 Developmental links between prelinguistic and linguistic development

The second goal was to study the predictive links between prelinguistic development and later language ability and difficulties. After the prelinguistic stage, children's language and communication development was followed at ages 2, 3,

4;7, 5;3, and in first grade (age range 7;2–8;4). Both parental questionnaires and psychometric tests were used to collect information about the children's receptive, expressive, and communication skills as well as verbal working memory. Study I addressed this question from a group level perspective by asking which aspects of early development best explain the variation in language ability at different ages. Studies II and III explored the developmental outcomes of the different ECD trajectories at ages 4;7 (Study II) and 5;3 (Study III), and sought to find out whether some of these trajectories would turn out to show early at-risk features of development.

4.2.1 Which aspects of prelinguistic development predict later ability?

Study I explored the connections of prelinguistic development with later language ability and, more specifically, which aspects of this early development best predict later ability. That is, whether it is the shared features of different prelinguistic skills (i.e., the common level or common pace of prelinguistic development) that are predictive of later language ability, or whether a specific skill, or a combination of skills at a specific age makes a unique contribution to language development over and above that of the common level and pace. These group-level analyses revealed that prelinguistic development across several skills was significantly associated with later language ability. The common pace of early development, that is, the growth across skills, was by far the best predictor of later ability, followed by the common level of prelinguistic skills. No skill- or age-specific connections were found.

Individual variation in development showed consistency across childhood. That is, infants with better development in prelinguistic skills at 6 to 18 months of age showed better language and communication skills in later childhood. These results support the idea of a continuum from prelinguistic to linguistic ability (e.g., Bates et al., 1979; Bruner, 1983). The findings also support the dimensional view of language ability (Rescorla, 2009; 2013) by showing that the overall endowment of skills, as reflected in the common level and growth factors, has a strong bearing on later development. The results also suggest that this endowment may be better depicted by the growth factor. Although the common level and growth factors were both significantly associated with later language ability, the association was stronger and more consistent for the growth factor. The pace of development was significantly connected to all of the follow-up language and communication measures, such that a faster rate of growth in prelinguistic skills led consistently to better language ability and fewer parent-reported difficulties. Thus, as suggested by Rowe et al. (2012), the potential for development might be better reflected by the pace of development rather than the level at any given age. A slow pace of development might be an indicator of developmental risk (i.e., weaker endowment) and thus might more accurately predict later language development and possible persistent difficulties (Lyytinen et al., 2006; Rescorla, Mirak, & Singh, 2000).

The amount of variance explained by the common level and growth factors of prelinguistic development combined varied between 10.5 and 53.3%

across the follow-up measures between ages 2 to 8 years. Comparable results were obtained by Wetherby et al. (2002, 2003), who examined the associations of the ITC at ages 12 to 24 months with receptive and expressive language skills at ages 2 and 3 years. They found that the ITC explained 20–51% of the variances in the language outcomes. In Reilly et al. (2007), the corresponding percentage between the ITC at 12 months and MCDI at 2 years was 14.2%. The findings of this research confirm and expand these results by showing that the predictive relation between prelinguistic skills and later language ability is present as early as at 6 months of age, and holds longitudinally until 8 years of age.

To examine the contribution of the early skill- and age-specific factors (i.e., the variation in each composite that was not shared across composites, and age related variations) to later development, specific pathways were tested in separate models. The model modification indices suggested several specific connections that could improve the model fit and were theoretically feasible. However, none of these pathways reached significance after controlling for multiple comparisons. Similar results have been reported by other researchers, who have found that the amount of shared variance is large relative to the unique contributions of single skills (Watt et al., 2006; Wetherby et al., 2002) and that the unique contributions of specific skills may diminish when overall communicative development is controlled for (Lyytinen et al., 2001; Salley et al., 2013).

Thus, somewhat contrary to the expectations, only the common level and growth were predictive of later language outcome. There are several possible reasons for the absence of reliable specific associations. Early socio-cognitive skills have been shown to be highly interrelated (Laakso et al., 1999; Watt et al., 2006; Wetherby et al., 2002), which could make it difficult to uncover connections with specific skills. In this context of strong interrelations, in order to have the statistical power to extract specific effects, the sample size would need to be rather large. In addition, the sensitivity of the level of measurement and the selected measures, both during the prelinguistic stage and the follow-ups, might affect the ability to capture more specific processes of development. It is possible that a broadband parental screener is only able to detect common trends in development. This is supported by the findings of Brooks and Meltzoff (2008), Laakso et al. (1999) and Watt et al. (2006), who were able to find specific predictive relations using observational methods, whereas parental reports yielded only general associations (Laakso et al., 1999) or no association at all (Brooks & Meltzoff, 2008). It is also possible that, at this early age, assessment of more domain-general skills such as attention (Salley et al., 2013) and memory (Heimann et al, 2006; Rose, Feldman, & Jankowski, 2009), which have been found to show discreteness already early on in life (Rose, Feldman, & Jankowski, 2005), might yield stronger specific predictive associations.

All in all, the results suggest that the communicative endowment children show in their prelinguistic development predicts later language performance and that individual differences in language and communication skills show some stability from infancy up to school age. The results are in line with previous findings on stability (e.g., Bornstein et al., 2013, Bornstein & Putnick, 2012)

and predictive relations (Dale, et al., 2003; Reilly et al., 2007; Rescorla, 2013). However, it seems that these group-level findings do not readily translate into identification at the individual level (Dale et al., 2003; Law et al., 2012). That is, despite stability in development, the accurate identification of individual children who are at risk for language difficulties has proven difficult.

4.2.2 Do certain developmental trajectories lead to later language difficulties?

Studies II and III sought to find out whether the individuality of development could be better captured by examining different trajectories of prelinguistic development and whether this type of analysis could lead to more accurate predictions of later difficulties than those obtained by group-level analyses (e.g., Dale et al., 2003; Law et al., 2012). According to the holistic-interactionistic framework and the person-oriented approach, patterns of development that take into account several of the involved factors and regard their development as a system over time are predictive of later development over and above the contribution of separate skills (Bergman & Anderson, 2010; Bergman et al., 2003; Sterba & Bauer, 2010).

The aim was to explore the connections between the different ECD groups and parent-reported language-related concerns at age 4;7 (Study II) and language difficulties and working memory performance measured with psychometric tests at age 5;3 (Study III). The results are summarized in Table 6. The notably small size of some of the groups should be taken into account in evaluating the results and their generalizability. In Study II, three of the six ECD trajectories were identified as showing at-risk features of development (BA+Sy, BD, ED). Two of these at-risk trajectories, BA+Sy and BD, showed consistent associations with later language difficulties at the individual level. These two

TABLE 6 Follow-up outcomes of the ECD groups at ages 4;7 (Study II) and 5;3 (Study III)

		Follow-up at 4,7 (Study II) n = 187		Follow-up at 5;3 (Study III) n = 91	
ECD groups		Parental concern % (n)		Language difficulties % (n)	
(n total/age 4;7/age 5;3)		No	Yes	No	Problems
1. A	(89/65/29)	96.9 (63)	3.1 (2)	96.6 (28)	3.4 (1)
2. AA	(69/48/20)	97.9 (47)	2.1 (1)	90.0 (18)	10.0 (2)
3. A+So	(20/17/7)	94.1 (16)	5.9 (1)	100 (7)	0 (0)
4. BA+SY	(57/37/23)	78.4 (29)	21.6 (8)	65.2 (15)	34.8 (8)
5. ED	(24/12/6)	58.3 (7)	41.7 (5)	100 (6)	0 (0)
6. BD	(12/8/6)	75.0 (6)	25.0 (2)	50.0 (3)	50.0 (3)
Total		89.8 (168)	10.2 (19)	84.6 (77)	15.4 (14)

Note. A = average; AA = above average; A+So = average with fluctuating social skills; BA+Sy = below average with symbolic difficulties; ED = expressive difficulties; BD = broad difficulties.

trajectories shared in common a slow development in social and symbolic skills, although differences in the level of skills were also evident. The third at-risk

group, ED, characterized by slow development in speech skills, showed contradictory results depending on the outcome measure.

The parents of the majority of the children whose early development did not show any risk features (groups A and AA), reported unproblematic language development (Study II), and the children's test performance also mostly showed no indications of compromised language skills (Study III). The results were similar for the group A+So with fluctuating performance in the social composite. That is, despite performing below 1 SD at age 18 months, they did not raise any language-related concerns at age 4;7 and performed at age-appropriate levels at age 5;3. Darrah and colleagues (2003) proposed that fluctuations in performance over time or a deviant score at a single time point does not necessarily indicate deviance, and our results seem to support these notions.

In sum, for the children in ECD groups A, AA, and A+So, only 3% of their parents reported any language-related concerns (Study II), while the psychometric tests suggested compromised language skills for 5% (Study III). These children represented about one-fifth of the children who had language difficulties at the follow-ups, either as reported by parents (21.1%; Study II) or as evaluated by tests (21.4%; Study III). Thus, almost 80% of the children who had any language-related difficulties at the follow-ups at ages 4;7 and 5;3 were members of the early at-risk groups BA+Sy, ED, or BD. The early developmental trajectories of the three at-risk groups differed from each other both in their level of performance across skills as well as in combinations of skills and difficulties. They also manifested some variations in their outcomes depending on the follow-up measures used.

Group BD showed a low level of development, performing consistently below -1 SD over time, in all three composites. Parents reported concerns for one fourth of these children (Study II), while half of them showed compromised language skills when language tests were used (Study III). Group BA+Sy also showed a rather stable profile, although minor differences were observed in the level of performance across the three composites. They performed close to average in the speech and close to the lower limit of the average range in the social and symbolic composites, their development in symbolic skills showing a downward trend that dropped eventually below one standard deviation. Parents reported language-related concerns for one fifth of these children (Study II), and one third of them showed indications of language difficulties in their test performance (Study III). When performance in the language tests was compared across all the ECD groups, these two groups consistently showed the lowest means, although not reaching statistical significance, in all the language measures. For the children in the third at-risk group, ED, characterized by a low level of early expressive language with otherwise average performance, parents reported language-related concerns for over two fifths of these children (Study II), although no language difficulties were found when psychometric tests were used (Study III).

The examination of the at-risk trajectories suggests that the clearest at-risk features of development were slow development in symbolic abilities (groups

BA+Sy and BD) followed closely by slow development in social abilities (group BD, and to some extent, group BA+Sy). These findings conform with those of Wetherby et al. (2002), who, after examining the predictive validity of the three composites of the CSBS DP, reported that social and symbolic composites at ages 12 to 16 months were the strongest predictors of both expressive and receptive language at the age of 2 years. It has rather consistently been shown that early language comprehension and play skills are reliable predictors of language skills during the second year of life (e.g., Lyytinen et al., 2001; Thal & Katich, 1996; Watt et al., 2006). In addition to symbolic skills, early intentional communication, as reflected in social responsiveness, capacity for joint attention and social use of gestures, has been shown to predict later language and communicative competence (Chiat & Roy, 2008; 2013).

For early expressive abilities, that is, the speech composite, the results were somewhat inconsistent (groups BD and ED). Compared to peers, slower emerging expressive abilities, while seeming to be a risk factor, did not consistently lead to weaker language skills later on. Similar conclusions have been reached by others, who have suggested that late talking while not a necessary condition for the emergence of later language difficulties, is clearly a risk factor for such problems (e.g., Bavin & Bretherton, 2013; Leonard, 2013). The dimensional view of language ability (Rescorla, 2002, 2005, 2009, 2013) posits that slow development in expressive skills may reflect weaker endowment, that is, a predisposition to slower language acquisition, and that this predisposition is stronger the more diverse the early delay. In other words, late language emergence accompanied with slow development in other areas of social communication or language could lead to later language impairment, whereas developmental slowness limited exclusively to expressive skills would manifest, not necessarily as a clinical impairment, but as slightly poorer language performance in later childhood (Rescorla, 2002, 2009; Rescorla, Roberts, & Dahlsgaard, 1997). However, others have suggested that such a limited delay does not pose a serious concern for future development (Lyytinen et al., 2001; Thal & Katich, 1996; Wetherby & Prizant, 2002).

The results for the group with slow expressive development but without other concomitant difficulties (ED) showed that, based on parent report, over 40% of the children showed some difficulties in language development at age 4;7, whereas their performance in psychometric tests was comparable to typically developing peers, and none of the individual children showed compromised language skills a few months later. There are several possibilities for this discrepancy in the results. First, it is possible that the parental measure was more sensitive to the difficulties exhibited by these children. There are indications that not all children with difficulties in language show poor test performance (Asikainen, 2005; Conti-Ramsden et al., 1997), but instead their difficulties are better captured in social situations (e.g., Bonifacio et al., 2007). Second, parental concerns may have been sustained by or intertwined with some confounding factors, such as child behavior, temperament or the parent-child relationship. In a study with the same group of children, it was found that parents reported

significantly weaker self-regulation skills, especially social skills and internalizing problems, for the children in group ED compared to those in the other ECD groups (Aro, Laakso, Määttä, Tolvanen, & Poikkeus, 2014). Previous research has also reported that parental ratings show more withdrawal, less compliance, more negative emotions and less acceptable characteristics for children with late language emergence compared to peers (Caulfield, Fischel, DeBaryshe, & Whitehurst, 1989; Irwin, Carter, & Briggs-Gowan, 2002; Kubicek & Emde, 2012; Paul & Kellogg, 1997; Rescorla, Ross, & McClure, 2007). Furthermore, parental perceptions of stressful child behaviors may also have an impact on their estimates of language skills (Chaffee, Cunningham, Secord-Gilbert, Elbart, & Richards, 1991).

It is also possible that, instead of a specific combination of early developmental difficulties, it is the accumulation of developmental risks per se, that is predictive of later development. Based on genetic studies of language, Bishop (2006) has concluded that in order for language to be compromised, more than one area of the underlying cognitive processes has to be disrupted. Research has shown rather consistently that children with delays in more than one area of language development (i.e., with a weaker endowment; Rescorla, 2013) have a higher risk for persistent language difficulties (Rutter, 2008). This was also the case in this research, in which group BD, which had the biggest theoretical risk for later language difficulties based on their overall low early performance, presented with the second most concerns reported by parents at age 4;7, the lowest group means in each follow-up language measure at age 5;3, and the largest percentage of compromised language skills on the individual level. The results support the view of accumulating risk factors and extend it to the prelinguistic stage and thus the inclusion of a broad selection of social communicative and symbolic skills in addition to expressive and receptive language in assessments.

In sum, developmental trajectories that show slowness in multiple areas of prelinguistic development seem to place children at the highest risk for later language difficulties. Based on the findings, it also seems that the predisposition to language and communication difficulties at this early age manifests more reliably as slow development in social and symbolic skills, rather than delayed expressive language. In addition, in line with previous observations (Dale et al., 2003; Darrah et al., 2003), the findings for group BA+Sy suggest that an at-risk profile need not necessarily show the most severe initial difficulties or consistently below-average performance. Thus, closer monitoring of children who, compared to peers, show even minor delays in multiple areas of development, particularly, if these include social and symbolic skills, would seem to be well justified.

4.2.3 Prelinguistic communication and connections to verbal working memory

As part of the second goal, the longitudinal connections between prelinguistic communication and different aspects of working memory at age 5;3 were explored (Studies I and III). At the group level (Study I), the strongest predictive

relation was found between the growth of prelinguistic skills and later verbal working memory capacity. Together, the level and growth of prelinguistic skills explained over half of the variation in the performance in the memory measures. When exploring the performance of the different ECD groups in the follow-up language and memory measures (Study III), significant group differences were found only in the measures of working memory. The two at-risk groups BA+Sy and BD consistently showed the weakest performance in all the memory measures. The differences were significant in Digit Span (DS) and Sentence Repetition (SR) and almost significant in Nonword Repetition (NWR) and the Corsi Block Task (CB).

These results are in line with a great deal of earlier research where working memory capacity has been associated with several aspects of language development (Engel de Abreu et al., 2011; Montgomery et al., 2010; Rescorla, 2013; Vance, 2008) and has also often shown limitations in children with language difficulties (Alt, 2011; Archibald & Gathercole, 2006; Conti-Ramsden & Hesketh, 2003; Petruccelli et al., 2012). However, the vast majority of the research on the relationship between language and memory has been conducted with children of preschool age or older. Research on the connections between prelinguistic development and working memory remain scarce. Hence more research is needed to shed light on the developmental interaction and co-development of early communication, language, and memory. In the early stages of development, domain-general features of cognition, such as memory, attention, and processing speed, seem to play a role and interact with language development (Rose et al., 2009). It has also been proposed that children with late onset of expressive language might show poorer memory development over time as well, and that immature memory functions could partly explain the language-related problems these children show at school age, even if their expressive language difficulties seem to have been resolved (Bavin & Bretherton, 2013).

With regard to the literature on the risk markers of language impairment, the results of this research offer partial support for the suggested role of NWR and SR (e.g., Archibald & Joanisse, 2009; Bishop et al, 1996; Coady & Evans, 2008; Petruccelli et al., 2012; Vance, 2008). These two tasks can be regarded as weak markers of language impairment; that is, they both represent a symptom but cannot be regarded as a single cause or an independent marker of language impairment (Conti-Ramsden & Hesketh, 2003). The difficulties in these tasks are not unique to language impairment; moreover, the ability of memory tasks to differentiate between different diagnostic groups has been reported to be rather poor (Botting & Conti-Ramsden, 2003; Conti-Ramsden & Hesketh, 2003). It has been hypothesized that instead of a phonological short-term memory deficit alone, a combination of memory deficits might place a child at risk for language difficulties (Gathercole, 2006).

It is plausible that the impact and manifestation of NWR and SR difficulties is influenced by an individual child's other linguistic and cognitive ability profiles, as performance in these tasks is closely linked to a range of other language skills (Archibald & Gathercole, 2006; Conti-Ramsden, 2003; Conti-

Ramsden, Botting, & Faragher, 2001; Conti-Ramsden & Hesketh, 2003; Stokes, Wong, Fletcher, & Leonard, 2006; Vance, 2008; Westman, Korkman, Mickos, & Byring, 2008). This was also evident in this research, where the two tasks, SR in particular, showed high correlations with the other memory and language measures. Sentence repetition is thought to rely on both verbal working memory and linguistic skills, such as speech processing and language knowledge (Archibald & Joanisse, 2009; Vance, 2008). Because the task is regarded as involving the integration of information from memory with long-term linguistic knowledge, it is often regarded as a measure of the episodic buffer of the Baddeley model (Boyle et al., 2013; Petruccelli et al., 2012). However, the role of working memory in the task continues to be disputed (Kidd, 2013), and it has been argued that instead of verbal memory, sentence repetition measures different aspects of language processing (Klem et al., 2015).

In sum, the results of both Studies I and III highlighted the connection between prelinguistic development and working memory. This connection between language and memory did not come as a surprise to us as memory processes are regarded as an important underlying component of language development (Gathercole, 2006; Heimann et al., 2006). However, the strength and systematicity of the connection, that is, the connection being stronger between prelinguistic development and later working memory, than between prelinguistic skills and later language, in both studies, was somewhat unexpected. Broadening the earlier conception of the interrelations of language and memory, our results suggest that the early precursors of working memory also merit attention in attempts to understand the developmental processes of communication and language.

4.3 The feasibility of a parental screener as a means for early identification of at-risk children

The third goal was to evaluate whether a short parental screener, that is, the ITC, would be a feasible method of early screening for language and communication difficulties. More specifically, it was asked whether a parental screener would be able to capture features of prelinguistic development that are associated with and predictive of later language development (Study I), and whether this parent-provided information would show potential for identifying individual children at-risk for later language difficulties (Studies II and III). The results showed that relevant features of early development could be identified using parent reports and that this information also showed potential for identifying children at risk, although its predictive accuracy left a lot to be desired.

Study I addressed this question from a group-level perspective by examining stability and continuity from early parental reports to later language ability measured with both parent-report and psychometric measures. The results of the regression analyses indicated that information collected from parents on

children as young as 6 months of age yielded information of value in predicting their children's later communicative ability. In addition, by repeating the same measurement several times, we were able to obtain information about the growth of infant communicative skills that was predictive of later development. Thus, it seems that with the aid of just a few questions repeated over time during the prelinguistic period, parents are able to report features of development that are precursors of later language development. This result is in line with previous accounts of the reliability and validity of parent-report measures (e.g., Feldman et al., 2005; Laakso et al., 1999; Rescorla & Alley, 2001) and of the predictive power of prelinguistic skills obtained by observational methods (e.g., Watt et al., 2006).

Studies II and III applied a more individual perspective on screening and considered the sensitivity and specificity of the ECD groups, derived longitudinally from the ITC, in predicting later language difficulties. Sensitivity refers to the accuracy of the procedure in detecting children with language difficulties (i.e., the proportion of children with difficulties correctly classified as having difficulties), whereas specificity refers to the accuracy in identifying children who do not have difficulties (i.e., the proportion of unaffected children correctly classified as such). In addition to these, two commonly used indicators of the accuracy of screening are negative predictive value and positive predictive value. These terms refer to the proportion of true negative and true positive cases, that is, the percentage of negative screens that are true negatives and the percentage of positive screens that are true positives. Both are dependent on the prevalence of the disorder in the screened population. Low negative and positive predictive values indicate a high proportion of false negatives and false positives, respectively (see Akobeng, 2007, for a detailed description).

Replicating the findings of several other studies (e.g., Law et al., 2012; Thal et al., 1997), the ECD trajectories more accurately predicted which children were not likely to show language difficulties in the follow-up assessments than those who were. Overall, we achieved rather high levels of sensitivity (78.9%, Study II; 78.6, Study III) and specificity (75.0%, Study II; 68.8%, Study III), as well as negative predictive ability (96.9%, Study II; 94.6%, Study III). However, the positive predictive values were low (26.3%, Study II; 31.4%, Study III), indicating that the number of false positives was high. In other words, while the majority of the children with language difficulties in kindergarten age were identified on the basis of the risk trajectories, our at-risk groups included several children who did not seem to have difficulties in later language as evaluated by the measures used in these two studies.

The findings for sensitivity and specificity are comparable with, although somewhat lower than, those obtained in previous research using the ITC (81–89% and 70–79% respectively; Wetherby et al., 2003). The small differences could be explained by the longer follow-up period. In this research the ITC was measured between 12 and 21 months of age and follow-ups conducted at ages 4;7 and 5;3, whereas the corresponding ages in Wetherby et al. (2003) were 12-24 months (the ITC) and 2 and 3 years (follow-ups). The high incidence of false

positives is also consonant with previous reports on the ITC (Pierce et al., 2011; Wetherby et al, 2003). The results are also in line with the findings of screening studies in older children (e.g., Klee et al., 1998; Law et al., 2000b; Nelson et al., 2006; Whitworth, Davies, Stokes, & Blain, 1993), which consistently report the problem of false positives. However, there are indications that the positive predictive value can be improved by using additional criteria, such as parental concern, in evaluating risk status (Klee, Pearce, & Carson, 2000).

One reason for the discrepancy between the number of children identified as at risk early on and the proportion of children presenting permanent language difficulties later on is that some children outgrow their difficulties. The prevalence of early language delay is considerably higher (2–19%; Law et al., 2000b; Nelson et al., 2006) than the prevalence of later language impairment (2–10%; Hulme & Snowing, 2009; Law et al, 2000b; Tomblin et al., 1997). Thus, it is not to be expected that all children showing delays in early development will end up having language difficulties later on. The reported percentages of persistence vary according to the age at which the initial difficulties were identified, tending to be higher, the older the children were at the time of identification. That is, around 40 to 50% of children with delayed language at toddler age continue to manifest difficulties at ages 4 to 5 years (Dale & Hayiou-Thomas, 2013; Dollaghan, 2013; Rescorla, 2013; Thal, Marchman, & Tomblin, 2013), whereas 50 to 90% of children with difficulties at kindergarten age show persistent difficulties later on (Law et al., 2000a; Hulme & Snowling, 2009; Stothard et al, 1998). Corresponding estimates of the prevalence of prelinguistic communication delay or the persistence of difficulties identified at the prelinguistic stage are not available. In this research, 34% of the sample showed at-risk features of development during the prelinguistic stage and around 30% of these children continued to have difficulties in language at ages 4;7 and 5;3.

Another reason for the discrepancy might be more statistical in nature. Although Latent Profile Analysis is able to take individual variation into account in searching for individual developmental trajectories, it is important to remember that the ECD trajectories represent average paths of development, not exact paths of individuals. Some individuals within a trajectory are closer to the mean of the trajectory while for some belonging to a certain group might not be as clear cut. An important question is, whether the individuals within a trajectory are similar enough for that trajectory to be meaningful, i.e., in our case, predictive. The values that evaluate how distinguishable the latent groups are from one another (AvePP; Muthén & Muthén, 1998–2007) ranged between .90 and .99, being .91, .97, and .99 for the risk trajectories BA+Sy, ED, and BD, respectively. Although exceeding abundantly the suggested threshold value of .70 (Nagin, 2005), the differences in these values might have an impact on the precision of prediction, for example the number of false positives or negatives in each group. It seems that despite the similar profile of development shared by individuals in a trajectory, the individual variation in that trajectory might be enough to blur the predictive associations. That is, the heterogeneity present in the risk trajectories confounds their ability to accurately identify

children with persistent language difficulties, an observation consistent with the conclusions of previous research on the profiles of language development (Ukoumunne et al., 2011).

Another important issue in examining the reliability of early screening is the reliability of later classification of children into those with difficulties and those without. In addition to the features of the early screener, the outcome measures affect the accuracy of prediction. The variability of language difficulties and the lack of a gold standard render the outcome assessment and the identification of children with difficulties challenging. Thus, with regard to each outcome measure questions related to reliability and validity such as, what aspect of language is being measured, what kind of norming sample has been used, which cutoff would be the most optimal, and how comparable the different measures and their cutoffs are, should be addressed. For example in this research, the groups of children identified as having difficulties using parent report at age 4;7 and psychometric tests at age 5;3, were not completely overlapping. For those children that had data from both time points, the percent agreement within the at risk groups was 68.6%, indicating that there were children identified as having difficulties exclusively at one time point but not the other. This might be due to differences in the measures (e.g., cutoffs and sensitivity, aspect of language measured, i.e., ecological and content validity), or some confounding factor that affects parent estimation (e.g., child behavior, attachment, parental expectations) or test performance (e.g., attention).

In light of the above-mentioned possibilities, the findings of low positive predictive values seem reasonable, although there is clearly a need to identify additional key components of development that act as risk factors for language development. This is also important from the point of view of differential diagnosis. The skills included in the ITC have a strong theoretical background as early predictors of language development (e.g., Laakso et al., 1999; Lyytinen et al., 2001; McCathren et al., 1996; Watt et al., 2006; Wetherby & Prizant, 2002), even if they are not entirely language specific. The communicative characteristics of prelinguistic children with a risk for either language difficulties, ASD or broader developmental delay are largely overlapping (Camarata, 2014; Paul, 2008; Veness et al., 2014; Wetherby et al., 2008). The ITC as a broadband screener might not be able to differentiate these children this early on in their development. The results offer tentative support for this view, as one of the at-risk groups, BD, showed a tendency to a lower overall level of cognition later on. Thus, early risk status, as suggested by the ITC, should be considered as an indicator of a need for further, more frequent and intensive surveillance of socio-cognitive development in general.

4.4 Practical implications

Warren (2000) outlines three goals for research and practice in early intervention for children with communication and language difficulties: 1) to provide highly responsive environments from infancy onward, 2) to identify communication and language delays and disorders as early as possible, and 3) to implement optimal intervention strategies as early as possible. To realize these goals requires increased effort to achieve earlier and more efficient identification of at-risk children, increased support for parents and professionals to enhance responsive interaction with children, and more interaction between research and practice (Warren, 2000).

This research contributes to these objectives by providing information about early developmental processes in prelinguistic skills, the implications of these processes for later language and communication development, and the potential of early developmental screening for early identification of at-risk children. With the aid of this information we should be better able to identify the key aspects of the developmental processes that need to be taken into account in screening procedures. By using a screening method that is both feasible and easily administered, we will be able to provide research results that can readily be applied in current clinical practice. Thus, the results have several important implications for early screening procedures. In addition to supporting the *rationale for early screening* in the first place, the results indicate that reliable screening should assess *a variety of skills* and that this assessment should be conducted *repeatedly* during the first two years of life.

The rationale for early screening was supported by the findings of longitudinal continuity in development, and that it is possible to identify at-risk children as early as by the age of two years. That is, at the group level, early communication development explained a significant amount of the variance in later language, communication, and verbal working memory performance. At the individual level, the majority of children with later difficulties showed features of at risk development already during the first two years of life. That said, it should be borne in mind that the substantial inter- and intraindividual variation in early development, along with the heterogeneity in the outcomes of children with early language and communication delays, complicates the early and accurate identification of children at risk of developing persistent language difficulties (e.g., De Koning et al., 2004; Ukoumunne et al., 2011). However, as Law et al. (2012) have pointed out, it might be possible to identify "key indicators that predict which children are likely to be more or less at risk across time" (p. e132). The identification of such key indicators to support the accuracy of early screening is essential, as positive outcomes are more likely the earlier the intervention occurs (Carscadden et al., 2010).

One key factor with regard to screening procedures, identified in this research, is that overall screening for prelinguistic skills could serve as a better predictor of later language outcome than any single skill alone. This was evi-

dent in both the group- and individual-level analyses: the longitudinal connections were significant when all the early communication composites were considered simultaneously, and the risk for later difficulties was strongest if the child showed slowness in multiple areas of early communication development. This is in line with the earlier conclusions reported by Wetherby et al. (2002; Watt et al., 2006) with regard to the ITC and other parts of the CSBS DP. This is also compatible with the neurodevelopmental ideas of Bates et al. (2002; Bates, 2004), and supports the suggestion of Bishop (2006) and others (e.g., Darrah et al., 2003; Law et al., 2000b; Lyytinen et al., 2001; Thal et al., 1997; Thal & Katich, 1996; Wetherby et al., 2002) that it is the accumulation of early difficulties that is meaningful for later development.

Based on the findings and the previous literature, it is suggested that to improve the accuracy of prediction we should be looking at the combination of several prelinguistic skills along with the possible precursors of working memory, and how these interact in their development. The prevailing approach in both health care practice and prediction studies, of confining assessment solely to early vocabulary and gestures (e.g., Dale et al., 2003; Feldman et al., 2005; Pesco & O'Neill, 2012; Westerlund et al., 2006) does not seem to be sufficient for the purposes of prediction, especially at this early age.

Indeed, what is noteworthy in the present results is the early age at which screening was conducted (6 to 21 months). Previous research has suggested that parental report is feasible after 24 months of age (e.g., Pesco & O'Neill, 2012; Stott et al., 2002) whereas screening before that age has been questioned by several researchers (Dale et al., 2003; Feldman et al., 2005; Pesco & O'Neill, 2012; Westerlund et al., 2006). However, by far the most common measures of early language skills used in these screening and predictive studies have concerned expressive language. The results suggest that, at this early age, the inclusion of social and symbolic skills is not only possible but indispensable. Although a delay in expressive language has rather consistently been reported as an early characteristic of children with later language impairment (Hulme & Snowling, 2009), there are indications that, when the skills are measured very early, social communication, receptive language skills and symbolic play skills are even better predictors of later language and communication skills than early expressive skills (Chiat & Roy, 2008; Dale, 2012; Watt et al., 2006; Wetherby et al., 2002). It is likely that the role of early expressive skills, especially in predicting later expressive skills, grows stronger over the course of development (Wetherby et al., 2002). It is possible that expressive language measures start to be more predictive only after the growth spurt in vocabulary, which is located at the edge of the transition from prelinguistic to linguistic, as with growing vocabulary skills children increasingly rely on words in their communication.

Another key finding regarding screening procedures, highlighted in our research, was that screening should take place repeatedly. That is, instead of a single assessment, developmental surveillance should be favored. This observation arose from the findings that, at the group level, the growth in prelinguistic skills was more predictive than the initial skill level, and that, at

the individual level, the pattern over time in our ECD subgroups was more relevant to later performance than any single-occasion assessment. These findings are in line with the conclusions of Ben-Sasson et al. (2014) and others (Barbaro et al., 2011; Darrah et al., 2003), who suggest that the screening of social-communication development should take place several times during the first years of life. Law et al. (2012) have also stated that patterns of change over time might serve as a method for identifying the children most at risk and that there is a strong case for the population monitoring of these at-risk children.

Together, the results indicate that repeated surveillance of early communication skills with a broadband parental screener is a feasible first step in identifying children at risk for developing further difficulties and possibly in need of early intervention. Repeated and comprehensive assessment of early communication skills might be able to overcome some of the challenges of prediction caused by the high variability in early typical development, as it does not rely on any single time point and it is able to take developmental progress, and the dimensionality of language ability, into account. For more accurate identification, children preliminarily identified as being at risk for later language and communication difficulties should be referred for further, and more in-depth, assessment. Several studies have suggested that direct professional assessment following initial screening could effectively reduce the number of false positives (Ben-Sasson et al., 2014; Bruce et al., 2003; Dale et al., 2003).

Repeated surveillance combined with direct assessment might also overcome some of the adverse effects of screening. According to Nelson et al. (2006) potential adverse effects of screening include false-positive and false-negative results. False-positives may cause families unnecessary anxiety and lead to redundant testing and intervention when children with normal communication skills are erroneously considered to be at risk. False-negatives, in turn, postpone the identification of impairments, and thus the provision of intervention for children in need of support, which can, in turn, lead to progressive language and communication delays and other long-term effects such as social and academic problems (Nelson et al., 2006). Repeated surveillance as a continuous process might be able to both a) reduce the amount of false-positives and –negatives, and b) raise the awareness of professionals and parents with regard to the potential and limitations of screening, and thus, modify the attitudes and expectations associated with it.

Another important point with regard to clinical practice is that screening and surveillance serve, if properly implemented, as a means of interaction and psychoeducation. Screening provides a natural context for interaction, provides shared language and terminology for parents and professionals, and lowers the threshold for parents to initiate conversation about developmental issues. Screening responds to the information needs of parents with regard to child development and could help them to become more confident in their role as caregivers (Bruce et al., 2003; Marden & Nicholas, 1997). Engaging parents in the process of screening might also lead to increased impressions of caregiver

support (Nelson et al., 2006) and high satisfaction with health care services (Bairati et al., 2011).

The process of screening guides parents by focusing their attention on developmental milestones and their child's development (Nelson et al, 2006). That is, screening and surveillance itself direct parents' attention to skills that are relevant in infancy. For example, Miller et al. (2011) reported that "the act of completing a formal screening questionnaire caused some parents to reconsider their child's developmental progress" (p. 870), which in some cases led parents to initiate a conversation with professionals that resulted in an appropriate referral. Thus, early screening can also contribute to early identification by raising parental awareness of developmental processes. This, in turn, enables parents to stimulate their child at a time when the conditions for spontaneous development are optimal (Bruce et al., 2003).

In addition to its potential in leading to earlier identification, engaging parents in the process of screening can serve as part of an intervention. Language acquisition and the development of communication is a process of interaction between the child's socio-cognitive development and language environment. The nature of parent-child interaction is reciprocal, that is, the contributions of both communicative partners are likely to influence, and be influenced, by the other (Hudson, Levickis, Down, Nicholls, & Wake, 2015; Sameroff, 2010). Thus, supporting both child communication and parental responses to child communication is likely to lead to better outcomes (Yoder & Warren, 2004). Providing information for and training parents in how they can support language and communication development is an important component of an effective intervention (Kaiser & Roberts, 2011). Manipulating aspects of the environment may have beneficial effects on, for example, vocabulary growth (Rowe et al., 2012). In addition to parental guidance, more formal, parent-implemented interventions have shown a promising effect on language development (Roberts & Kaiser, 2011).

4.5 Strengths, limitations and future directions

Conducting a research that focuses on both typical and atypical development at the population level and on screening involves many considerations of an economic and methodological nature. Furthermore, a longitudinal design poses its own challenges by asking how often, for how long, and how intensively and extensively the initial sample should be followed. Often the task of allocating limited resources means striking a balance between the comprehensiveness of the measurement and the size and coverage of the data. There are no unambiguous or correct answers to these questions. However, the decisions made on these issues need to be considered when evaluating and interpreting studies.

One clear asset of the present research is the use of a population-based sample; the initial data were collected from an authentic healthcare setting serving the whole population, and the sample was followed irrespective of the

screening result. Eriksson, Westerlund, and Miniscalco (2010) propose that prospective cohort designs are the most appropriate for evaluations of early language screening and criticize studies that validate screen positives only. According to Westerlund et al. (2006), an instrument should be tested on a normal population in a field setting in order to reveal its potential. Although such data are more difficult to control compared to experimental data the strength of this approach resides in its direct applicability to the setting in which the results are intended to be used (Eriksson et al., 2010; Westerlund et al., 2006). Thus, the data and the measures and methods used in this research both strengthen the ecological validity of the research and pose several limitations that should be taken into account in the interpretation and generalization of the results. Despite the strong longitudinal associations found in this research between prelinguistic skills and later language on both the group and individual levels, these limitations complicate the accurate identification of at-risk children and call for particular caution in comparing the outcomes of the individual developmental trajectories.

With respect to the data, while the initial sample size was rather large, it also has several limitations. First, due to limited time and resources, it was not possible to include the whole sample in each follow-up round or to use psychometric testing at each age stage. This means rather large variation over time in the subsample sizes (the coverage of the initial sample in the subsamples ranges from 20.1 to 58.3% across subsamples) and measures used. This makes comparison of the stability estimates between different ages difficult. However, the coefficients of determination did not seem to vary systematically according to the coverage of the initial sample or the source of information, that is, parent report or psychometric assessment (Study I). Second, in the follow-ups where efforts were made to contact all the originally participating families, the level of attrition was rather high (41.7% at age 4;7 and 46.3% in first grade). However, dropout was not exceptionally high when compared to the attrition rates of questionnaire data in other longitudinal studies of language and communication that have extended their follow-ups into early school age (e.g., Chiat & Roy, 2013; Haworth, Davis, & Plomin, 2013; Jaddoe et al., 2012; range 36–43%; see also Eriksson et al., 2010). In addition, there were no systematic differences between the demographic variables in the different follow-up subsamples, although in the last two follow-ups there was a tendency for the children's mothers to be slightly older and more educated. This observation is in line with the reports of previous longitudinal studies where attrition tends to be lower among children with older and more educated mothers (Henrichs et al, 2011; Reilly et al, 2010). Third, in examining the developmental trajectories, that is, the ECD subgroups, the size of some of the groups was rather small to begin with and grew even smaller over time due to the sampling procedures and attrition. This complicates comparison of the group outcomes over time and affects statistical power and hence also effect sizes. At follow-up in Study II, between 50 and 85% of the group members were present whereas at follow-up in Study III the corresponding proportion was between 25 and 50%. This is partic-

ularly problematic in the case of the smallest groups, A+So, ED and BD, which originally had only 20, 24 and 12 members, respectively. With such small numbers of children the impact of attrition on the outcomes of these groups could have been considerable as only a few individuals were present at the follow-ups. Thus, the interpretations given to the outcomes obtained for these groups should be treated with caution, and replication with larger samples is needed.

One of the strengths of this research was the rather comprehensive collection of prelinguistic communication skills included in the initial assessments. However, despite its comprehensiveness in content, the measure was short and based solely on parent reports. This might explain why specific predictive connections were not found. In order to better understand the processes that underlie the emergence and early development of language, a comprehensive study including also standardized testing or observations of the possible sociocognitive precursors of language, such as working memory and processing efficiency (Fernald & Marchman, 2012), attentional capacity (Rose et al., 2009), joint attention and gestures (Beuker et al., 2013), and symbolic play (Bruce et al., 2003) would be ideal. However, this was not within the scope of this research. In addition, as one of the specific purposes of the study was to examine the feasibility of screening, the use of the ITC in measuring early communication skills was justified. The evaluation of screening tools has practical value when improving and developing clinical policies and evaluation methods. The use of parental reports in early skill measurement is well grounded, as the ultimate goal is to find valid and cost-effective ways of conducting early screening for use in basic health care settings, even if they result in false positives. From a clinical perspective, early social and symbolic skills together with processing skills would be potential candidates for the more in-depth assessment that should follow the initial screening.

One unfortunate shortcoming with regard to the measurement of early skills was the lack of a proper measure of early working memory. The ITC does not measure working memory as such, although our results suggest that it did capture some aspect or correlate of early memory. However, to the best of my knowledge, no reliable measure of working memory at this early age exists in Finland. Thus, the development of reliable and valid measures of early working memory that are sensitive to developmental change, and a fine-grained examination of the developmental interplay between early memory, communication and language functions would be interesting and important topics for future research.

The multifaceted selection of language and memory measures in the follow-up rounds was an asset of the research. According to Conti-Ramsden and Durkin (2012), the complex nature of language requires that several dimensions of language, along with working memory capacity, are taken into account in assessing language. The aim in the selection of the language tests to be used over time was to incorporate multiple measures and multiple sources of information, that is, to take several aspects of language and communication into account (e.g., receptive, expressive and pragmatic), and to include both question-

naire and psychometric data. However, some limitations remain in the set of language measures used in this research. One such limitation was the lack of a measure of morphosyntax. Children with a history of early language delay or with SLI have often been shown to have difficulties with inflectional morphology and syntax (Girolametto et al., 2001; Kunnari et al., 2011; Leonard, 2013; Rescorla, Dahlsgaard, & Roberts, 2000). In addition, it has been recommended that spontaneous language samples (e.g., Conti-Ramsden & Durkin, 2012) and oral narratives (e.g. Marini, Tavano, & Fabbro, 2008) be used in evaluating children's language skills, as it seems that standardized language tests are not able to systematically identify all children with language impairment (e.g., Asikainen, 2005). Moreover, no single measure has been found to consistently show poor performance within the group of children with language difficulties (Asikainen, 2005). Large variability in performance in the different language tasks was also observed in this study. The children with compromised language skills exhibited no clear patterns of difficulties, but instead each child showed a unique combination of skills and difficulties. The observed variability in performance in the measures used, together with small group sizes, might explain why we found no significant differences between the ECD groups in any of the language measures at age 5;3.

It could also be argued that, although rather comprehensive, the selection of language tasks was not one that is universally used in the assessments by speech and language pathologists or in studies of language development. However, all the language and memory tasks used are common in psychological assessments of cognitive functioning and language skills in Finland. This said, it is an unfortunate fact that standardized quality measures of language are lacking in Finland. That is, Finland has no reliable gold standard for evaluating language outcome and defining clinical status. Thus, the measures used in this research did not allow for the determination of which children could be classified as having SLI. Diagnostic status as such was not a core issue in this research, as the focus was in the full variety of language difficulties regardless of whether they fulfilled explicit diagnostic criteria or not. Nonetheless, for the purposes of studies such as the present one, because screening requires validation, it is necessary to decide the cut-off for a phenomenon that is a matter of degree or is a continuum in its nature (Eriksson et al., 2010). It is important to pay attention to the ways in which language status is determined when evaluating the performance of screening measures, as the variance in reference tests and cut-offs renders comparison of different screening studies difficult (Eriksson et al., 2010; Law et al., 2000b; Stott et al., 2002). In this research, the percentage of children with parent-reported language difficulties was 10.2% (Study II) and that with compromised language skills determined with psychometric tests 15.4% (Study III). These numbers are rather high compared to previously reported estimates of the prevalence of SLI (2–10%, Hulme & Snowing, 2009; Law et al, 2000b; Tomblin et al., 1997). This discrepancy is likely due to the parent measure being a screener as well as to the criteria for compromised language (performance -1.5 SD in at least two language measures). However, based on the findings that

children with subclinical weaknesses in language are also at risk for later academic difficulties (e.g., Lyytinen et al., 2005; Rescorla, 2009; Roos & Ellis Weismer, 2008), it is important to identify these children as early as possible.

In addition to measurements of language and memory, it is evident that there are other important risk and resilience factors that contribute to language development. Unfortunately, these were not systematically controlled for in this research. Shared features of development across age and several prelinguistic skills were at best able to explain about half of the variation in later development (Study I). This, along with previous findings of comparable coefficients of determination (e.g., Wetherby et al., 2002, 2003), endorses the view that despite strong continuity between early and later skills, development is affected by several other factors as well. These confounding factors that could affect estimation of the stability and accuracy of prediction, include factors related to the child (e.g., gender, nonverbal ability) and the family (e.g., parental age and education) (e.g., Bornstein et al., 2013). In their review, Nelson et al. (2006) list family history, male gender and perinatal factors to be the most consistent associated risk factors. However, the evidence on whether the inclusion of additional risk factors improves the prediction is conflicting (see Peyre et al., 2014). In the early stages of development, these variables have been shown to have little explanatory power (Henrichs et al., 2011; Reilly et al., 2006; Sylvestre et al., 2012). At later ages, they have been shown to contribute more to later language status but, at best, to show only modest discrimination between children with and without low language ability (Law et al., 2012; Reilly et al., 2010). In Study II, gender differences were observed in the composition of the ECD groups, as girls were overrepresented in the highest performing group (AA) and there was a tendency of the at-risk groups to include more boys, but risk for persistent difficulties over time did not seem to be affected by gender.

Another important factor that merits attention is the child's social environment. Social interaction creates the context for language development and communicative partners have a crucial role in this process (Bruner, 1983; Tomasello, 2001; Tomasello et al., 2007). For example, maternal responsivity has been shown to mediate the relation between early communication and later language ability (Wu & Gros-Louis, 2014; Yoder & Warren, 1999) and to predict slow-to-talk toddler's later language ability in childhood (Hudson et al., 2015). As communication is reciprocal by nature, factors related to both the child's social environment and the child's ability should be taken into account in order to gain a better understanding of the developmental processes of language and communication (e.g., Bornstein & Manian, 2013). That is, in addition to individual differences in the early endowment of language and communication, differences in parental language, parental responsivity or the wider social environment might affect communication skill development within the ECD groups both during prelinguistic period and the long-term outcomes of the individuals. It is possible, and probable, that two children showing a similar early endowment but having a qualitatively different social environment differ in their later developmental trajectories of both prelinguistic and linguistic skills.

In addition, the use of speech and language therapy services is likely to affect children's outcomes (Law, Garrett, & Nye, 2003), and thus merits attention in predictive studies. It is highly probable that families whose children have shown slowness in their early language and communication development compared to peers, have been provided both parental guidance and speech and language therapy services. In Finland, the access to these services does not require a formal diagnosis. The eligibility is determined based on evaluations and observations by the child health care nurse or doctor, and in collaboration with the parents. Unfortunately, we did not have information regarding the use of these services for the whole sample, and thus, could not statistically control for this in our models. However, it is important to remember that the use of these services might have influenced the developmental outcomes of the individuals at later ages having an effect on the results of predictive analyses, for example the number of false positives.

Despite these limitations, this research makes an important contribution to current literature on prelinguistic development and screening, and offers interesting openings for future studies. The use of a rather large community-based sample, multifaceted and repeated assessment of communication at the prelinguistic stage, the length of the follow-up period, and the frequency of the follow-up measurements along with a multifaceted selection of follow-up measures that included a rather comprehensive assessment of working memory were strengths of this study. In addition, this research is, to my knowledge, among the first to examine individual trajectories of development during the prelinguistic stage (see Darrah et al., 2003; Reilly et al., 2006; Veness et al., 2011). However, replication of the developmental trajectories found here with a more intact data set and more comprehensive information about the participants is called for. Causal processes likely involve complex interplay between mechanisms of risk and protective factors (Rutter, Pickles, Murray, & Eaves, 2001). Thus, a more detailed comparison of the developmental trajectories, and subsequent identification of possible additional attributes of risk and resilience associated with these, is needed. This would lay a stronger foundation for the validation of both the early screening procedure and the individual trajectories extracted from it, for more reliable and valid generalizations of subgroup outcomes together with more accurate identification of pathways leading to persistent difficulties, and for the identification of potential implications for prevention and intervention.

4.6 Conclusions

The acquisition of language and mastering the means of social communication are important developmental outcomes in their own right. In addition, these abilities serve as developmental means for social competence, literacy, education, and employment (e.g., Taylor, Zubrik, & Rice, 2013), and have been shown to relate to academic and social outcomes across the lifespan (Hulme & Snowl-

ing, 2009; Taanila et al., 2007). The prominent role that language and communication play in all stages of life makes the studying of the processes of language and communication development an important task. Providing information and support as early as possible for children and families struggling with the early stages of communication development seems a legitimate goal of research. Despite the recent advances in understanding of the prelinguistic foundations of language and of the processes of early identification, early and accurate identification of at-risk children and effective provision of early intervention in natural environments continue to challenge the field of language and communication studies as well as clinical practice (Kaiser & Roberts, 2011).

This research contributes to the literature by following the development of several prelinguistic skills during the first two years of life, by examining the predictive relations between this early development and later language ability, and by critically evaluating the implications these observations have for screening procedures. The results support the view that a developmental link exists between prelinguistic communication and later language ability and indicate stability in development over time. The findings of strong developmental interrelations both concurrently and over time between different aspects of prelinguistic communication, and of significant predictive relations between these early developmental patterns and later language ability, support the view that language ability is built up from several early socio-cognitive skills (Bates, 2004; Bates et al., 1979, 2002) and that these skills together form an early endowment that has a bearing on later development (Rescorla, 2009, 2013). In other words, the findings suggest that a notable proportion of the children who show at-risk features of development already before their second birthday continue to show poorer language and communication skills along with limitations in working memory in their later development compared to peers with a history of unproblematic prelinguistic development. Based on the results, the most prominent at-risk feature of development was the accumulation of early difficulties, that is, slowness in development in several areas of prelinguistic skills, especially if symbolic and social abilities were included. Thus, the results support the dimensional view of language ability (Rescorla, 2013) and endorse the view that language difficulties can have different origins, of which late onset of expressive language is just one and not necessarily the most indicative or predictive of later development (Leonard, 2013).

The results of this research also have important implications for the development of screening procedures of early language and communication. Bruce et al. (2003) state that the relevant questions with regard to screening for early language and communication skills are when, how, and by whom the screening should be performed. Based on the observations in Studies I, II and III, along with a careful reading of the current literature, our answers to these questions would be: 1) repeatedly during the first two years of life, 2) taking several of the prelinguistic skills into account simultaneously, and 3) by combining initial parent report with clinical assessment of the identified at-risk children. By assessing multiple early communication skills instead of just oral language, and

by following development in these skills over short periods of time, we might be able to identify at-risk children more accurately and at an earlier age. It seems possible that a specific profile of early skills and difficulties over time predisposes children to a greater risk of later language difficulties. In addition, multifaceted early assessment of relevant socio-cognitive skills could aid in choosing targets for early intervention. After all, the primary goal of screening is not just the identification of individuals in need of support but also the subsequent provision of appropriate support.

YHTEENVETO (FINNISH SUMMARY)

Kielen kehityksen polut: Seurantatutkimus esikielellisen kehityksen vaiheesta koulun alkuun

Tämän tutkimuksen tavoitteena oli tarkastella esikielellisten kommunikaatiotaitojen kehitystä ensimmäisten kahden ikävuoden aikana sekä tämän kehityksen yhteyksiä myöhempiin kielellisiin taitoihin kouluikään saakka. Vuorovaikutustaitojen tehokas hallinta ja kielen käyttö kommunikaation välineenä ovat keskeisiä lapsuuden kehitystehtäviä. Kielen ja kommunikaation vaikeudet kuuluvat yleisimpiin varhaislapsuuden kehityshäiriöihin. Niiden esiintyvyyden on arvioitu olevan määritelmästä ja iästä riippuen 2–19 % (Law ym., 2000b). Arvioiden suuresta vaihtelusta huolimatta on selvää, että huomattavalla määrällä lapsia on kielen kehityksen häiriöitä ja yhä useammalla lievempiä kielen ja kommunikaation vaikeuksia. Lisäksi on havaittu, että kielellisiin vaikeuksiin liittyy usein erilaisia oppimiseen, sosiaalisiin taitoihin ja hyvinvointiin liittyviä liitännäisvaikeuksia (Beitchman, Wilson, Brownlie, Walters, Inglis, & Lancee, 1996; Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996).

Riskilasten varhainen ja tarkka tunnistaminen on ensimmäinen askel lasten ja perheiden tukemisessa sekä myöhempien vaikeuksien ennaltaehkäisemisessä. Tämänhetkisen tietämyksen ja seulontamenetelmien pohjalta riskilasten tarkka tunnistaminen on kuitenkin vielä hankalaa. Tarvitaan lisää tutkimusta, jotta voitaisiin aiempaa tarkemmin tunnistaa kielellisten vaikeuksien ilmenemiseen vaikuttavat varhaiset riskitekijät, saataisiin parempi kuva kielen ja kommunikaation kehityskuluista, sekä luotaisiin syvempi ymmärrys esikielellisen kehityksen merkityksestä myöhemmille kielellisille taidoille. Lisäksi seulontamenetelmiä tulisi kehittää niin, että ne palvelisivat neuvolan seulontakäytänteitä entistä paremmin. Tämän tutkimuksen tavoitteena oli tarkastella ja selkeyttää näitä ilmiöitä tutkimalla kielen ja kommunikaation kehitystä pitkittäisasetelman avulla esikielellisen kehityksen vaiheesta kouluikään.

Tutkimus koostuu kolmesta osatutkimuksesta. Aineistonkeruu toteutettiin vuosina 2003–2011 osana Jyväskylän yliopiston ja Niilo Mäki Instituutin Esikko- ja Tomera-yhteistyöhanketta. Esikko-hankkeen tavoitteena oli tutkia lyhyen seulontalomakkeen käyttöä esikielellisten taitojen kehityksen systemaattisessa seurannassa neuvoloissa. Kaikki Jyväskylän alueen neuvolat olivat mukana aineistonkeruussa. Mukaan pyydettiin kaikkia perheitä, joissa oli 6–24 kk:n ikäisiä lapsia ja kaiken kaikkiaan 508 lasta (50,2 % poikia, 49,8 % tyttöjä) perheineen osallistui tutkimukseen. Esikielellisiä vuorovaikutustaitoja seurattiin kolmen kuukauden välein (yhteensä seitsemän mittausta, 6 kk n = 229, 9 kk n = 203, 12 kk n = 322, 15 kk n = 305, 18 kk n = 279, 21 kk n = 273, 24 kk n = 330) vanhemmille suunnatulla Esikko-seulontalomakkeella (Laakso, ym., 2011; alkuperäinen lomake Infant-Toddler Checklist, ITC, Wetherby & Prizant, 2002). Esikko-lomakkeella kartoitetaan varhaisen kielen ja kommunikaation kehityksen pääpiirteitä kolmella kehityksen eri osa-alueella: sosiaalinen kommunikaatio, puheen tuottaminen ja ymmärtäminen. Tomera-hankkeessa samojen lasten kie-

len ja kommunikaatiotaitojen kehitystä seurattiin toistuvasti ensimmäisen luokan kevääseen saakka. Seurantapisteitä oli yhteensä viisi: 2 vuoden iässä (n = 104, kyselylomake), 3 vuoden iässä (n = 112, yksilölliset arvioinnit), 4 vuoden 7 kuukauden iässä (n = 296, kyselylomake), 5 vuoden 3 kuukauden iässä (n = 102, yksilölliset arvioinnit) ja ensimmäisen luokan kevätlukukaudella (n = 273, iän vaihteluväli 7 v 2 kk–8 v 4kk, kyselylomake). Tässä tutkimuksessa käytettiin osaotoksia kerätystä datasta (osatutkimusten otokset on kuvattu Taulukossa 1.)

Tutkimuksella oli kolme päätavoitetta. Ensimmäinen tavoite oli seurata ja kuvata useiden esikielellisten kommunikaatiotaitojen kehitystä kahden ensimmäisen ikävuoden aikana. Tätä tutkittiin osatutkimuksissa I ja II. Osatutkimuksessa I esikielellisten kommunikaatiotaitojen kehitystä tarkasteltiin 6–18 kk:n iässä ryhmätasolla muuttujasuuntautuneesta näkökulmasta. Analyysimenetelmänä oli latentti kasvukäyrämallinnus (Latent Growth Curve, LGC). Analyyseissä mallinnettiin ensin kunkin osa-alueen (sosiaalinen kommunikaatio, puheen tuottaminen ja ymmärtäminen) kehitys, ja kehityksestä etsittiin yhteisiä tekijöitä toisen asteen faktoreiden avulla. Erityisesti tarkasteltiin, onko esikielellisten kommunikaatiotaitojen osa-alueiden kehityksessä pääosin päällekkäisyyttä, vai onko kehityksessä havaittavissa tiettyyn taitoon tai ikävaiheeseen liittyviä erityispiirteitä. Myös yksilöllisten erojen pysyvyyttä tarkasteltiin. Osatutkimuksessa II kehitystä tarkasteltiin henkilösuuntautuneesta näkökulmasta. Päätavoitteena oli tunnistaa tyypillisiä kehityskulkuja 12–21 kk:n iässä hyödyntämällä latenttia profiilianalyysiä (Latent Profile Analysis, LPA). Pyrkimyksenä oli löytää latentteja alaryhmiä, jotka eroavat toisistaan esikielellisessä kehityksessä niin tilastollisesti kuin sisällöllisestikin. Tulokset osoittivat, että kun useiden esikielellisten taitojen kehitystä tarkasteltiin yhtäaikaisesti, yksilölliset erot kehityksessä näyttäytyivät suhteellisen jatkuvina ja pysyvinä. Ryhmätasolla eri osa-alueiden kehityksessä oli huomattavaa päällekkäisyyttä, eli eri taidot näyttivät kehittyvän pääsääntöisesti samaan tahtiin ja samalla tasolla. Kehityksessä oli kuitenkin havaittavissa suuria yksilöllisiä eroja, ja aineistosta tunnistettiin kuusi selkeästi toisistaan eroavaa tyypillistä kehityskulkua.

Toisena tavoitteena oli tutkia varhaiskehityksen ennustavuutta suhteessa kielellisiin taitoihin ja vaikeuksiin 2–8 ikävuoden välillä sekä muistitaitoihin viiden vuoden iässä. Osatutkimuksessa I tarkasteltiin, mitkä varhaiskehityksen tekijät (kuten kehitys yli taitojen tai erityisesti tiettyyn taitoon tai ikään liittyvät tekijät) parhaiten ennustavat myöhempiä taitoja ryhmätasolla 2–8 vuoden iässä. Osatutkimuksessa II seurattiin, miten varhaiskehityksen tyypilliset kehityskulut olivat yhteydessä kielellisiin vaikeuksiin 4 vuoden 7 kuukauden iässä ja osatutkimuksessa III tarkastelu ulotettiin koskemaan 5 vuoden 3 kuukauden iässä tehtyjä kielen ja muistin tutkimuksia. Tavoitteena oli selvittää, johtivatko tietyt varhaiset kehityskulut todennäköisemmin myöhempiin kielellisin vaikeuksiin. Esikielellisten taitojen kehitys oli järjestelmällisesti yhteydessä sekä vanhempien raportoimiin että psykometrisin testein arvioituihin kielellisiin taitoihin sekä suoriutumiseen työmuistitehtävissä. Esikielellisten taitojen kokonaiskehitys ennusti parhaiten myöhempiä kielellisiä taitoja ryhmätasolla. Yksilötasolla selkein kehityksellinen riskipiirre oli useiden vaikeuksien ilmeneminen varhais-

kehityksen aikana erityisesti, jos vaikeudet liittyivät varhaisiin symbolisiin (ymmärtäminen) ja sosiaalisiin taitoihin. Erityisen vahva ennustava yhteys löytyi esikielellisten taitojen kehityksen ja myöhemmän työmuistisuoriutumisen väliltä.

Kolmas tavoite oli arvioida varhaisen vanhempien avulla toteutettavan seulonnan soveltuvuutta ja luotettavuutta kielen ja kommunikaation kehityksen seurannassa ja kehitykseen liittyvien riskien tunnistamisessa. Tätä tarkasteltiin kaikissa kolmessa osatutkimuksessa. Osatutkimus I arvioi, onko vanhempien arvioimien esikielellisten taitojen ja myöhempien monipuolisesti arvioitujen kielellisten taitojen kehityksessä nähtävissä jatkuvuutta ja pysyvyyttä. Osatutkimuksissa II ja III varhaisten vanhempien arviointien ennustavuutta tutkittiin yksilötasolla tarkastelemalla seulontamenetelmän sensitiivisyyttä (herkkyys) ja spesifisyyttä (tarkkuus). Tulokset osoittivat, että myöhempää kehitystä ennustavia varhaisia kehityspiirteitä voidaan luotettavasti tunnistaa vanhempien antaman lomaketiedon pohjalta. Yhteydet vanhempien varhaisten arviointien ja myöhempien kielellisten taitojen välillä olivat nähtävissä sekä ryhmä- että yksilötasolla.

Tämän tutkimuksen tulokset tukevat näkemystä, jonka mukaan kielen ja kommunikaation kehitys etenee jatkumona esikielellisestä kehityksestä kielellisiin taitoihin (mm. Bates ym., 1979; Bruner, 1983). Yksilöllisten erojen pysyvyys ja vahvat kehitykselliset yhteydet eri taitojen välillä esikielellisen kehityksen aikana sekä esikielellisten taitojen ja myöhempien kielellisten taitojen välillä puoltavat ajatusta siitä, että kieli ja kommunikaatio rakentuvat useista varhaisista sosiokognitiivisista taidoista ja yksilölliset erot näissä taidoissa ovat lähtökohta myöhemmälle kehitykselle (Bates, 2004; Bates ym., 1979, 2002; Rescorla, 2009, 2013). Tulokset osoittavat, että verrattuna lapsiin, joiden esikielellinen kehitys on edennyt ongelmitta, lapsilla, joiden kehityksessä on havaittavissa useita riskipiirteitä jo ennen kahta ikävuotta, kielen ja kommunikaation taidot ovat heikommat ja työmuisti rajoittunut myös myöhemmissä ikävaiheissa. Tulosten perusteella merkittävin kehityksellinen riskipiirre oli vaikeuksien kasaantuminen erityisesti, jos kehitys eteni hitaasti sosiaalisissa ja symbolisissa taidoissa. Kaiken kaikkiaan tulokset tukevat kielellisten taitojen dimensionaalista näkemystä (Rescorla, 2013), jonka mukaan kielelliset erityisvaikeudet edustavat kielellisten taitojen normaalijakauman ääripäätä, eivät laadullisesti erilaista kehitystä. Tulokset viittaavat myös vahvasti siihen, että kielellisten vaikeuksien taustalla voi olla monenlaisia vaikeuksia, eikä tuottavan kielen viive ole ainoa tai paras ennustava tekijä varhaiskehityksen aikana.

Tämän tutkimuksen tulokset tarjoavat myös tärkeää tietoa neuvolassa toteutettavan kielen ja kommunikaation seulonnan kannalta. Tulosten perusteella voidaan todeta, että varhainen seulonta on perusteltua, joskin lisätutkimusta tarvitaan tarkkuuden lisäämiseksi. Seulonnan näkökulmasta olennaisinta näyttäisi olevan, että arviointi kattaa esikielelliset taidot monipuolisesti ja tuottaa tietoa myös taitojen kehityksestä. Toisin sanoen tuottavan kielen taitojen lisäksi olisi tärkeää kiinnittää huomiota myös muihin kommunikaatiotaitoihin ja yksittäisen arvioinnin sijaan kehitystä tulisi seurata toistuvasti ensimmäisten kahden

ikävuoden aikana. Toistuvan ja monipuolisen arvioinnin avulla on mahdollista tunnistaa hyvin varhain suurin osa lapsista, joilla on riski myöhemmille kielellisille vaikeuksille. Arviointi tuottaa kuitenkin paljon myös vääriä hälytyksiä, jolloin riskipiirteen olemassaolo ei johda myöhempiin vaikeuksiin. Yksi mahdollisuus tarkkuuden lisäämiseksi on yhdistää vanhempien avulla toteutettavaan kehityksen seurantaan tarkempi kliininen arviointi niiden lasten osalta, joiden varhaiskehitys osoittaa useita riskipiirteitä. Tämäntyyppinen arviointiprosessi toimii myös hyvänä lähtökohtana tukitoimien suunnittelulle, johon kehityksen seulonnan tulisi aina tarvittaessa johtaa.

REFERENCES

Adamson, L. B., Bakeman, R., & Deckner, D. F. (2004). The development of symbol-infused joint engagement. *Child Development, 75,* 1171–1187.

Adamson, L. B., Bakeman, R., Deckner, D. F., & Romski, M. A. (2009). Joint engagement and the emergence of language in children with autism and down syndrome. *Journal of Autism and Developmental Disorders, 39*, 84–96.

Ahonen, T., Tuovinen, S., & Leppäsaari, T. (2003). *Nopean sarjallisen nimeämisen testi* [A test for rapid automatized naming]. Jyväskylä: Haukkarannan koulu, Niilo Mäki Instituutti.

Akobeng, A. K. (2007). Understanding diagnostic tests 1: Sensitivity, specificity and predictive values. *Acta Paediatrica*, *96*, 338–341.

Alloway, T. P. & Gathercole, S. E. (2005). The role of sentence recall in reading and language skills of children with learning difficulties. *Learning and Individual Differences, 15*, 271–282.

Alt, M. (2011). Phonological working memory impairments in children with specific language impairment: Where does the problem lie? *Journal of Communication Disorders, 44*, 173–185.

Archibald, L. M. D. & Gathercole, S. E. (2006). Short-term and working memory in specific language impairment. *International Journal of Language & Communication Disorders, 41*, 675–693.

Archibald, L. M. D. & Joanisse, M. F. (2009). On the sensitivity and specificity of nonword repetition and sentence recall to language and memory impairments in children. *Journal of Speech, Language, and Hearing Research, 52*, 899–914.

Arkkila, E., Räsänen, P., Roine, R. P., & Vilkman, E. (2008). Specific language impairment in childhood is associated with impaired mental health and social well-being in adulthood. *Logopedics Phoniatrics Vocology, 33*, 179–189.

Armstrong, E. S., Marchman, V. A., & Owen, M. T. (2007). *School age cognitive and achievement outcomes for late talkers and late bloomers: Do late bloomers really bloom?* Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Boston, November 2007.

Aro, T., Laakso, M.-L., Määttä, S., Tolvanen, A., & Poikkeus, A.-M. (2014). Associations between toddler-age communication and kindergarten-age self-regulatory skills. *Journal of Speech, Language, and Hearing Research, 57*, 1405–1417.

Asikainen, M. (2005). *Diagnosing specific language impairment.* Tampere: Acta Universitatis Tamperensis, 1113.

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*, 417–423.

Baddeley, A. (2003). Working memory and language: An overview. *Journal of Communication Disorders, 36*, 189–208.

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*, 1–29.

Baddeley, A. D. & Hitch, G. J. (1974). Working memory. In G. A. Bower (Ed.), *The psychology of learning and motivation* (pp. 47–89). New York: Academic Press.

Bairati, I., Meyer, F., Gueye, C. B. D., Desmarais, C., Rouleau, N., & Sylvestre, A. (2011). Factors influencing parent satisfaction with preventive health services for the early detection of speech and language delay in preschool children. *Open Journal of Preventive Medicine, 1,* 135–142. doi: 10.4236/ojpm.2011.13018

Baird, G., Charman, T., Cox, A., Baron-Cohen, S., Swettenham, J., Wheelwright, S., & Drew, A. (2001). Screening and surveillance for autism and pervasive developmental disorders. *Archives of Disease in Childhood, 84*, 468–475.

Barbaro, J., Ridgway, L., & Dissanayake, C. (2011). Developmental surveillance of infants and toddlers by maternal and child health nurses in an australian community-based setting: Promoting the early identification of autism spectrum disorders. *Journal of Pediatric Nursing, 26*, 334–347.

Bates, E. A. (2004). Explaining and interpreting deficits in language development across clinical groups: Where do we go from here? *Brain and Language, 88*, 248–253.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). *The emergence of symbols: Cognition and communication in infancy.* New York: Academic Press.

Bates, E., Dale, P. S., & Thal, D. (1995). Individual differences and their implications for theories of language development. In P. Fletcher & B. MacWhinney (Eds.), *Handbook of child language* (pp. 96–151). Oxford: Blackwell.

Bates, E. & Dick, F. (2002). Language, gesture, and the developing brain. *Developmental Psychobiology, 40*, 293–310.

Bates, E., Thal, D., Finlay, B. L., & Clancy, B. (2002). Early language development and its neural correlates. In S. J. Segalowitz & I. Rapin (Eds.), *Handbook of neuropsychology, Vol. 8: Child neurology* (2nd ed., pp. 109–176). Amsterdam: Elsevier Scientific.

Bavin, E. L. & Bretherton, L. (2013). The Early Language in Victoria Study. Late talkers, predictors, and outcomes. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions, and outcomes* (pp. 3–21). Baltimore, MD: Brookes.

Beeghly, M. (2006). Translational research on early language development: Current challenges and future directions. *Development and Psychopathology, 18, 737–757*.

Beitchman, J. H., Wilson, B., Brownlie, E. B., Walters, H., Inglis, A., & Lancee, W. (1996). Long-term consistency in speech/language profiles: II. Behavioral, emotional, and social outcomes. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 815–825.

Beitchman, J. H., Wilson, B., Brownlie, E. B., Walters, H., & Lancee, W. (1996). Long-term consistency in speech/language profiles: I. Developmental and

academic outcomes. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 804–814.

Ben-Sasson, A., Habib, S., & Tirosh, E. (2014). Feasibility and validity of early screening for identifying infants with poor social-communication development in a well-baby clinic system. *Journal of Pediatric Nursing, 29*, 238–247.

Bergman, L. R. & Andersson, H. (2010). The person and the variable in developmental psychology. *Journal of Psychology, 218,* 155–165.

Bergman, L. R., Magnusson, D., & El-Khouri, B. M. (2003). *Studying individual development in an interindividual context: A person-oriented approach.* Mahwah, NJ: Erlbaum.

Bergman, L. R. & Trost, K. (2006). The person-oriented versus the variable-oriented approach: Are they complementary, opposites, or exploring different worlds? *Merrill-Palmer Quarterly, 52*, 601–632.

Beuker, K. T., Rommelse, N. N. J., Donders, R., & Buitelaar, J. K. (2013). Development of early communication skills in the first two years of life. *Infant Behavior and Development, 36,* 71–83.

Bishop, D. V. M. (2003). *The Children's Communication Checklist* (Vol 2). London: Harcourt Assessment.

Bishop, D. V. M. (2006). What causes specific language impairment in children? *Current Directions in Psychological Science, 15*, 217–221.

Bishop, D. V. M. (2014). CCC-2 -Lasten ja nuorten kommunikointitaitojen kysely [*The Children's Communication Checklist,* Vol 2]. Helsinki: Hogrefe Psykologien Kustannus.

Bishop, D. V. M., North, T., & Donlan, C. (1996). Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study. *Journal of Child Psychology and Psychiatry, 37*, 391–403.

Bollen, K. A. & Curran, P. J. (2006*). Latent curve models: A structural equation perspective*. New Jersey: Wiley.

Bonifacio, S., Girolametto, L., Bulligan, M., Callegari, M., Vignola, S., & Zocconi, E. (2007). Assertive and responsive conversational skills of Italian-speaking late talkers. I*nternational Journal of Language & Communication Disorders, 42*, 607–623.

Bornstein, M. H., Hahn, C.-S., Putnick, D. L., & Suwalsky, J. T. D. (2013). Stability of core language skill from early childhood to adolescence: A latent variable approach. *Child Development, 85*, 1346–1356.

Bornstein, M. H. & Manian, N. (2013). Maternal responsiveness and sensitivity reconsidered: Some is more. *Development and Psychopathology, 25,* 957–971.

Bornstein, M. H. & Putnick, D. L. (2012). Stability of language in childhood: A multiage, multidomain, multimeasure, and multisource study. *Developmental Psychology, 48,* 477–491.

Botting, N. & Conti-Ramsden, G. (2003). Autism, primary pragmatic difficulties, and specific language impairment: Can we distinguish them using psycholinguistic markers? *Developmental Medicine & Child Neurology, 45*, 515–524.

Boyle, J., Gillham, B., & Smith, N. (1996). Screening for early language delay in the 18-36 month age-range: The predictive validity of tests of production, and implications for practice. *Child Language Teaching and Therapy, 12,* 113–127.

Boyle, W., Lindell, A. K., & Kidd, E. (2013). Investigating the role of verbal working memory in young children's sentence comprehension. *Language Learning, 63,* 211–242.

Brinton, B. & Fujiki, M. (1999). Social interactional behaviors of children with specific language impairment. *Topics in Language Disorders, 19*, 49–69.

Brooks, R. & Meltzoff, A. N. (2008) Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: A longitudinal, growth curve modeling study. *Journal of Child Language, 35*, 207–220.

Bruce, B., Kornfält, R., Radeborg, K., Hansson, K., & Nettelbladt, U. (2003). Identifying children at risk for language impairment: Screening of communication at 18 months. *Acta Paediatrica, 92,* 1090–1095.

Bruner, J. (1983). *Child's talk: Learning to use language.* Oxford: Oxford University Press.

Callister, L. C., Lauri, S., & Vehviläinen-Julkunen, K. (2000). A description of birth in Finland. *The American Journal of Maternal/Child Nursing, 25,* 146–150.

Camarata, S. (2014). Early identification and early intervention in autism spectrum disorders: Accurate and effective? *International Journal of Speech-Language Pathology*, 16, 1–10.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*, 1–143.

Carscadden, J., Corsiatto, P., Ericson, L., Illchuk, R., Esopenko, C., Sterner, E., … Oddie, S. D. (2010). A pilot study to evaluate a new early screening instrument for speech and language delays. Une étude pilote pour évaluer un nouvel instrument de dépistage des retards de la parole et du langage. *Revue Canadienne d'Orthophonie et d'Audiologie, 34*, 87–95.

Caulfield, M. B., Fischel, J. E., DeBaryshe, B. D., & Whitehurst, G. J. (1989). Behavioral correlates of developmental expressive language disorder. *Journal of Abnormal Child Psychology, 17*, 187–201.

Chaffee, C. A., Cunningham, C., Secord-Gilbert, M., Elbart, H., & Richards, J. (1991). The influence of parenting stress and child behavior problems on parental estimates of expressive and receptive language development. *Journal of Abnormal Child Psychology, 19*, 65–74.

Chiat, S. & Roy, P. (2008). Early phonological and sociocognitive skills as predictors of later language and social communication outcomes. *The Journal of Child Psychology and Psychiatry, 49*, 635–645.

Chiat, S. & Roy, P. (2013). Early predictors of language and social communication impairments at ages 9–11 years: A follow-up study of early-referred children. *Journal of Speech, Language, and Hearing Research, 56*, 1824–1836.

Clegg, J., Hollis, C., Mawhood, L., & Rutter, M. (2005). Developmental language disorders – A follow-up in later adult life. Cognitive, language and psychosocial outcomes. *The Journal of Child Psychology and Psychiatry, 46*, 128–149.

Coady, J. A. & Evans, J. L. (2008). Uses and interpretations of non-word repetition tasks in children with and without Specific Language Impairments (SLI). *International Journal of Language & Communication Disorders, 43,* 1–40.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.

Colonnesi, C., Stams, G. J. J. M., Koster, I., & Noom, M. J. (2010). The relation between pointing and language development: A meta-analysis. *Developmental review, 30*, 352–366.

Conti-Ramsden, G. (2003). Processing and linguistic markers in young children with Specific Language Impairment (SLI). *Journal of Speech, Language, and Hearing Research, 46,* 1029–1037.

Conti-Ramsden, G. & Botting, N. (1999). Classification of children with Specific Language Impairment: Longitudinal considerations. *Journal of Speech, Language, and Hearing, Research, 42,* 1195–1204.

Conti-Ramsden, G., Botting, N., & Faragher, B. (2001). Psycholinguistic markers for Specific Language Impairment (SLI). *Journal of Child Psychology and Psychiatry and Allied Disciplines, 42,* 741–748.

Conti-Ramsden, G., Botting, N., Simkin, Z., & Knox, E. (2001). Follow-up of children attending infant language units: Outcomes at 11 years of age. *International Journal of Language and Communication Disorders, 36*, 207–219.

Conti-Ramsden, G., Crutchley, A., & Botting, N. (1997). The extent to which psychometric tests differentiate subgroups of children with SLI. *Journal of Speech, Language, and Hearing Research, 40*, 765–777.

Conti-Ramsden, G. & Durkin, K. (2012). Language development and assessment in the preschool period. *Neuropsychology Review, 22*, 384–401.

Conti-Ramsden, G. & Hesketh, A. (2003). Risk markers for SLI: A study of young language-learning children. *International Journal of Language and Communication Disorders, 38,* 251–263.

Corsi, P. M. (1972). *Human memory and the medial temporal region of the brain*. (Doctoral dissertation). McGill University. Retrieved from digitool.library.mcgill.ca/ thesisfile70754.pdf

Crais, E. R. (2011). Testing and beyond: Strategies and tools for evaluating and assessing infants and toddlers. *Language, Speech, and Hearing Services in Schools, 42,* 341–364.

Cramér, H. (1946). *Mathematical methods of statistics*. Princeton, NJ: Princeton University Press.

Dale, P. S. (2012). Emotional expression and language: A psycholinguistic perspective. Commentary to Kubicek and Emde (2012). *Infant Mental Health Journal, 33*, 593–596.

Dale, P. S. & Hayiou-Thomas, M. E. (2013). Outcomes for late talkers: A twin study. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language*

development, interventions, and outcomes (pp. 241–257). Baltimore, MD: Brookes.

Dale, P. S., McMillan, A. J., Hayiou-Thomas, M. E., & Plomin, R. (2014). Illusory recovery: Are recovered children with early language delay at continuing elevated risk? *American Journal of Speech-Language Pathology, 23*, 437–447.

Dale, P. S., Price, T. S., Bishop, D. V. M., & Plomin, R. (2003). Outcomes of early language delay: I. Predicting persistent and transient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research, 46*, 544–560.

Darrah, J., Hodge, M., Magill-Evans, J., & Kembhavi, G. (2003). Stability of serial assessments of motor and communication abilities in typically developing infants – Implications for screening. *Early Human Development, 72*, 97–110.

de Koning, H. J., de Ridder-Sluiter, J.G., van Agt, H. M. V. Reep-van den Bergh, C. M. M., van der Stege, H.A., Korfage, I. J., … van der Maas, P. J. (2004). A cluster-randomised trial of screening for language disorders in toddlers. *Journal of Medical Screening, 11*, 109–116.

Denckla, M. B. & Cutting, L. E. (1999). History and significance of rapid automatized naming. *Annals of Dyslexia, 49*, 29–42.

Desmarais, C., Sylvestre, A., Meyer, F., Bairati, I., & Rouleau, N. (2010). Three profiles of language abilities in toddlers with an expressive vocabulary delay: Variations on a theme. *Journal of Speech, Language, and Hearing Research, 53*, 699–709.

Dollaghan, C. A. (2004). Taxometric analyses of specific language impairment in 3- and 4-year-old children. *Journal of Speech, Language, and Hearing Research, 47*, 464–475.

Dollaghan, C. A. (2011). Taxometric analyses of specific language impairment in 6-year-old children. *Journal of Speech, Language, and Hearing Research, 54*, 1361–1371.

Dollaghan, C. (2013). Late talker as a clinical category: A critical evaluation. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions and outcomes* (pp. 91–112). Baltimore, MD: Brookes.

Duncan, T. E., Duncan, S. C., & Strycker L. A. (2006). *An introduction to latent variable growth curve modeling: Concepts, issues, and applications.* (2nd ed.) Mahwah, NJ: Erlbaum.

Dunn, L. M & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test – Revised*. Circle Pines, MN: American Guidance Service.

Ellis, E. M. & Thal, D. J. (2008). Early language delay and risk for language impairment. *Perspectives on Language, Learning, and Education, 15*, 93–100.

Ellis Weismer, S., Murray-Branch, J., & Miller, J. F. (1994). A prospective longitudinal study of language development in late talkers. *Journal of Speech and Hearing Research, 37*, 852–867.

Enders, C. K. (2010). *Applied missing data analysis*. New York: Guilford.

Engel de Abreu, P. M. J., Gathercole, S. E., & Martin, R. (2011). Disentangling the relationship between working memory and language: The roles of

short-term storage and cognitive control. *Learning and Individual Differences, 21*, 569–574.

Eriksson, M., Westerlund, M., & Miniscalco, C. (2010). Problems and limitations in studies on screening for language delay. *Research in Developmental Disabilities, 31*, 943–950.

Feldman, H. M., Dale, P. S., Campbell, T. F., Colborn, D. K., Kurs-Lasky, M., Rockette, H. E., & Paradise, J. L. (2005). Concurrent and predictive validity of parent reports of child language at ages 2 and 3 years. *Child Development, 76*, 856–868.

Fenson, L., Bates, E., Dale, P., Goodman, J., Reznik, J. S., & Thal, D. (2000). Measuring variability in early child language: Don't shoot the messenger. *Child Development, 71,* 323–328.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*.

Fernald, A. & Marchman, V. A. (2012). Individual differences in lexical processing at 18 months predict vocabulary growth in typically developing and late-talking toddlers. *Child Development, 83*, 203–222.

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics, 27,* 513–543.

Girolametto, L., Wiigs, M., Smyth, R., Weitzman, E., & Pearce, P. S. (2001). Children with a history of expressive vocabulary delay: Outcomes at 5 years of age. *American Journal of Speech-Language Pathology, 10*, 358–369.

Graham, J. W. & Coffman, D. L. (2012). Structural equation modeling with missing data. In R. H. Hoyle (Ed.), *Handbook of Structural Equation Modeling* (pp. 277–295). New York: Guilford.

Gray, S., Plante, E., Vance, R., & Henrichsen, M. (1999). The diagnostic accuracy of four vocabulary tests administered to preschool-age children. *Language, Speech & Hearing Services in Schools, 3*0, 196–206.

Guralnick, M. J. (1997). Effectiveness of early intervention for vulnerable children: A developmental perspective. *American Journal on Mental Retardation, 102*, 319–345.

Haworth, C. M. A., Davis, O. S. P., & Plomin, R. (2013). Twins Early Development Study (TEDS): A genetically sensitive investigation of cognitive and behavioral development from childhood to young adulthood. *Twin Research and Human Genetics, 16,* 117–125.

Heilmann, J., Ellis Weismer, S., Evans, J., & Hollar, C. (2005). Utility of the MacArthur-Bates Communicative Development Inventory in identifying language abilities of late-talking and typically developing toddlers. *American Journal of Speech-Language Pathology, 14*, 40–51.

Heimann, M., Strid, K., Smith, L., Tjus, T., Ulvund, S. E., & Meltzoff, A. N. (2006). Exploring the relation between memory, gestural communication, and the emergence of language in infancy: A longitudinal study. *Infant and Child Development, 15,* 233–249.

Henrichs, J., Rescorla, L., Schenk, J. J., Schimdt, H. G., Jaddoe, V. W. V., Hofman, A., … Tiemeierc, H. (2011). Examining continuity of early expressive vocabulary development: The Generation R Study. *Journal of Speech, Language, and Hearing Research, 54*, 854–869.

Hewitt, L. E., Scheffner Hammer, C., Yont, K. M., & Tomblin, J. B. (2005). Language sampling for kindergarten children with and without SLI: Mean length of utterance, IPSYN, and NDW. *Journal of Communication Disorders, 38*, 197–213.

Hick, R. F., Botting, N., & Conti-Ramsden, G. (2005). Short-term memory and vocabulary in children with Down syndrome and children with specific language impairment. *Developmental Medicine & Child Neurology, 47,* 532–538.

Hoff, E. (2006). The uses of longitudinal data and personcentered analyses in the study of cognitive and language development. *Merrill-Palmer Quarterly, 52*, 633–644.

Hohm, E., Jennen-Steinmetz, C., Schmidt, M. H., & Laucht, M. (2007). Language development at ten months. Predictive of language outcome and school achievement ten years later? *European Child & Adolescent Psychiatry, 16*, 149–156.

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder – a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *Journal of Child Psychology and Psychiatry, 41,* 561–578.

Hu, L. & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1–55.

Hudson, S., Levickis, P., Down, K., Nicholls, R., & Wake, M. (2015). Maternal responsiveness predicts child language at ages 3 and 4 in a community-based sample of slow-to-talk toddlers. *International Journal of Language & Communication Disorders, 50,* 136–142.

Hulme, C. & Snowling, M. J. (2009). Specific language impairment. In C. Hulme & M. J. Snowling (Eds.), *Developmental disorders of language learning and cognition* (pp. 129–171). Chichester: Wiley-Blackwell.

Irwin, J. R., Carter, A. S., & Briggs-Gowan, M. J. (2002). The social-emotional development of "late-talking" toddlers. *Journal of American Academy of Child & Adolescent Psychiatry, 41,* 1324–1332.

Iverson, J. M., Hall, A. J., Nickel, L., & Wozniak, R. H. (2007). The relationship between reduplicated babble onset and laterality biases in infant rhythmic arm movements. *Brain and Language, 101*, 198–207.

Jaddoe, V., Duijn, C., Franco, O., Heijden, A., IIzendoorn, M., Jongste, J., … Hofman, A. (2012). The Generation R Study: Design and cohort update 2012. *European Journal of Epidemiology, 27,* 739–756.

Jeličić, H., Phelps, E., & Lerner, R. M. (2009). Use of missing data methods in longitudinal studies: The persistence of bad practices in developmental psychology. *Developmental Psychology, 45,* 1195–1199.

Kadesjö, B., Janols, L.-O., Korkman, M., Mickelsson, K., Strand, G., Trillingsgaard, A., & Gillberg, C. (2004). The FTF (Five to Fifteen): The development of a parent questionnaire for the assessment of ADHD and comorbid conditions. *European Child and Adolescent Psychiatry, 13*, 3–13.

Kaiser, A. P. & Roberts, M. Y. (2011). Advances in early communication and language intervention. *Journal of Early Intervention, 33*, 298–309.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test.* Philadelphia: Lea & Febiger

Karousou, A. & López-Ornat, S. (2013). Prespeech vocalizations and the emergence of speech: A study of 1005 Spanish children. *Spanish Journal of Psychology, 16*. doi: 10.1017/sjp.2013.27

Kasper, J., Kreis, J., Scheibler, F., Möller, D., Skipka, G., Lange, S., & von dem Knesebeck, O. (2011). Population-based screening of children for specific speech and language impairment in Germany: A systematic review. *Folia Phoniatrica et Logopaedica, 63,* 247–263.

Katz, W. F., Curtiss, S., & Tallal, P. (1992). Rapid automatized naming and gesture by normal and language-impaired children. *Brain and Language, 43,* 623–641.

Kidd, E. (2013). The role of verbal working memory in children's sentence comprehension. A critical review. *Topics in Language Disorders, 33,* 208–223.

Klee, T., Carson, D. K., Gavin, W. J., Hall, L., Kent, A., & Reece, S. (1998). Concurrent and predictive validity of an early language screening program. *Journal of Speech, Language, and Hearing Research, 41*, 627–641.

Klee, T., Pearce, K., & Carson, D. K. (2000). Improving the positive predictive value of screening for developmental language disorder. *Journal of Speech, Language, and Hearing Research, 43*, 821–833.

Klem, M., Melby-Lervåg, M., Hagtvet, B., Lyster, S.-A. H., Gustafsson, J.-E., & Hulme, C. (2015). Sentence repetition is a measure of children's language skills rather than working memory limitations. *Developmental Science, 18,* 146–154.

Korkman, M., Jaakkola, M., Ahlroth, A., Pesonen, A.-E., & Turunen, M.-M. (2004). Screening of developmental disorders in five-year-olds using the FTF (Five to Fifteen) questionnaire: A validation study. *European Child and Adolescent Psychiatry, 13*, 31–38.

Korkman, M., Kirk, U., & Kemp, S.L. (1997). *NEPSY: Lasten neuropsykologinen tutkimus [NEPSY: A Developmental Neuropsychological Assessment*]. Helsinki: Psykologien Kustannus.

Korkman, M., Kirk, U., & Kemp, S. L. (2008). *NEPSY-II: Lasten neuropsykologinen tutkimus [NEPSY-II: A Developmental Neuropsychological Assessment, Second edition].* Helsinki: Hogrefe Psykologien Kustannus.

Korpilahti, P. (1996). *Lausetesti. [Test for the language comprehension of sentences.]* Oulu: Language and Communication Care.

Kubicek, L. R. & Emde, R. N. (2012). Emotional expression and language: A longitudinal study of typically developing earlier and later talkers from 15 to 30 months. *Infant Mental Health Journal, 33*, 553–584.

Kunnari, S., Savinainen-Makkonen, T., Leonard, L. B., Mäkinen, L., Tolonen, A.-K., Luotonen, M., & Leinonen, E. (2011). Children with specific language impairment in Finnish: The use of tense and agreement inflections. *Journal of Child Language, 38*, 999–1027.

Laakso, M.-L., Poikkeus, A.-M., & Eklund, K. (2011). *Lapsen esikielellisen kommunikaation ja kielen ensikartoitus [The Infant-Toddler Checklist of children's prelinguistic communication and language].* Jyväskylä: Niilo Mäki Instituutti.

Laakso, M.-L., Poikkeus, A.-M., Katajamäki, J., & Lyytinen, P. (1999). Early intentional communication as a predictor of language development in young toddlers. *First Language, 19,* 207–231.

Laursen, B. & Hoff, E. (2006). Person-centered and variable-centered approaches to longitudinal data. *Merrill-Palmer Quarterly, 52*, 377–389.

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000a). Prevalence and natural history of primary speech and language delay: Findings from a systematic review of the literature. *International Journal of Language & Communication Disorders, 35*, 165–188.

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000b). The feasibility of universal screening for primary speech and language delay: Findings from a systematic review of the literature. *Developmental Medicine & Child Neurology, 42*, 190–200.

Law, J., Garrett, Z., & Nye, C. (2003). Speech and language therapy interventions for children with primary speech and language delay or disorder. *The Cochrane database of systematic reviews, Issue 3*. Art. No: CD004110.

Law, J. & Roy, P. (2008). Parental report of infant language skills: A review of the development and application of the communicative development inventories. *Child and Adolescent Mental Health, 13,* 198–206.

Law, J., Rush, R., Anandan, C., Cox, M., & Wood, R. (2012). Predicting language change between 3 and 5 years and its implications for early identification. *Pediatrics, 130*, e132–e137. doi: 10.1542/peds.2011-1673

Lee, J. (2011). Size matters: Early vocabulary as a predictor of language and literacy competence. *Applied Psycholinguistics, 32*, 69–92.

Leonard, L. B. (1991). Specific Language Impairment as a clinical category. *Language, Speech, and Hearing Services in Schools, 22*, 66–68.

Leonard, L. B. (2013). Alternative routes to language impairment. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions, and outcomes* (pp. 363–376). Baltimore, MD: Brookes.

Leonard, L. B. (2014). *Children with Specific Language Impairment*. Cambridge, MA: MIT Press.

Longobardi, E., Rossi-Arnaud, C., & Spataro, P. (2012). Individual differences in the prevalence of words and gestures in the second year of life: Developmental trends in Italian children. *Infant Behavior & Development, 35,* 847–859.

Lyytinen, H., Ahonen, T., Eklund, K., Guttorm, T., Kulju, P., Laakso, M-L., … Viholainen, H. (2004). Early development of children at familial risk for dyslexia – Follow-up from birth to school age. *Dyslexia, 10*, 146–178.

Lyytinen, H. Erskine, J., Tolvanen, A., Torppa, M., Poikkeus, A.-M., & Lyytinen, P. (2006). Trajectories of reading development: A follow-up from birth to school age of children with and without risk for dyslexia. *Merrill-Palmer Quarterly, 52*, 514–546.

Lyytinen, P. (1999). *Varhaisen kommunikaation ja kielen kehityksen arviointimenetelmä [Finnish Manual for Communicative Development Inventories]*. Jyväskylä: Jyväskylän yliopiston lapsitutkimuskeskus ja Niilo Mäki Instituutti.

Lyytinen, P., Eklund, K., & Lyytinen, H. (2005). Language development and literacy skills in late-talking toddlers with and without familial risk for dyslexia. *Annals of Dyslexia, 55,* 166–192.

Lyytinen, P., Poikkeus, A.-M., Laakso, M.-L., Eklund, K., & Lyytinen, H. (2001). Language development and symbolic play in children with and without familial risk for dyslexia. *Journal of Speech, Language, and Hearing Research, 44,* 873–885.

Marchman, V. A. & Fernald, A. (2008). Speed of word recognition and vocabulary knowledge in infancy predict cognitive and language outcomes in later childhood. *Developmental Science, 11*, F9–F16.

Marden, M. & Nicholas, D. (1997). The information needs of parents. *Child Language Teaching and Therapy, 13,* 279–285.

Marini, A., Tavano, A., & Fabbro, F. (2008). Assessment of linguistic abilities in Italian children with specific language impairment. *Neuropsychologia, 46*, 2816–2823.

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches for setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal, 11,* 320–341.

Mawhood, L., Howlin, P., & Rutter, M. (2000). Autism and developmental receptive language disorder – a comparative follow-up in early adult life. I: Cognitive and language outcomes. *Journal of Child Psychology and Psychiatry, 41*, 547–559.

McArdle, J. J. (1988). Dynamic but structural equation modeling of repeated measures data. In R. B. Cattell & J. Nesselroade (Eds.), *Handbook of multivariate experimental psychology* (2nd ed., pp. 561–614). New York: Plenum.

McCathren, R. B., Yoder, P. J., & Warren, S. F. (1999). The relationship between prelinguistic vocalization and later expressive vocabulary in young children with developmental delay. *Journal of Speech, Language, and Hearing Research, 42*, 915–924.

McCathren, R. B., Warren, S. F., & Yoder, P. J. (1996). Prelinguistic predictors of later language development. In K. N. Cole, P. S. Dale, & D. J. Thal (Eds.), *Assessment of communication and language* (pp. 57–75). Baltimore, MD: Brookes.

McCune, L. (1995). A normative study of representational play at the transition to language. *Developmental Psychology, 31*, 198–206.

Messer, D. & Dockrell, J. E. (2006). Children's naming and word-finding difficulties: Descriptions and explanations. *Journal of Speech, Language, and Hearing Research, 49*, 309–324.

Miles, J. & Shevlin, M. (2007). A time and a place for incremental fit indices. *Personality and Individual Differences, 42*, 869–874.

Miller, J. S., Gabrielsen, T., Villalobos, M., Alleman, R., Wahmhoff, N., Carbone, P. S., & Segura, B. (2011). The Each Child Study: Systematic screening for autism spectrum disorders in a pediatric setting. *Pediatrics, 127*, 866–871.

Miyake, A. & Shah, P. (Eds.) (1999). *Models of working memory. Mechanisms of active maintenance and executive control.* New York: Cambridge University Press.

Montgomery, J. W., Magimairaj, B. M., & Finney, M. C. (2010). Working memory and specific language impairment: An update on the relation and perspectives on assessment and treatment. *American Journal of Speech-Language Pathology, 19*, 78–94.

Morales, M., Mundy, P., Delgado, C. E. F., Yale, M., Messinger, D., Neal, R., & Schwartz, H. K. (2000). Responding to joint attention across the 6- through 24-month age period and early language acquisition. *Journal of Applied Developmental Psychology, 21*, 283–298.

Moyle, M. J., Ellis Weismer, S., Evans, J. L., & Lindstrom, M. J. (2007). Longitudinal relationships between lexical and grammatical development in typical and late-talking children. *Journal of Speech, Language, and Hearing Research, 50*, 508–528.

Muthén, B. O. (2001). Latent variable mixture modelling. In G. A. Marcoulides & R. E. Schumacker (Eds.), *New developments and techniques in structural equation modeling* (pp. 1–34). Mahwah, NJ: Erlbaum.

Muthén, L. K., & Muthén, B. O. (1998–2007). *Mplus user's guide*. Fifth edition. Los Angeles: Muthén & Muthén.

Muthén, L. K. & Muthén, B. O. (1998–2010). *Mplus user's guide.* Sixth edition. Los Angeles: Muthén & Muthén.

Muthén, B. & Shedden, K. (1999). Finite mixture modeling with mixture outcomes using the EM algorithm. *Biometrics, 55*, 463–469.

Nagin, D. S. (2005). *Group-based modeling of development*. Cambridge, MA: Harvard University Press.

Nelson, H. D., Nygren, P., Walker, M., & Panoscha, R. (2006). Screening for speech and language delay in preschool children: Systematic evidence review for the US preventive services task force. *Pediatrics, 117*, e298–e319. doi: 10.1542/peds.2005-1467

Newman, R., Ratner, N. B., Jusczyk, A. M., Jusczyk, P. W., & Dow, K. A. (2006). Infants' early ability to segment the conversational speech signal predicts later language development: A retrospective analysis. *Developmental Psychology, 42*, 643–655.

Nip, I. S. B., Green J. R., & Marx, D. B. (2011). The co-emergence of cognition, language, and speech motor control in early development: A longitudinal correlation study. *Journal of Communication Disorders, 44,* 149–160.

Norbury, C. F., Nash, M., Baird, G., & Bishop, D. V. M. (2004). Using a parental checklist to identify diagnostic groups in children with communication impairment: A validation of the Children's Communication Checklist – 2. *International Journal of Language and Communication Disorders, 39,* 345–364.

Noterdaeme, M. & Amorosa, H. (1999). Evaluation of emotional and behavioral problems in language impaired children using the Child Behavior Checklist. *European Child & Adolescent Psychiatry, 8*, 71–77.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling, 14,* 535–569.

Official Statistics of Finland (2013). Väestön koulutusrakenne [Educational structure of population]. Helsinki: Statistics Finland. Retrieved from: http://www.stat.fi/til/vkour/

Oller, D. K., Eilers, R. E., Neal, A. R., & Cobo-Lewis, A. B. (1998). Late onset canonical babbling: A possible early marker of abnormal development. *American Journal on Mental Retardation, 103*, 249-263.

Oller, D. K., Eilers, R. E., Neal, A. R., & Schwartz, H. K. (1999). Precursors to speech in infancy: The prediction of speech and language disorders. *Journal of Communication Disorders, 32*, 223–245.

Paul, R. (2008). Interventions to improve communication. *Child and Adolescent Psychiatric Clinics of North America, 17*, 835–856.

Paul, R. & Kellogg, L. (1997). Temperament in late talkers. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 38*, 803–811.

Paul, R. & Roth, F. P. (2011). Characterizing and predicting outcomes of communication delays in infants and toddlers: Implications for clinical practice. *Language, Speech, and Hearing Services in Schools, 42*, 331–340.

Pesco, D. & O'Neill, D. K., (2012). Predicting later language outcomes from the Language Use Inventory. *Journal of Speech, Language, and Hearing Research, 55,* 421–434.

Petruccelli, N., Bavin, E. L., & Bretherton, L. (2012). Children with specific language impairment and resolved late talkers: Working memory profiles at 5 years. *Journal of Speech, Language, and Hearing Research, 55,* 1690–1703.

Peyre, H., Bernard, J. Y., Forhan, A., Charles, M.-A., De Agostini, M., Heude, B., & Ramus, F. (2014). Predicting changes in language skills between 2 and 3 years in the EDEN mother–child cohort. *PeerJ, 2*, e335–e350. doi: 10.7717/peerj.335

Piaget, J. (1971). *The construction of reality in the child.* New York: Ballantine Books.

Pierce, K., Carter, C., Weinfeld, M., Desmond, J., Hazin, R., Bjork, R., & Gallagher, N. (2011). Detecting, studying, and treating autism early: The one-year well-baby check-up approach. *The Journal of pediatrics*, *159,* 458–465.

Pool, J. L. & Hourcade, J. J. (2011). Developmental screening: A review of contemporary practice. *Education and Training in Autism and Developmental Disabilities, 46*, 267–275.

Ramey, C. T, Campbell, F. A., & Ramey, S. L. (1999). Early intervention: Successful pathways to improving intellectual development, *Developmental Neuropsychology, 16,* 385–392.

Reilly, S., Bishop, D. V. M., & Tomblin, B. (2014). Terminological debate over language impairment in children: Forward movement and sticking points. *International Journal of Language and Communication Disorders, 49*, 452–562.

Reilly, S., Eadie, P., Bavin, E. L., Wake, M., Prior, M., Williams, J., ... Ukoumunne, O. C. (2006). Growth of infant communication between 8 and 12 months: A population study. *Journal of Paediatrics and Child Health, 42,* 764–770.

Reilly, S., Wake, M., Bavin, E. L., Prior, M., Williams, J., Bretherton, L., … Ukoumunne, O. C. (2007). Predicting language at 2 years of age: A prospective community study. *Pediatrics, 120*, e1441–e1449. doi: 10.1542/peds.2007-0045

Reilly, S., Wake, M., Ukoumunne, O. C., Bavin, E., Prior, M., Cini, E., … Bretherton, L. (2010). Predicting language outcomes at 4 years of age: Findings from Early Language in Victoria Study. *Pediatrics, 126*, e1530–e1537. doi: 10.1542/peds.2010-0254

Rescorla, L. (2002). Language and reading outcomes to age 9 in late-talking toddlers. *Journal of Speech, Language, and Hearing Research, 45*, 360–371.

Rescorla, L. (2005). Age 13 language and reading outcomes in late-talking toddlers. *Journal of Speech, Language, and Hearing Research, 48*, 459–472.

Rescorla, L. (2009). Age 17 language and reading outcomes in late-talking toddlers: Support for a dimensional perspective on language delay. *Journal of Speech, Language, and Hearing Research, 52,* 16–30.

Rescorla, L. A. (2013). Late-talking toddlers – A 15-year follow-up. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions, and outcomes* (pp. 219–239). Baltimore, MD: Brookes.

Rescorla, L. & Alley, A. (2001). Validation of the Language Development Survey (LDS): A parent report tool for identifying language delay in toddlers. *Journal of Speech, Language, and Hearing Research, 44,* 434–445.

Rescorla, L., Dahlsgaard, K., & Roberts, J. (2000). Latetalking toddlers: MLU and IPSyn outcomes at 3;0 and 4;0. *Journal of Child Language, 27*, 643–664.

Rescorla, L. A. & Dale, P. S. (Eds.) (2013). *Late talkers: Language development, intervention and outcomes.* Baltimore, MD: Brookes.

Rescorla, L., Mirak, J., & Singh, L. (2000). Vocabulary growth in late talkers: Lexical development from 2;0 to 3;0. *Journal of Child Language, 27*, 293–311.

Rescorla, L., Roberts, J., & Dahlsgaard, K. (1997). Late talkers at 2: Outcome at age 3. *Journal of Speech, Language, and Hearing Research, 40*, 556–566.

Rescorla, L., Ross, G. S., & McClure, S. (2007). Language delay and behavioral/emotional problems in toddlers: Findings from two developmental clinics. *Journal of Speech, Language, and Hearing Research, 50*, 1063–1078.

Rice, M. L. & Hoffman, L. (2015). Predicting vocabulary growth in children with and without specific language impairment: A longitudinal study from 2;6 to 21 years of age. *Journal of Speech, Language, and Hearing Research, 58,* 345–359.

Rice, M. L., Smolik, F., Perpich, D., Thompson, T., Rytting, N., & Blossom, M. (2010). Mean length of utterance levels in 6-month intervals for children 3 to 9 years with and without language impairments. *Journal of Speech, Language, and Hearing Research, 53,* 333–349.

Rice, M. L., Taylor, C. L., & Zubrick, S. R. (2008). Language outcomes of 7-year-old children with or without a history of late language emergence at 24 months. *Journal of Speech, Language, and Hearing Research, 51,* 394–407.

Rice, M. L., Tomblin, J. B., Hoffman, L., Richman, W. A., & Marquis, J. (2004). Grammatical tense deficits in children with SLI and nonspecific language impairment: Relationships with nonverbal IQ over time. *Journal of Speech, Language, and Hearing Research, 47,* 816–834.

Rice, M. L. & Wexler, (1996). Toward tense as a clinical marker of specific language impairment in English-speaking children. *Journal of Speech and Hearing Research, 39*, 1239–1257.

Roberts, M. Y. & Kaiser, A. P. (2011). The effectiveness of parent-implemented language interventions: A meta-analysis. *American Journal of Speech-Language Pathology, 20*, 180–199.

Roos, E. M. & Ellis Weismer, S. (2008). Language outcomes of late talking toddlers at preschool and beyond. *SIG 1 Perspectives on Language Learning and Education, 15*, 119–126.

Rose, S. A, Feldman, J. R., & Jankowski, J. J. (2005). The structure of infant cognition at 1 year. *Intelligence, 33*, 231–250.

Rose, S. A, Feldman, J. R., & Jankowski, J. J. (2009). A cognitive approach to the development of early language. *Child Development, 80*, 134–150.

Rose, S. A, Feldman, J. R., Jankowski, J. J., & Van Rossem, R. (2008). A cognitive cascade in infancy: Pathways from prematurity to later mental development. *Intelligence, 36*, 367–378.

Rowe, M. L., Raudenbush, S. W., & Goldin-Meadow, S. (2012). The pace of vocabulary growth helps predict later vocabulary skill. *Child Development, 83,* 508–525.

Rutter, M. (2008). Diagnostic concepts and risk processes. In C. F. Norbury, J. B. Tomblin, & D. Bishop (Eds.), *Understanding developmental language disorders: From theory to practice* (pp. 205–215). New York: Psychology Press.

Rutter, M., Pickles, A., Murray, R., & Eaves, L. (2001). Testing hypotheses on specific environmental causal effects on behavior. *Psychological Bulletin, 127*, 291–324.

Salley, B., Panneton, R. K., & Colombo, J. (2013). Separable attentional predictors of language outcome. *Infancy, 18*, 462–489.

Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development, 81,* 6–22.

Schwartz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics, 6*, 461–464.

Siller, M. & Sigman, M. (2008). Modeling longitudinal change in the language abilities of children with autism: Parent behaviors and child characteristics as predictors of change. *Developmental Psychology, 44,* 1691–1704.

Smith, L. (1998). Predicting communicative competence at 2 and 3 years from pragmatic skills at 10 months. *International Journal of Language & Communication Disorders, 33,* 127–148.

Sterba, S. K. & Bauer, D. J. (2010). Matching method with theory in person-oriented developmental psychopathology research. *Development and Psychopathology, 22*, 239–254.

Stokes, S. F., Wong, A. M.-Y., Fletcher, P., & Leonard, L. B. (2006). Nonword repetition and sentence repetition as clinical markers of specific language impairment: The case of Cantonese. *Journal of Speech, Language, and Hearing Research, 49,* 219–236.

Stothard, S. E., Snowling, M. J., Bishop, D. V. M., Chipchase, B. C. & Kaplan, C. A. (1998). Language-impaired preschoolers: A follow-up into adolescence. *Journal of Speech, Language, and Hearing Research, 41*, 407–418.

Stott, C. M., Merricks, M. J., Bolton, P. F., & Goodyer, I. M. (2002). Screening for speech and language disorders: The reliability, validity and accuracy of the general language screen. *International Journal of Language & Communication Disorders, 37,* 133–151.

Sylvestre, A., Desmarais, C., Meyer, F., Bairati, I., Rouleau, N., & Merette, C. (2012). Factors associated with expressive and receptive language in french-speaking toddlers clinically diagnosed with language delay. *Infants & Young Children, 25*, 158–171.

Taanila, A., Murray, G. K., Jokelainen, J., Isohanni, M., & Rantakallio, P. (2007). Infant developmental milestones: A 31-year follow-up. *Developmental Medicine & Child Neurology, 47*, 581–586.

Taylor, C. L., Zubrik, S. R., & Rice, M. L. (2013). Population and public health perspective on late langauge emergence at 24 months as a risk indicator for language impairment at 7 years. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions, and outcomes* (pp. 23–40). Baltimore, MD: Brookes.

Thal, D. J., Bates, E., Goodman, J., & Jahn-Samilo, J. (1997). Continuity of language abilities: An exploratory study of late- and early-talking toddlers. *Developmental Neuropsychology, 13,* 239–273.

Thal, D. J. & Katich, J. (1996). Predicaments in early identification of specific language impairment: Does the early bird always catch the worm? In K. N. Cole, P. S. Dale, & D. J. Thal (Eds.), *Assessment of communication and language* (pp. 1–28). Baltimore, MD: Brookes.

Thal, D. J., Marchman, V. A., & Tomblin, J. B. (2013). Late-talking toddlers: Characterization and prediction of continuing delay. In L. A. Rescorla & P. S. Dale (Eds.), *Late talkers: Language development, interventions and outcomes* (pp. 169–201). Baltimore, MD: Brookes.

Thal, D. J., Miller, S., Carlson, J., & Vega, M. M. (2005). Nonword repetition and language development in 4-year-old children with and without a history of early language delay. *Journal of Speech, Language, and Hearing Research, 48*, 1481–1495.

Thal, D. J., O'Hanlon, L., Clemmons, M., & Fralin, L. (1999). Validity of a parent report measure of vocabulary and syntax for preschool children with language impairment. *Journal of Speech, Language, and Hearing Research, 42,* 482–496.

Thal, D. & Tobias, S. (1994). Relationships between language and gesture in normally developing and late-talking toddlers. *Journal of Speech and Hearing Research, 37*, 157–170.

Tolvanen, A. (2007). *Latent growth mixture modeling: A simulation study.* University of Jyväskylä, A Department of Mathematics and Statistics Report, 111.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P.J. Dunham (Eds.), *Joint attention – Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Erlbaum.

Tomasello, M. (2000). The social-pragmatic theory of word learning. *Pragmatics, 10,* 401–413.

Tomasello, M. (2001). Perceiving intentions and learning words in the second year of life. In M. Bowerman & S. C. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 132-158). Cambridge: Cambridge University Press.

Tomasello, M., Carpenter, M., & Liszkowski, U. (2007). A new look at infant pointing. *Child Development, 78*, 705–722.

Tomblin, J. B., Records, N. L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research, 40*, 1245–1260.

Tomblin, J. B., Zhang, X., Buckwalter, P., & O'Brien, M. (2003). The stability of primary language disorder: Four years after kindergarten diagnosis. *Journal of Speech, Language, and Hearing Research, 46*, 1283–1296.

Tomblin, J. B., Zhang, X., Weiss, A., Catts, H., & Ellis Weismer, S. (2004). Dimensions of individual differences in communication skills among primary grade children. In M. L. Rice & S. F. Warren (Eds.), *Developmental language disorders: From phenotypes to etiologies* (pp. 53–76). Mahwah, NJ: Erlbaum.

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with Autism Spectrum Disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders, 36*, 993–1005.

Ukoumunne, O. C., Wake, M., Carlin, J., Bavin, E. L., Lum, J., Skeat, J., . . . Reilly, S. (2011). Profiles of language development in pre-school children: A longitudinal latent class analysis of data from the Early Language in Victoria Study. *Child: Care, Health, and Development, 38*, 341–349.

van Geert, P. & van Dijk, M. (2002). Focus on variability: New tools to study intra-individual variability in developmental data. *Infant Behavior & Development, 25*, 340–374.

Vance, M. (2008). Short-term memory in children with developmental language disorder. In C. F. Norbury, J. B. Tomblin, & D. Bishop (Eds.), *Understanding developmental language disorders: From theory to practice* (pp. 23–38). New York: Psychology Press.

Veness, X., Prior, M., Bavin, E., Eadie, P., Cini, E., & Reilly, S. (2011). Early indicators of autism spectrum disorders at 12 and 24 months of age: A prospective, longitudinal comparative study. *Autism, 16,* 163–177.

Veness, C., Prior, M., Eadie, P., Bavin, E., & Reilly, S. (2014). Predicting autism diagnosis by 7 years of age using parent report of infant social communication skills. *Journal of Paediatrics and Child Health, 50*, 693–700.

von Eye, A. & Bogat, G. A. (2006). Person-oriented and variable-oriented research: Concepts, results, and development. *Merrill-Palmer Quarterly, 52,* 390–420.

Vuori, E. & Gissler, M. (2004). *Parturients, births and newborns 2003.* Helsinki: Statistical summary/Stakes: 26/2004.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Warren, S. F. (2000). The future of early communication and language intervention. *Topics in Early Childhood Special Education, 20,* 33–37.

Watt, N., Wetherby, A., & Shumway, S. (2006). Prelinguistic predictors of language outcome at 3 years of age. *Journal of Speech, Language, and Hearing Research, 49*, 1224–1237.

Webb, S. J., Jones, E. J. H., Kelly, J., & Dawson, G. (2014). The motivation for very early intervention for infants at high risk for autism spectrum disorders. *International Journal of Speech-Language Pathology, 16,* 36–42.

Wechsler, D. (1995). *WPPSI-R Käsikirja [Wechsler Preschool and Primary Scale of Intelligence: Revised. Manual for the Finnish adaptation].* Helsinki: Psykologien Kustannus.

Wechsler, D. (1999). *WISC-III käsikirja [Wechsler Intelligence Scale for Children–Third Edition. Manual for the Finnish Adaptation].* Helsinki: Psykologien Kustannus.

Weckerly, J., Wulfeck, B., & Reilly, J. (2001). Verbal fluency deficits in children with specific language impairment: Slow rapid naming or slow to name? *Child Neuropsychology, 7*, 142–152.

Westman, M., Korkman, M., Mickos, A., & Byring, R. (2008). Language profiles of monolingual and bilingual Finnish preschool children at risk for language impairment. *International Journal of Language and Communicaiton Disorders, 43*, 699–711.

Westerlund, M., Berglund, E., & Eriksson, M. (2006). Can severely language delayed 3-year-olds be identified at 18 months? Evaluation of a screening version of the MacArthur–Bates Communicative Development Inventories. *Journal of Speech, Language, and Hearing Research, 49*, 237–247.

Wetherby, A. M., Allen, L., Cleary, J., Kublin, K., & Goldstein, H. (2002). Validity and reliability of the Communication and Symbolic Behavior Scales Developmental Profile with very young children. *Journal of Speech, Language, and Hearing Research, 45,* 1202–1218.

Wetherby, A. M., Brosnan-Maddox, S., Peace, V., & Newton, L. (2008).Validation of the Infant-Toddler Checklist as a broadband screener for autism spectrum disorders from 9 to 24 months of age. *Autism, 12,* 487–511.

Wetherby, A. M., Goldstein, H., Cleary, J., Allen, L., & Kublin, K. (2003). Early identification of children with communication disorders: Concurrent and predictive validity of the CSBS Developmental Profile. *Infants and Young Children, 16*, 161–174.

Wetherby, A. M. & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile* (First normed edition.). Baltimore, MD: Brookes.

Wetherby, A. M., Warren, S. F., & Reichle, J. (1998). Introduction to transitions in prelinguistic communication. In A.M. Wetherby, S. F. Warren, & J. Reichle (Eds.), *Transitions in prelinguistic communication.* Vol 7. (pp. 1–11). Baltimore, MD: Brookes.

Whitehurst, G. J., Smith, M., Fischel, J. E., Arnold, D. S., & Lonigan, C. J. (1991). The continuity of babble and speech in children with specific expressive language delay. *Journal of Speech, Language, and Hearing Research, 34,* 1121–1129.

Whitworth, A., Davies, C., Stokes, S., & Blain, T. (1993). Identification of communication impairments in preschoolers: A comparison of parent and teacher success. *Australian Journal of Human Communication Disorders, 21,* 112–133.

Wu, Z. & Gros-Louis, J. (2014). Infants' prelinguistic communicative acts and maternal responses: Relations to linguistic development. *First Language, 34*, 72–90.

Yoder, P. J. & Warren, S. F. (1999). Maternal responsivity mediates the relationship between prelinguistic intentional communication and later language. *Journal of Early Intervention, 22,* 126–136.

Yoder, P. J. & Warren, S. F. (2004). Early predictors of language in children with and without Down syndrome. *American Journal on Mental Retardation, 109*, 285–300.

APPENDICES

APPENDIX 1 Correlations between the Infant-Toddler Checklist composites at different ages

		Soc06	Soc09	Soc12	Soc15	Soc18	Soc21	Soc24	Spe06	Spe09	Spe12	Spe15	Spe18	Spe21	Spe24	Sym06	Sym09	Sym12	Sym15	Sym21	Sym24
Soc09	r	.471***																			
	n	202																			
Soc12	r	.386***	.560***																		
	n	142	135																		
Soc15	r	.302***	.477***	.619***																	
	n	151	142	277																	
Soc18	r	.278***	.404***	.594***	.721***																
	n	149	140	234	246																
Soc21	r	.236**	.355***	.487***	.589***	.718***															
	n	141	131	233	243	255															
Soc24	r	.189*	.230**	.445***	.542***	.649***	.774***														
	n	133	126	220	228	227	232														
Spe06	r	.304***	.236***	.182*	.070	.115	.010	.024													
	n	229	202	142	151	149	141	133													
Spe09	r	.225***	.281***	.162	.220**	.148	.124	.036	.340***												
	n	202	203	135	142	140	131	126	202												
Spe12	r	.220**	.406***	.439***	.342***	.403***	.337***	.239***	.257**	.484***											
	n	142	135	322	277	234	233	220	142	135											
Spe15	r	.099	.216**	.345***	.431***	.385***	.282***	.256***	.180*	.425***	.529***										
	n	151	142	276	304	246	243	228	151	142	276										
Spe18	r	.098	.203*	.330***	.380***	.384***	.302***	.223***	.132	.407***	.468***	.786***									
	n	149	140	234	246	279	255	227	149	140	234	246									
Spe21	r	.043	.117	.319***	.381***	.378***	.276***	.278***	.085	.327***	.321***	.638***	.740***								
	n	141	131	233	243	255	273	232	141	131	233	243	255								

		Soc06	Soc09	Soc12	Soc15	Soc18	Soc21	Soc24	Spe06	Spe09	Spe12	Spe15	Spe18	Spe21	Spe24	Sym06	Sym09	Sym12	Sym15	Sym21	Sym24
Spe24	r	.174*	.201*	.281***	.378***	.292***	.226***	.300***	.029	.161	.237***	.425***	.551***	.649***							
	n	133	126	220	228	227	232	330	133	126	220	228	227	232							
Sym06	r	.509***	.368***	.188*	.109	.099	.023	-.039	.369***	.256***	.168*	.072	.086	-.021	-.097						
	n	229	202	142	151	149	141	133	229	202	142	151	149	141	133						
Sym09	r	.352***	.493***	.419***	.322***	.250**	.181*	.051	.278***	.389***	.385***	.274***	.289***	.209*	.143	.402***					
	n	202	203	135	142	140	131	126	202	203	135	142	140	131	126	202					
Sym12	r	.181*	.309***	.501***	.445***	.334***	.251***	.233***	.250**	.251**	.443***	.388***	.339***	.318***	.239***	.189*	.496***				
	n	142	135	322	277	234	233	220	142	135	322	276	234	233	220	142	135				
Sym15	r	.156	.287***	.466***	.530***	.386***	.308***	.295***	.149	.234**	.339***	.477***	.406***	.364***	.302***	.067	.457***	.666***			
	n	151	142	277	305	246	243	228	151	142	277	304	246	243	228	151	142	277			
Sym18	r	.157	.366***	.482***	.553***	.487***	.413***	.343***	.138	.284***	.363***	.429***	.465***	.315***	.273***	-.009	.331***	.501***	.683***		
	n	149	140	234	246	279	255	227	149	140	234	246	279	255	227	149	140	234	246		
Sym21	r	.100	.407***	.421***	.527***	.508***	.477***	.400***	.074	.262**	.367***	.410***	.464***	.380***	.478***	-.067	.333***	.470***	.522***	.671***	
	n	141	131	233	243	255	273	232	141	131	233	243	255	273	232	141	131	233	243	255	
Sym24	r	.186*	.308***	.387***	.555***	.462***	.375***	.366***	.072	.262**	.287***	.352***	.400***	.504***	.510***	-.029	.141	.317***	.456***	.510***	.560***
	n	133	126	220	228	227	232	330	133	126	220	228	227	232	330	133	126	220	228	227	232

Note. Soc = Social composite; Spe = Speech composite; Sym = Symbolic composite. Numbers after soc. spe. and sym represent age in months.
*<.05. **<.01. ***.001.

APPENDIX 2 Correlations between the Infant-Toddler Checklist composites and the follow-up measures

		2 years			3 years		4;7			5;3							1st grade	
		MBCDI					FTF										CCC2	
		Voc	Inf	MSL	Boston	PPVT	Comp	Expr	Comm	SI	PPVT-	SC	VF	DS	NWR	SR	Lang	Comm
Soc06	r	.104	-.195	-.086	.186	.234	-.098	-.099	-.163	.087	.037	-.092	.039	.031	-.084	-.113	-.079	-.003
	n	37	36	35	46	45	130	130	130	47	47	49	47	49	47	48	129	129
Soc09	r	.191	-.108	.057	.172	.126	-.107	-.254**	-.232*	.202	.157	-.131	.080	.148	-.083	.088	-.232*	-.153
	n	35	35	34	46	45	119	119	119	46	46	48	46	48	46	47	119	119
Soc12	r	.404***	.259**	.380***	.321***	.198*	-.241***	-.148*	-.295***	.136	.108	.158	.185	.167	.169	.157	-.330***	-.302***
	n	99	98	95	109	108	206	206	206	89	91	93	88	92	89	91	190	190
Soc15	r	.390***	.254*	.385***	.334***	.255**	-.247***	-.257***	-.352***	.075	.207*	.160	.257*	.078	.099	.197	-.398***	-.357***
	n	101	100	97	108	107	208	208	208	93	95	97	92	96	93	95	193	193
Soc18	r	.328***	.264**	.347***	.280**	.181	-.222**	-.247***	-.342***	.173	.112	.177	.073	.198	.168	.195	-.438***	-.340***
	n	98	97	94	105	104	191	191	191	84	86	88	83	87	84	86	171	171
Soc21	r	.179	.163	.226*	.204*	-.006	-.136	-.170*	-.283***	.015	.125	.098	-.010	.207	.039	.103	-.348***	-.290***
	n	101	100	97	107	106	191	191	191	86	88	90	85	89	86	88	175	175
Soc24	r	.233*	.107	.214*	.165	.029	-.154*	-.120	-.230***	.036	.102	.111	.098	.192	.048	.082	-.269***	-.232***
	n	91	90	87	95	95	224	224	224	84	86	88	83	87	84	86	199	199
Spe06	r	.055	-.103	-.163	-.265	-.184	.066	.079	.099	-.206	.079	.079	.015	-.008	-.247	-.183	-.032	.020
	n	37	36	35	46	45	130	130	130	47	47	49	47	49	47	48	129	129
Spe09	r	.290	.282	.567***	.293*	.053	-.268**	-.216*	-.270**	.082	-.006	.191	.100	.345*	.023	.114	-.172	-.089
	n	35	35	34	46	45	119	119	119	46	46	48	46	48	46	47	119	119
Spe12	r	.414***	.414***	.405***	.267**	.184	-.224***	-.293***	-.266***	.144	.122	.105	.159	.198	.242*	.354***	-.327***	-.224***
	n	99	98	95	109	108	206	206	206	89	91	93	88	92	89	91	190	190
Spe15	r	.523***	.501***	.544***	.371***	.133	-.275***	-.337***	-.327***	.255*	.156	.156	.190	.311**	.333***	.395***	-.406***	-.325***
	n	101	100	97	108	107	208	208	208	93	95	97	92	96	93	95	192	192
Spe18	r	.539***	.582***	.551***	.447***	.248*	-.360***	-.430***	-.393***	.160	.018	.083	.082	.346***	.359***	.387***	-.462***	-.314***
	n	98	97	94	105	104	191	191	191	84	86	88	83	87	84	86	171	171

		2 years			3 years		4;7						5;3				1st grade	
		MBCDI					FTF										CCC2	
		Voc	Inf	MSL	Boston	PPVT	Comp	Expr	Comm	SI	PPVT-	SC	VF	DS	NWR	SR	Lang	Comm
Spe21	r	.625***	.615***	.565***	.461***	.284**	-.349***	-.354***	-.398***	.139	.011	.034	.098	.316**	.242*	.318**	-.507***	-.335***
	n	101	100	97	107	106	191	191	191	86	88	90	85	89	86	88	175	175
Spe24	r	.697***	.653***	.597***	.467***	.326***	-.295***	-.489***	-.347***	.226*	.073	.128	.090	.355***	.397***	.507***	-.466***	-.262***
	n	91	90	87	95	95	224	224	224	84	86	88	83	87	84	86	199	199
Sym06	r	.055	-.159	-.078	-.141	-.099	-.007	-.081	-.050	.086	.053	-.224	-.090	-.156	.011	-.195	-.022	-.016
	n	37	36	35	46	45	130	130	130	47	47	49	47	49	47	48	129	129
Sym09	r	.191	.044	.193	.249	.170	-.309***	-.259**	-.284**	.039	.156	-.224	.088	.022	-.164	.001	-.252**	-.193*
	n	35	35	34	46	45	119	119	119	46	46	48	46	48	46	47	119	119
Sym12	r	.306**	.258*	.361***	.329***	.366***	-.256***	-.190**	-.299***	.011	.154	-.020	.296**	.162	.109	.204	-.303***	-.301***
	n	99	98	95	109	108	206	206	206	89	91	93	88	92	89	91	190	190
Sym15	r	.437***	.370***	.454***	.380***	.281**	-.259***	-.232***	-.246***	.077	.149	.063	.279**	.144	.152	.201	-.374***	-.401***
	n	101	100	97	108	107	208	208	208	93	95	97	92	96	93	95	193	193
Sym18	r	.315**	.305**	.294**	.396***	.306**	-.327***	-.386***	-.353***	0.212	.224*	0.150	.273*	.258*	.242*	.425***	-.522***	-.475***
	n	98	97	94	105	104	191	191	191	84	86	88	83	87	84	86	171	171
Sym21	r	.334***	.306**	.374***	.392***	.267**	-.361***	-.437***	-.378***	.238*	.239*	0.064	.226*	.368***	.348***	.507***	-.593***	-.447***
	n	101	100	97	107	106	191	191	191	86	88	90	85	89	86	88	175	175
Sym24	r	.618***	.513***	.494***	.409***	.310**	-.266***	-.303***	-.277***	0.194	0.137	0.183	.253*	0.206	0.149	.259*	-.451***	-.273***
	n	91	90	87	95	95	224	224	224	84	86	88	83	87	84	86	199	199

Note. Soc = Social composite; Spe = Speech composite; Sym = Symbolic composite.; MBCDI = MacArthur-Bates Communicative Development Inventories; Voc = Vocabulary; Inf = Inflections; MSL = Mean Sentence Length; PPVT = Peabody Picture Vocabulary Test; FTF = Five to Fifteen; Comp = Comprehension; Exp = Expressive language, Comm = Communication skills; CCC-II = Children's Communication Checklist –Second Edition; Lang = Language. Numbers after soc, spe, and sym represent age in months.
*<.05. **<.01. ***.001.

ORIGINAL PAPERS

I

CONTINUITY FROM PRELINGUISTIC COMMUNICATION TO LATER LANGUAGE ABILITY: A FOLLOW-UP STUDY FROM INFANCY TO SCHOOL AGE.

by

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Continuity from prelinguistic communication to later language ability: a follow-up study from infancy to early school age

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Abstract

Purpose: This longitudinal study examined the development of prelinguistic skills, and continuity of communication and language from prelinguistic stage to school age.

Method: Prelinguistic communication of 427 Finnish children was followed repeatedly from 6 to18 months of age (*n*=203-322 at ages 6, 9, 12, 15, and 18 months), and its associations with language ability at ages 2;0 (*n*=104), 3;0 (*n*=112), 4;7 (*n*=253), 5;3 (*n*=102) and 7;9 (*n*=236) were examined using latent growth curve modeling.

Results: Prelinguistic development across several skills emerged as a rather stable intra-individual characteristic during the first two years of life. Continuity from prelinguistic development to later language ability was indicated. The common level and growth of prelinguistic skills were significant predictors of language ability between ages 2;0-7;9, the percentage explained varying between 10.5-53.3%. A slow pace of development across multiple skills, in particular, led to weaker language skills.

Conclusions: The results support the idea of a developmental continuum from prelinguistic to linguistic ability, and the dimensional view of language ability, by indicating that individual variations in early communication skills show consistency that extends beyond the toddler years. Our results also advocate developmental surveillance of early communication by emphasizing the significance of growth in predicting language development.

Keywords: communication, language, development

Continuity from prelinguistic communication to later language ability: a follow-up study from infancy to early school age

The development of communication skills starts long before children are able to use language as their primary means of communication. The prelinguistic stage refers to the period during which children use mainly nonverbal means of communication, and spans intentional preverbal communication and the transition to first words (Watt, Wetherby, & Shumway, 2006). The first two years of life is an important period in the development of these early communication skills. The way infants communicate prelinguistically is thought to form a developmental continuum with later, more language-based, communication (Bruner, 1983). Accordingly, Bates (2004) and Rescorla (2009, 2013) have suggested that several interrelated but distinct early socio-cognitive skills serve as building blocks for later language. That is, language emerges from the interactions of these early socio-cognitive processes (Bates, 2004), and differences in language ability stem, in part, from the differential endowment of these language-subserving skills (Rescorla, 2009).

These early socio-cognitive skills (i.e., prelinguistic means of communication) include joint attention, gestures, early vocalizations, first words, language comprehension, and play (Watt et al., 2006). Although these skills and their connections to later language outcome have been rather extensively studied (for a review, see McCathren, Warren, & Yoder, 1996), studies examining several of these skills together, their co-development over time and the implications that this co-development has on later language, are lacking. Thus, it is not possible to ascertain whether it is the general level or pace of early communication development (i.e., the variation that is shared across skills) that is predictive of later language ability, or whether a specific skill, or a combination of skills, at a specific age makes a unique contribution to language development over and above that of the general level. The present study utilizes a longitudinal design to address how prelinguistic communication skills, assessed repeatedly with a multifaceted parental screener covering relevant areas of social, speech, and symbolic skills, develop during the first two years of life. The connections between this development and that of later

language and communication are followed up to school age.

The development of prelinguistic skills

Language and communication development is characterized by substantial inter- and intra-individual variation in the acquisition of different skills. However, despite this variation, both continuity (i.e., group-mean-level consistency) and stability (i.e., consistency in the relative standing of individuals over time) in language development have been reported (Bornstein, Hahn, Putnick, Suwalsky, 2013; Bornstein & Putnick, 2012; Fenson et al., 1994; Thal, Bates, Goodman, & Jahn-Samilo, 1997). The dimensional view of language ability (Rescorla, 2009, 2013) argues for the stability of individual differences in language skills by suggesting that the rank order of children is partly determined by differential endowment. According to Rescorla (2009, 2013) this endowment, that is, a spectrum of language ability which she compares to that of intelligence, derives from variation in several language-subserving socio-cognitive skills and is, at least partly, constitutionally based. These skills, such as auditory perception and processing, verbal working memory, and joint reference are assumed to form the base from which prelinguistic communication and later, language ability develops (Bates, 2004; Rescorla, 2013).

Research on stability in the development of language and communication has tended to focus more on older ages. For example, according to Bornstein and colleagues (2012, 2013), when multiple domains, measures, and sources are used across age, child language emerges as a stable characteristic of individual differences. The development of communication in the prelinguistic period has been less extensively studied. The developmental sequences of separate prelinguistic skills such as gestures (Bates & Dick 2002) and joint attention (Carpenter, Nagell, & Tomasello, 1998) have been studied, but several prelinguistic skills have been included in the same analysis in only a few studies, while even fewer have tracked the co-development of these skills in the prelinguistic period.

The few studies that have examined multiple prelinguistic skills simultaneously have reported significant correlations between measures of different skills (e.g., Laakso, Poikkeus, Katajamäki, &

Lyytinen, 1999; Watt, et al., 2006), indicating that these measures partially tap the same underlying functions (i.e. language endowment). For example, in Laakso et al. (1999) parental report on gestures and concurrently observed joint attention correlated significantly (r =.21-.26) at age 14 months. Watt et al. (2006) explored the concurrent correlations of several prelinguistic skills and reported that gestures (r =.29-.46) and joint attention (r =.29-.47) were significantly correlated with most of the other measures, especially early in the second year of life (a total of 22/36 correlations were significant, r =.01-.61 at 14 months, and 11/36, r =.00-.75 at 20 months).

Darrah, Hodge, Magill-Evans, and Kembhavi (2003), Reilly et al. (2006), Watt et al. (2006), and Wetherby, Allen, Cleary, Kublin, and Goldstein (2002) have examined the development of the social, speech, and symbolic skills of children using the Infant-Toddler Checklist (ITC) or the Behavioral Sample of the Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP, Wetherby & Prizant, 2002). These studies have all reported significant longitudinal correlations between assessments of joint attention, gestures, vocalizations, first words, and comprehension in the prelinguistic period (13-21 months r =.46-.55 for the total score in Darrah et al., 2003; 8-12 months β =.56 for the total score in Reilly et al, 2006; 14-20 months, r =.39-.59 in separate skills in Watt et al., 2006; 13-20 months, r =.77-89 for the different composites, and r = .85-.91 for the total score in Wetherby et al., 2002). These correlations indicate stability in individual differences in the development of these skills over time whereas concurrent reports on increases in raw scores indicate fast growth in these skills (Watt et al., 2006; Wetherby et al., 2002).

General level and pace of development or skill- and age-specific associations?

It has been shown that a major predictor of communication and language status at a given age is the level of skills at an earlier age, both in the prelinguistic stage (Reilly et al., 2006, 2007) and during later language development (Bornstein & Putnick, 2012). However, it has also been suggested that the pace of development, rather than the level at any given age, might be more predictive of later development (e.g. Rowe, Raudenbush, & Goldin-Meadow, 2012). This view has received support from

studies examining vocabulary development (Rescorla, Mirak, & Singh, 2000), and early precursors of literacy (Lyytinen et al., 2006). According to Rowe et al. (2012), it is plausible that "the rates of growth likely contain more information about the child's language acquisition potential than their ability at one point in time" (p. 510). This could be the case, especially with respect to early communication development, where growth depends also on the acquisition of new skills as well as augmenting existing skills (Reilly et al., 2006).

Another relevant question is whether it is the general (i.e., common) level or growth of prelinguistic development across several skills or a specific skill at a specific age that best predicts later language ability. Research has established links between several early socio-cognitive and prelinguistic communication skills and later language ability: for example, gaze following (Brooks & Meltzoff, 2008), and other forms of joint attention (Beuker, Rommelse, Donders, & Buitelaar, 2013), gestures (Colonnesi, Stams, Koster, & Noom, 2010), deferred imitation (Heimann, et al., 2006), verbal comprehension and symbolic play (Bruce, Kornfält, Radeborg, Hansson, & Nettelbladt, 2003), and frequency of intentional communication and reciprocity (Paavola, Kemppinen, Kumpulainen, Moilanen, & Ebeling, 2006). However, the comparison of studies is difficult, as their measures, ages and methodology vary considerably. In addition, multiple prelinguistic skills have been rarely addressed in the same study.

The results reported thus far suggest that the proportion of shared variance between the different prelinguistic measures is large relative to the unique contribution of single skills (Watt et al., 2006; Wetherby et al., 2002). For example in the studies by Wetherby and colleagues (2002; Watt et al., 2006), the joint contribution of gaze following, joint attention, gestures, vocalizations, first words, comprehension, and play was large relative to the unique contribution of any of these skills for the predicted variance. This led the authors to conclude that judgments about the relative importance of any particular skill in predicting language outcome should be guarded, and that using an array of prelinguistic measures strengthens their predictive value.

However, despite the large shared variance, the studies by Wetherby and colleagues on the different composites of the ITC have found specific associations between the social and symbolic composites and receptive language (*pr* =.23-.62), the speech composite and expressive language (*pr* = .17-.59, Wetherby et al., 2002), and the social composite and later autism spectrum disorder (Wetherby, Brosnan-Maddox, Peace, & Newton, 2008). Heimann et al. (2006) tracked the development of deferred imitation (early memory) and joint attention between ages 6-14 months and found that deferred imitation at 9 months was the single strongest predictor of gestures (β =.53) at age 14 months. In addition, Bruce et al. (2003) reported significant unique contributions of verbal comprehension (*r* =-.58) and symbolic play (*r* = -.40) at age 18 months to language difficulties at age 4;5. However, despite a rather comprehensive assessment of language at the follow-up, they reported the outcome results as frequency of difficulties, thus rendering generalization to typical development difficult. In Lyytinen, Poikkeus, Laakso, Eklund, and Lyytinen (2001), symbolic play at 14 months of age was found to correlate significantly (*r* =.28-.39) with later receptive language skills in typically developing children. However, when early comprehension was controlled for in regression models, symbolic play did not uniquely predict language outcome (β =.13). Similarly, Salley, Panneton and Colombo (2013) found that visual attention and joint attention made unique contributions to later vocabulary size (β = 0.278), but when baseline communication was controlled for, joined attention was no longer a significant predictor (β = 0.093). Thus, the results on the unique predictive ability of different prelinguistic skills remain inconclusive.

The predictive relations of different prelinguistic skills with language development have also been found to show age-specificity. Watt et al. (2006) studied the different variables of the CSBS DP and found that the predictive relations varied according to age: Early in the second year of life, specific predictive associations were found between gestures and receptive language, and joint attention and expressive language. Late in the second year, inventory of consonants contributed uniquely to expressive language. Comprehension was predictive of later receptive and expressive language

throughout the second year. Others (Brooks & Meltzoff, 2008; Heimann et al., 2006; Rose, Feldman, Jankowski, & Van Rossem, 2008) have also suggested that the age at which early skills are assessed might affect the way they relate to later abilities, that is, the predictive power of a certain skill might vary depending on whether the skill is just emerging or already more established.

Goals of the present study

This study addresses the question of continuity and stability both within the prelinguistic period and from the prelinguistic period to linguistic development. We examined the development of early communication skills by repeatedly following, during the first two years of life, several of the relevant developmental areas suggested by previous research. In addition, we explored the longitudinal associations of this early development with later language ability. Following the premises of the dimensional view of language (Rescorla, 2013) and the suggestions of Bornstein and Putnick (2012) and Conti-Ramsden and Durkin (2012), a multiage, multidomain, multimeasure, and multisource approach was adopted in the follow-up procedures of the present study. The complex nature of language requires that both multiple dimensions of language and measures of working memory be used in the assessment (Conti-Ramsden & Durkin, 2012). The associations between prelinguistic development and subsequent language outcomes were studied in separate but largely overlapping subsamples at five consecutive time points (at age 2, 3, 4;7, 5;3 and first grade, mean age 7;9, range 7;2 – 8;4). Three areas of language development (expressive, receptive, communicative/pragmatic), along with verbal working memory, were explored using several different measures, including both parental report and psychometric testing.

Specifically, we asked:

1. How is the development of prelinguistic communication skills depicted when three relevant areas of development (social, speech, symbolic) are assessed longitudinally between 6 and 18 months of age? In particular, we explored the stability of individual differences over time, and whether development in these three areas is mainly overlapping (i.e., can be depicted by a model of common level and growth)

or distinct (i.e., skill-specificity), and whether the course of development shows age-related differences (i.e., age-specificity). Based on previous findings on early communication skills (Laakso et al., 1999) and the ITC (Watt et al., 2006; Wetherby et al., 2002), we expected the three studied areas to show significant shared variance and also, to some extent, skill- and age-specific variance. In addition, we expected to find stability in development over time.

2. Which aspects of early development (i.e., common level and growth or skill- or age-specific features) best predict later language ability? In accordance with the dimensional view (Rescorla, 2009, 2013), and earlier findings (e.g., Bornstein et al., 2013), we expected to find indications of continuity and stability on the aggregate level (i.e., common level and growth predicting later abilities). Based on the findings of Wetherby and colleagues (2002; Watt et al., 2006) in somewhat older samples, we hypothesized that social and symbolic skills would show more predictive power early on in development, whereas the role of speech skills might be more pronounced later on.

Method

Brief summaries of the methods follow; for a more detailed description of the participants, procedures, and measures, see the online Supporting Material.

Participants and procedure

The participants of the present study represent subsets of a community-based sample collected in a longitudinal study of early language and communication development conducted between the ages of 6 months and 8 years (see Määttä, Laakso, Tolvanen, Ahonen & Aro, 2012, 2014). Altogether, 508 children (50.2 % boys, 49.8 % girls) aged 6 to 24 months participated in the study. All of the families were Caucasian, and all of the children spoke Finnish as their native language. At the initial assessment, mothers' mean age was 29.8 years (*SD* = 5.4), and fathers' 32.1 years (*SD* = 6.3). Educational attainment was assessed with a 7-point scale ranging from no vocational education (0) to a higher-level university degree (6). The mean educational level was 3.9 (*SD* = 2.0) for mothers and 3.6 (*SD* = 2.0) for fathers.

The early questionnaire (ITC) data were collected repeatedly every three months until the children were 24 months of age. The total number of questionnaires filled in by the parents depended on the age of their child at recruitment and on how many of the subsequent forms they completed. In the present study we used the data gathered on the children across ages 6 – 18 months. This yielded a total sample of 427 children (n = 229 at 6 months, n = 203 at 9 months, n = 322 at 12 months, n = 305 at 15 months, and n = 279 at 18 months of age). Of these 427 children 25.8 % had data from all five data points, 9.6 % from four, 29.0 % from three, 23.4 % from two and 12.2 % from one data point. The last two measurements of the early data, collected at 21 and 24 months, were excluded from the analyses due to skewed and kurtic distributions (ceiling effect).

Subgroups of the original participants were followed after the ITC data collection phase at the age of 2, 3, 4;7, and 5;3 years, and in the spring term of first grade (mean age 7;9, range 7;2-8;4). The numbers of participants are described in Figure 1, subsample differences in the ITC scores in Table SM1, and the demographic data of the different subsamples along with information on Finnish families and family services in the online Supporting Material and Table SM2. In the follow-ups at ages 2, 3, and 5;3, we were not able to collect information from all the families, owing to time and resource limitations. Thus, the subsamples were constructed so as to ensure that a sufficient number of at-risk children would participate. At-risk status was defined as slow communication development in ITC at ages 12, 15 and 18 months following the criteria suggested by Wetherby & Prizant (2002; follow-ups at ages 2 and 3 years) or as a high score (90^{th} percentile) in a parent report symptom questionnaire at age 4;7 (follow-up at age 5;3). In the follow-ups at age 4;7 and first grade, all the originally participating families, excluding those who had declined to participate in further follow-ups in the previous data collection phases, were attempted to contact. For the families that were not reached, we were unable to find a valid address.

Insert Figure 1 about here.

At age 2, a small subset of families (n = 143) was invited to fill in the MacArthur-Bates Communicative Inventories (MBCDI; Fenson et al., 1994; Lyytinen, 1999). The participants included 65 children who were identified as being at risk based on their scores in the ITC, using the norms and 10th percentile cut-off reported by the original authors (Wetherby & Prizant, 2002). These children performed either in the lowest 10 percent in the social or symbolic composites at 12 or 15 months of age or within the lowest 10 percent in the speech composite at 15 or 18 months of age. The rest of the sample (n = 78) performed above the 10th percentile in all three composites at all ages. In total, 104 families (72.7%, at risk n = 44, no risk n = 60) returned the questionnaire. The mean age of the children at the time of the completion of the questionnaire was 25.3 months (SD = 1.2, range 24-30 months). The ITC composite scores at 12, 15, and 18 months were compared between the children who had data at age 2 (n = 99, 101, and 98 respectively) and those who did not, (n = 223, 204, and 181). Effect sizes were calculated using partial eta squared (η_p^2). Significant differences between the children emerged in the speech composite at 15 months, $F(1, 302) = 17.557$, $\eta_p^2 = .055$, $p = .000$ after controlling for multiple comparisons (Table SM1).

At age 3, the same subset of families was invited for individual assessments of vocabulary. Of these families, 112 (at-risk n = 56, no risk n = 56) agreed to participate. The mean age of the children at the time of the assessment was 36.7 months (SD = 0.8, range 36-41). When comparing the children with data at age 3 (n = 109, 108, and 105 at 12, 15, and 18 months of age respectively) and those without (n = 213, 196, and 174), small but significant differences in the social composite at 15 months, $F(1, 303) = 12.282$, $\eta_p^2 = .039$, $p = .001$, and speech composite at 15 months, $F(1, 302) = 15.346$, $\eta_p^2 = .048$, $p = .000$ and 18 months, $F(1, 277) = 12.948$, $\eta_p^2 = .045$, $p = .001$ of age remained after controlling for multiple comparisons (Table SM1). In both 2 and 3 year data comparisons, the significant differences resulted from the participating children having lower mean and showing larger variation than the children without follow-up data. In the present study all the available data from the assessments at ages 2 and 3

years were used.

When the children were aged 4 years 7 months all the originally participating families were sent a questionnaire concerning their child's language and communication skills. Of the 508 families, 473 (93.1%) were reached, and 296 (62.6% of reached; 58.3% of the original sample; total attrition rate 41.7%) returned the questionnaire. The mean age of the children at the time of the completion of the questionnaire was 56.9 months (*SD* = 4.0, range 52-69). There were no significant differences in ITC scores at ages 12, 15, and 18 months between the children who participated in this follow-up and those who did not. In the present study, children who had early data only from ages 21 and 24 months were excluded, and thus data from 253 children were used.

At age 5 years 3 months (5;3), a subsample of 102 children were invited for individual follow-up assessment. Primarily, children with full datasets from the previous assessment points (early questionnaire data, vocabulary data from either age 2 or 3 or both, and questionnaire data from age 4;7, *n* = 70) were selected to ensure adequate data for studying development over time. The sample was supplemented with children whose parents reported concerns related to language and communication, hyperactivity, or executive functions in the previous follow-up stage at age 4;7 (*n* = 32). The mean age of the children at the time of the assessment was 62.3 months (*SD* = 0.5, range 61-65 months). No significant differences were observed in the ITC scores at ages 12, 15, and 18 months between the children who participated in this follow-up (*n* = 93, 97, and 88, respectively) and those who did not (*n* = 229, 208, and 191). In the present study, all the available data were used.

The final follow-up was conducted during the spring term of the first grade (mean age = 93.3, *SD* = 3.9, range 86-103 months). All the originally participating families were sent a questionnaire on their child's language and communication skills. Altogether, 453 families (89.2%) were reached and 273 (60.3 % of reached; 53.7 % of the original sample; total attrition rate 46.3%) returned the questionnaire. There were no significant differences in ITC scores at ages 12, 15, and 18 months between the children who participated in this follow-up and those who did not. In the present study,

children with early data only from ages 21 and 24 months were excluded, resulting in a sample of 236 children.

Measures

Parents completed questionnaires every three months between the ages 6 to 18 months and at the follow-ups at ages 2 years, 4;7, and first grade. Face-to-face assessments were administered at the ages of 3 years, and 5;3 (see Table 1.).

Insert Table 1 about here.

Early development measure. The Finnish version of the Infant-Toddler Checklist (ITC) of the Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP, Laakso, Poikkeus, & Eklund, 2011; Wetherby & Prizant, 2002) was used to obtain parental estimates of their children's early communication skills. The ITC is one of the most comprehensive parent-report screening tools for prelinguistic and early language skills currently available (for a review of methods, see Crais, 2011). The questionnaire covers three composites of development that address several relevant aspects of prelinguistic communication, such as emotion and eye gaze, gestures, and communication (social), sounds and words (speech), and understanding and object use (symbolic). Wetherby and Prizant (2002) report Cronbach's alphas (αs) ranging from .87 to .99 for the three composites combined over the age span of 6 to 24 months, which indicates a high degree of internal consistency. In the present data, the Cronbach's αs over the age span of 6 to 18 months ranged from .80 to 89, and by age (6, 9, 12, 15, and 18 months; ns = 191-320) from .68 to .73 for the social composite, from .47 to .63 for the speech composite, and from .38 to .58 for the symbolic composite.

The ITC has been shown to be able to detect developmental growth and produce relatively stable rankings of children over short periods of time (Reilly et al., 2006; Wetherby et al., 2002), although indications of instability in ITC rankings both between and within individuals have also been reported

(Darrah et al., 2003). Longitudinal connections between ITC scores and receptive and expressive language at 2 and 3 years of age (Wetherby, Goldstein, Cleary, Allen, Kublin, 2003), and between the ITC and later communication difficulties, including autism spectrum disorders (Wetherby et al, 2008) have been reported. However, studies extending the follow-up period beyond the toddler years remain scarce (for exceptions, see Määttä et al., 2012, 2014; Reilly et al., 2006).

Follow-up measures

Measures at 2 years (n = 104). The vocabulary scale, sum of noun and verb inflections, and maximum sentence length subscales of the Finnish version of the MacArthur-Bates Communicative Development Inventories Words and Sentences (MBCDI; Fenson et al., 1994; Lyytinen, 1999) was used as a measure of early expressive vocabulary. Cronbach's α for the vocabulary scale was .95.

Measures at 3 years (n = 112). Children's receptive vocabulary was assessed with the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1981) and expressive vocabulary with Boston naming (Kaplan, Goodglass, & Weintraub, 1983). Cronbach's αs were .94 for PPVT and .82 for Boston naming.

Measures at 4;7 (n = 253). Children's language-related difficulties were assessed using the questionnaire Five to Fifteen (FTF; Kadesjö et al., 2004). As the FTF is a symptom questionnaire based on parent report the results are regarded to represent parental concerns as opposed to clinically evaluated difficulties. The language domain of the FTF includes three subscales that cover comprehension, expressive, and communication skills. The Cronbach's αs for the scales were .66 for comprehension, .87 for expressive and .71 for comprehension.

Measures at 5;3 (n = 98-102). The language tasks were selected to measure a range of language-based skills that tap different dimensions of language in both the receptive and expressive domains. The Similarities subtest (SI, WPPSI-R; Wechsler, 1995) was used to assess verbal abstract reasoning and conceptualization abilities. Single-word receptive vocabulary was assessed with a short version of Peabody Picture Vocabulary Test – Revised (PPVT; Dunn & Dunn, 1981). As a measure of receptive grammar, we used the Korpilahti Auditory Sentence Comprehension test (SC; Korpilahti, 1996), which

assesses the ability to process semantic and syntactic information in sentences of increasing complexity. The Verbal Fluency subtest of NEPSY-II (VF; Korkman, Kirk, & Kemp, 2008) was used to assess verbal fluency and vocabulary through the ability to generate words within specific semantic categories.

The memory tasks were selected to measure different subsystems of Baddeley's (2003) model of working memory. The phonological loop (i.e., auditory short-term memory) was assessed with the Digit Span- forwards subtest (DSf, WISC-III; Wechsler, 1999) and the Repetition of Nonsense Words task (NWR, NEPSY; Korkman, Kirk, & Kemp, 1997). The Digit Span- backwards subtest (DSf, WISC-III; Wechsler, 1999) was used to assess the central executive and the Sentence Repetition task (SR, NEPSY-II; Korkman et al., 2008) to assess the episodic buffer.

Measures in first grade (mean age 7;9, range 7;2-8;4, n = 236). The Finnish version of the Children's Communication Checklist-II (CCC-2; Bishop, 2003; 2014) was used to assess children's language and communication difficulties. The questionnaire includes four subscales evaluating language-related abilities (speech, syntax, semantics, coherence; Cronbach's α = .91) and four subscales concentrating on pragmatics (inappropriate initiations, stereotyped language, use of context, nonverbal communication; α = .92).

Data analyses

The repeated measures of early communication skills (the three composites of the ITC: social, speech, and symbolic) were analyzed using a type of second-order multivariate Latent Growth Curve modeling (LGC, Bollen & Curran, 2006; factor-of-curves, Duncan, Duncan, & Strycker, 2006). The analyses were performed using the Mplus statistical package (version 7; Muthén & Muthén, 1998-2010). The missing data function in Mplus enables all the observations in the data to be used in estimating the parameters of the models. Because some of the variables were skewed, the robust MLR estimation method was used (Muthén & Muthén, 1998-2010). The goodness-of-fit of the estimated LGC models was evaluated using the χ^2 test (p >.05), the Comparative Fit Index (CFI ≥ .95), the Tucker-Lewin Index (TLI ≥ .95), the Root Mean Square Error of Approximation (RMSEA < .06), and

Standardized Root Mean Square Error of Approximation (SRMR < .08) (Hu & Bentler, 1999; Muthén & Muthén, 1998-2010). Instead of as definitive cut-off criteria, the values of the fit indices were used as guidelines for evaluating the model fit (for a critical discussion, see Marsh, Hau, & Wen, 2004). Greater weight was given to the other fit indices than to chi-square, as the chi-square value is known to be sensitive to large sample sizes (Miles & Shevlin, 2007). The model modification indices, alongside with theoretical considerations, were utilized in specifying the model.

In the analysis, the growth curves were first applied simultaneously to each ITC composite, estimating the initial level of each composite (i.e., the level), the average rate of growth (i.e., the slope), and individual variation in the initial level and growth. These first-order factors described individual differences within each ITC composite. Second-order common factors (common level and common growth) were then added to describe commonality (i.e., to model the correlation structure) among the first-order factors. The associations of early communication development (the early LGC model) with later language ability were explored by regressing the follow-up measures on the common level and growth factors. Skill- and age-specific connections were tested by building the specific pathways suggested by the model modification indices. The regressions were run separately for each follow-up stage. Raw scores were used in all the analyses.

Results

A latent growth curve (LGC) model for early communication development

The means and standard deviations of the three ITC composites (social, speech, symbolic) between ages 6 and 18 months are shown in the upper part of Table 2. All three composites showed marked growth throughout the assessment period and all the successive measurements within the composites correlated significantly with each other (social r =.47 - .72, p <.001; speech r =.34 - .79, p <.001, and symbolic r =.40 - .68, p <.001; for a full correlation matrix, see Table SM3) with a large effect size (Cohen, 1992). However, there were also notable differences between individuals throughout the period. That is, overlap in the scores was observed between the different age stages – the highest performing children at

only 6 months of age scored almost as high as the lowest performing children at ages 15 and 18 months (95 % confidence intervals).

Insert Table 2 about here.

A LGC model for each of the three early communication composites was estimated simultaneously (see Figure 2). Altogether, 427 children were included in the analysis. The coverage of the elements in the covariance matrix varied from 31.6 to 75.4 % (see Table SM4). Due to the sequential nature of the data, all the successive measurements were allowed to correlate with each other within the composites. Following the suggestions of the modification indices and visual inspection of the individual growth curves, nonlinear growth was estimated: the first and last factor loadings on the growth factors of each communication composite were fixed, and the factor loadings at ages 9, 12, and 15 months were estimated freely. The level and growth factors of the three composites were allowed to correlate, and the correlations were high and significant both between the level factors (r =.57-.81, p <.001), and the growth factors (r = .48 - .67; p <.001 - .010).

A second-order factor structure was then added to the previous model in order to model the correlation structure between the first-order factors. The three first-order level factors were set to load onto the second-order level factor (common level) and the three first-order growth factors were set to load onto the second-order growth factor (common slope; see Figure 2). Because of high correlations between the residuals of the different composites at ages 9, 12 and 15 months, specific factors by age were added to explain the residual covariance. The loadings of the three composites were set equal across the three measurements. The model fitted the data well: $\chi^2(73) = 87.405$, p =.120 , CFI =.991 , TLI =.987, RMSEA = .021 and SRMR =.083.

Insert Figure 2 about here.

All loadings on the second-order level and growth factors were significant and positive, with small differences in the magnitude of the loadings between the different composites. The second-order level factor explained (R^2) 74 % of the variance in the first-order level factor of the social composite, 72 % of that of the speech composite, and all of the variance in the level of the symbolic composite (due to a small negative residual variance, the residue of the first-order level factor of the symbolic composite was set to zero). The second-order growth factor explained 88 % of the variance in the first-order growth factor of the social composite, and 91 % of the symbolic composite. For the speech composite, the percentage explained was somewhat smaller (66 %), although significant. The second-order level and growth factors correlated negatively (r = -.48), indicating that the rate of growth was steeper for children who started at a lower initial level. The residuals of the first-order level factors of the social and speech composites, and the first-order growth factor of the speech composite were significant (.26 - .34, p = .010-.031). This indicates that, despite good model fit, there was skill-specific variation that was not explained by the common level and growth factors. In addition, the presence of the age-specific factors at ages 9, 12 and 15 months suggest that there is also age-specific variation, not captured by the growth model.

In sum, the LGC model of early communication skills suggested that there is a large amount of shared variance in the development of early social, speech, and symbolic skills. That is, individuals tend to be on a similar level (i.e. to have similar ranking relative to others) across the different skills, and the rate of development tends also to be similar across the skills, especially in social and symbolic composites. However, despite the notable commonalities, there is also significant skill- and age-specific variation, as indicated by the significant residual variances of the skill-specific factors, and the emergence of the age-specific factors.

Early communication development and later language and communication skills

The longitudinal associations of the LGC model for early communication development with later

language and communication development were explored separately for each follow-up measurement at ages 2, 3, 4;7, and 5;3 years, and in first grade. The analysis was performed in two steps. First, the follow-up measures were regressed on the second-order factors (i.e., common level and growth). Second, in order to explore possible skill- and age-specific pathways, the specific associations suggested by the model modification indices were tested. For a summary of the model fit indices see Table SM5 in the online Supporting Material. The regression coefficients together with the tested specific associations are summarized in Table 3.

Insert Table 3 about here.

LGC and vocabulary at 2 years (n = 104). The MBCDI vocabulary, inflections and maximum sentence length (MSL) were used as the outcome measures. These data were available for 24 % of the children in the early LGC model. The resulting model fitted the data well: $\chi^2(112) = 153.548$, $p = .0056$, CFI = .979, TLI = .971, RMSEA = .029, SRMR = .091. The level and growth of early communication skills explained 32.4 % ($\beta_L = .32$, $\beta_G = .64$) of the variance in the MBCDI vocabulary, and the growth of early communication skills alone explained 41.1 % ($\beta_G = .69$) and 46.7 % ($\beta_G = .74$) of the variances of the MBCDI inflections and MSL, respectively.

LGC and vocabulary at 3 years (n = 112). At three years of age, the Boston naming, and PPVT were administered to a subsample of the children (26 % of the children in the LGC model). The model fitted the data well: $\chi^2(99) = 119.435$, $p = .0793$, CFI = .988, TLI = .984, RMSEA = .022 ,and SRMR = .083. For Boston naming, the common growth in early communication skills explained 27.6 % ($\beta_G = .58$) of the variance. For the PPVT, both the common level and growth of early communication skills together explained 10.5 % ($\beta_L = .29$, $\beta_G = .33$) of the variance.

LGC and parental concerns of language development at age 4;7 (n = 253). Parents reported language related difficulties in the areas of expressive and receptive language and communication skills

using the FTF when the children were aged 4;7. These data were available for 59 % of the children in the LGC model. The model fitted the data well: $\chi^2(112) = 136.459$, $p = .0579$, CFI = .987, TLI = .982, RMSEA = .022, and SRMR = .078. Together, the common level and growth of early communication skills explained 15.0 % (β_L =-.28, β_G =-.43), 19.8 % (β_L =-.26, β_G =-.50), and 20.9 % (β_L =-.32, β_G =-.51) of the variances of the parent-reported concerns in the areas of receptive and expressive language, and communication, respectively.

LGC and language and verbal working memory skills at 5;3 (n = 102). Two factors were constructed from the tasks administered at the age of 5;3 months to a subsample of the children (24 % of the children in the LGC model). The language factor included the Similarities, PPVT, Verbal Fluency, and Sentence Comprehension tasks. The memory factor included the Digit Span forwards and backwards, Nonword Repetition, and Sentence Repetition tasks. The two parts of the Digit Span task were allowed to correlate. The resulting model fitted the data well: $\chi^2(207) = 258.160$, p =.0090, CFI =.973, TLI =.967, RMSEA = .024,and SRMR =.089. The common growth factor of early communication skills explained 33.4 % (β_G =.65) of the variance in the language factor, and 53.3 % (β_G =.74) of the variance in the memory factor. The at-risk status was added to the model as a covariate in order to control for the possible effects it may have on the follow-up outcome. However, the connections were not significant (language β =.02, p =.85; memory β =-.09, p =.29).

LGC and communication skills in the first grade (n = 236). Parents reported strengths and difficulties in language and communication using the Children's Communication Checklist-II when their children were in the first grade. These data were available for 55 % of the children in the LGC model. Two factors were constructed from the CCC-II subscales based on their content. The language factor included the subscales Speech, Syntax, Semantics, and Coherence. The communication factor included the subscales Inappropriate initiation, Stereotyped language, Use of context, and Non-verbal communication. Correlations were allowed within the factors for Speech and Syntax, and Stereotyped language and Non-verbal communication. The correlation between the factors was .87 (p <.000). The

resulting model fitted the data well: $\chi^2(206) = 236.476$, $p = .0714$, CFI =.991, TLI =.988, RMSEA = .018, and SRMR =.071. The common level and growth factors explained 48.2 % (β_L =-.31, β_G =-.78) and 38.9 % (β_L =-.24, β_G =-.70) of the variances in the language and communication factors.

Skill- and age-specific pathways. All in all, there were 108 possible specific pathways (12 outcome measures x 9 specific factors), and thus the significance level was set at $p < .001$. Of these possible pathways, 17 were tested based on the model modification indices (see Table 3 and online Supporting Material). None of these pathways were significant at the .001 significance level, while three of these pathways approached significance: the growth factor of the speech composite to the memory factor at age 4;7 (p =.002) and to the language factor in first grade (p =.007), and the age-specific factor at 15 months of age to language in first grade (p =.007).

Summary of the common and specific connections. The initial level and, in particular, the growth of early communication skills were significant predictors of later language ability. The children who had a higher initial level of communication skills showed better productive vocabulary at 2 years and better receptive vocabulary at 3 years, and their parents reported fewer language- and communication-related concerns at age 4;7 and in first grade. Children who had a faster rate of growth in early communication skills during the period from 6 to 18 months showed better vocabulary skills at ages 2 and 3 years, had fewer parent reported concerns about language and communication development at 4;7 and in first grade, and showed better language and verbal working memory skills at age 5;3. The percentage explained by the level and growth factors varied from 10.5 to 53.3 %. The model modification indices suggested several skill- and age-specific pathways, but none of these pathways were significant at the .001 significance level, and thus, no specific paths were added to the regression models.

Discussion

The aim of this study was to explore the co-development of several early communication skills during the prelinguistic period, and the associations between this development and later language ability. Early

communication skills showed fast growth throughout the ages from 6 to 18 months. There were large individual differences in the development of these skills and these differences showed rather high stability throughout the prelinguistic period. The development in different early communication skills showed a large amount of shared variance which was indicated by the significant and high loadings on the common level and growth factors. However, despite the notable commonalities in development across skills, significant skill- and age-specific variance was also present. The follow-ups were conducted at several time points using multiple measures and sources. The level and especially the growth of early communication skills were significant predictors of later language ability, explaining between 10.5 to 53.3% of the outcome variances. No reliable skill- or age-specific connections were found. The results support a continuum from prelinguistic to linguistic ability (Bruner, 1983), and the dimensional view of language ability (Rescorla, 2009, 2013), by indicating that the individual variations in early language endowment show consistency that extends far beyond the toddler years.

The development of early communication skills between 6 and 18 months of age

Marked growth was evident in all three areas of early communication development (social, speech, and symbolic) across the age span from 6 to 18 months. Also evident was large interindividual variation in the development of these early skills, as shown by the overlap in scores across the different ages. However, despite the change in the mean scores at group level and large interindividual variation, both continuity and stability were present. The high correlations between the successive measurements suggested continuity in individual differences in these skills over age, whereas the significant loadings of the measurements at each age on the skill-specific level and growth factors indicated stability. That is, within a composite, the relative standings of individuals in their development were rather consistent over time.

As expected, the LGC model suggested a large amount of shared variance in the development of early social, speech, and symbolic skills. The level factors of the three composites loaded significantly on the common level factor, indicating that individuals tended to have a similar ranking relative to

others across the three composites. In other words, individuals performing high in one composite were also likely to perform high in the other two. Likewise, the three growth factors of the three composites loaded significantly on the common growth factor, indicating that the relative pace of development was similar across the composites. For example, individuals who showed slow development in one skill composite tended to be slow in the other two as well. Development in the social and symbolic composites, in particular, seemed to go side by side.

Thus, when multiple early communication skills were assessed repeatedly with a parental screener, early communication ability emerged as a rather continuous and stable characteristic of individual differences during the prelinguistic period, that is, the first two years of life. This is in line with previous results on early communication skills obtained by observational methods (Watt et al., 2006). However, the common level and growth factors did not explain all of the variation in development, as shown by the significant residual variances of the skill-specific factors and the emergence of age-specific factors. This indicates that notable skill- and age-specific variation was also present in early communication development, an issue we will turn to later on.

The development of prelinguistic communication skills and later language ability

Both common level and growth of early communication were significant predictors of later language and communication ability. Together, the common level and growth factors explained 10.5 to 53.3 % of the variance in the follow-up measures. These percentages are comparable to those obtained by Wetherby et al. (2002; 2003), who found that the ITC, filled in between 12 and 24 months, explained 20-51 % of the variances in receptive and expressive language outcomes at 2 and 3 years of age. Our results consolidate and expand these results by suggesting that the predictive relation between early communication skills and later language ability is present as early as at 6 months of age, and holds longitudinally up until 8 years of age.

The connection was stronger for the common growth factor, which was significantly connected to all of the follow-up language and communication measures from age 2 years to first grade. A faster

rate of growth in early communication skills consistently led to better language ability and fewer parent-reported difficulties later on. Our results support the suggestion that the pace of development, rather than the level at any given age, better reflects the language acquisition potential of the child, and thus might predict later language development more accurately (Rowe et al., 2012). A slow pace of development might be an indicator of risk for later language difficulties and could be useful in identifying which children might go on to have persistent language difficulties (Lyytinen et al., 2006; Rescorla et al., 2000).

The amount of variance explained by the early communication model did not decrease over time, nor was it consistently the largest when the same source of information was used (parental reports). In addition, it did not seem to be dependent on whether the follow-up sample was based on a selected subsample (ages 2, 3, and 5;3) or the full sample (ages 4;7 and first grade). Thus, our results cannot be accounted for solely by the temporal closeness of the assessments, shared source variance, or sampling procedures. Interestingly, the strongest predictive relation was found between the growth of early skills and later verbal working memory capacity. Although based on a selected subsample of children at age 5;3, we do not believe this finding results from sampling issues, since there were no significant differences in early communication skills (the ITC) between the children who participated in the follow-up at 5;3 and those who did not, and since the at-risk status was not a significant covariate. Instead of being an isolated cognitive skill, language has been shown to be rather inextricably linked to a set of processes shared with other realms of cognition early in life (including memory, attention, and processing speed; e.g., Rose, Feldman, & Jankowski, 2009). Memory processes are considered to be an important underlying component of language development (Gathercole, 2006; Heimann et al., 2006), and have been shown to yield a significant level of consistency over time (Rescorla, 2013). Our results seem to fit in with these findings. Thus, the development and application of infant measures that can tap early memory skills more specifically than the ITC in order to provide more information about the co-development of early language and memory, might prove worthwhile in trying to predict language

outcome.

Skill- and age-specific factors and later language ability

The common level and growth factors captured the variance shared by the three composites across age. However, as indicated by the significant residual variances of the skill-specific factors and the emergence of age-specific factors at 9, 12 and 15 months of age, significant skill- and age-specific variation was also apparent in early communication development. The contribution of these factors to later language development was examined by testing the specific pathways suggested by the model modification indices. Several such pathways were tested, but, contrary to our expectations, none of them reached significance. These results seem to be in line with those of previous studies reporting that when other aspects of communicative development are controlled for, the unique contributions of specific skills diminish (Lyytinen et al., 2001; Salley et al., 2013) and that the amount of shared variance is notably large relative to the unique contributions (Watt et al., 2006; Wetherby et al., 2002). However, despite the large body of research on prelinguistic predictors of language development, studies that have considered multiple concurrent predictors and their unique contributions to later development remain scarce and the results are not able to lead to firm conclusions. While the tested pathways failed to reach significance in the present study, they nonetheless raise interesting topics for future research.

There are several possible reasons we did not find any reliable specific associations. As indicated by the significant correlations found between early socio-cognitive skills in earlier studies (Laakso et al., 1999; Watt et al., 2006; Wetherby at al., 2002), these skills are highly interrelated, and thus specific connections might be difficult to discern. It is possible that a broadband screener is only able to describe the common trends in development, and that to be able to capture the more specific processes of development, a more fine-tuned measurement is needed. For example, Laakso et al. (1999) found that parental ratings of intentional communication yielded general associations to later language ability, whereas the associations from observed joint attention to later language varied depending on the specific aspects of the joint attention behaviors under observation. Watt et al. (2006) also found, using

observational methods, that some skills make a unique contribution to language outcome despite sharing a substantial amount of variance. In addition, Brooks and Meltzoff (2008) found that observed pointing in an experimental setting, but not parental report of pointing, was a significant predictor of vocabulary growth. Specific predictive relations might also be stronger when the focus of assessment is centered more on domain-general skills, such as attention (Salley et al., 2013) and memory (Heimann et al., 2006; Rose et al., 2009), which have been shown to show discreteness already early on in life (Rose, Feldman, & Jankowski, 2005).

Strengths, limitations and further directions

This study examined the continuity and stability of language and communication development from 6 months to first grade. So far, few studies have examined developmental continuity and predictive relations starting from such an early age and extending over a notably long follow-up period (however, see Reilly et al., 2006). The use of a rather large community-based sample, repeated assessment of early communication skills during the prelinguistic period, the inclusion of social and symbolic abilities in addition to oral communication in the early assessments, and a diverse assessment of language and communication with the inclusion of working memory measures in the follow-ups are clear assets of the study.

Although the present study established that strong longitudinal associations exist between prelinguistic development and later language ability, several important limitations must be noted. First, despite its initial size, our study is limited by the nature of the sample. Due to sampling decisions and attrition, the number of children having data at each follow-up ranged between 23 – 26% in selected subsamples, and between 60 - 63% in population follow-up samples. The variation in the subsample sizes and measures makes comparison of the coefficients of determination (R^2) challenging. However, these values did not systematically vary according to the coverage of the initial sample or the source of information (parent report or psychometric assessment). It is also important to bear in mind that in some of the follow-up samples (2;0, 3;0, and 5;3) children with possible risks for language difficulties were

slightly oversampled and thus, inferences based on these follow-ups should be interpreted with caution. However, although there were some differences in the ITC composite scores between the children participating and not participating in these follow-ups, these differences did not seem to be systematic across the follow-ups.

Second, our parental questionnaire on early communication skills was comprehensive in its contents, but nevertheless short and designed for screening purposes. Parent-report measures of communication and language skills have been shown to be reliable and valid, and to correlate with concurrent and subsequent behavioral measures (e.g., Feldman et al., 2005; Laakso et al., 1999). However, more direct assessments of the possible (socio)-cognitive precursors of language, such as working memory and processing efficiency (e.g., Fernald & Marchman, 2012), attentional capacity (Rose et al., 2009), joint attention and gestures (Beuker et al., 2013), and symbolic play (Bruce et al., 2003) in infancy, would aid in better understanding the processes that underlie the emergence and further development of language. Our results suggest that the role of early working memory especially should be studied further. From a clinical perspective, however, studying feasible and implementable methods is essential.

Third, we did not control for possible confounding variables related to the child (e.g., gender, nonverbal ability) or the family (e.g., parental age and education) that could affect the estimation of stability (see, Bornstein et al., 2013; McKean et al, 2015). It has been shown that these variables show little explanatory power in the early stages of development (5-6% in Reilly et al., 2006). At later ages, they have been shown to contribute more to later language status (19-21% in Reilly et al., 2010), but to show only modest discrimination between children with and without low language ability. For the current study, data related to birth and family are, however, reported in the Supporting material along with descriptions of Finnish society. Fourth, it is likely that there are other important risk or resilience factors that contribute to later language ability that we did not assess in this study. As language develops in social interaction, factors related to the social environment might prove useful (Bruner, 1983; Paavola

et al., 2006). For example, maternal responsivity has been shown to mediate the relation between early communication and later language (Yoder & Warren, 1999). In addition, it is likely that the use of speech and language therapy services affect children's outcomes (Law, Garrett, Nye, 2003). Unfortunately, we did not have this information for the whole sample, and thus could not control for it.

Finally, it is important to bear in mind that the results obtained in this study reflect predictive relations at the group level. Studying stability and prediction at the individual level was not within the scope of this study. However, examination of the persistency of at-risk status and estimations of sensitivity, specificity and other predictive values is a natural next step in our research. The sensitivity and specificity estimates obtained in previous studies using the ITC have been relatively good (81-89 % and 70-79 %) up to three years of age (Wetherby et al., 2003).

The present study contributes to the literature on early language development by adducing further evidence for the link between prelinguistic communication and later language ability. The results support the dimensional view of language ability (Rescorla, 2009, 2013) by showing that instead of a specific skill, the combined development of several early communication skills (i.e., the early language endowment) is more predictive of later language ability. Our results conform to the views of Bates (2004) and Rescorla (2009, 2013) that language ability builds up from the interactions of several interrelated early communication skills that do not map one-on-one to later abilities. Our results also advocate developmental surveillance of early communication skills by showing that the pace of development, rather than the level at any given age, is more predictive of later development. In addition to providing a better understanding of developmental processes in typical development, these results have important implications for early screening procedures. By assessing multiple early communication skills concurrently, and by following the development in these skills over short periods of time, we might be able to identify at-risk children more accurately and at an earlier age.

References

Baddeley, A. (2003). Working memory and language: an overview. *Journal of Communication Disorders, 36*, 189-208. doi: 10.1016/S0021-9924(03)00019-4

Bates, E. A. (2004). Explaining and interpreting deficits in language development across clinical groups: Where do we go from here? *Brain and Language, 88*, 248-253. doi: 10.1016/S0093-934X(03)00102-0

Bates, E., & Dick, F. (2002). Language, gesture, and the developing brain. *Developmental Psychobiology, 40*, 293–310. doi:10.1002/dev.10034

Beuker, K. T., Rommelse, N. N. J., Donders, R., & Buitelaar, J. K. (2013). Development of early communication skills in the first two years of life. *Infant Behavior and Development, 36,* 71-83. doi: 10.1016/j.infbeh.2012.11.001

Bishop, D. V. M. (2003). *The Children's Communication Checklist* (Vol 2). London: Harcourt Assessment.

Bishop, D. V. M. (2014). *The Children's Communication Checklist* (Vol 2). [Manual for the Finnish adaptation]. Helsinki: Hogrefe Psykologien Kustannus.

Bollen, K. A., & Curran, P. J. (2006*). Latent curve models: A structural equation perspective*. New Jersey: John Wiley & Sons.

Bornstein, M. H., Hahn, C.-S., Putnick, D. L., & Suwalsky, J. T. D. (2013). Stability of core language skill from early childhood to adolescence: A latent variable approach. *Child Development*. Advance online publication. doi: 10.1111/cdev.12192

Bornstein, M. H. & Putnick, D. L. (2012). Stability of language in childhood: a multiage, multidomain, multimeasure, and multisource study. *Developmental Psychology, 48,* 477-491. doi: 10.1037/a0025889

Brooks, R. & Meltzoff, A. N. (2008) Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: a longitudinal, growth curve modeling study. *Journal of Child Language, 35*, 207-220. doi:10.1017/S030500090700829X

Bruce, B, Kornfält, R., Radeborg, K., Hansson, K., & Nettelbladt, U. (2003). Identifying children at risk for language impairment: screening of communication at 18 months. *Acta Paediatric, 92,* 1090-1095. doi: 10.1080/08035250310004414

Bruner, J. (1983). *Child's talk: Learning to use language*. Oxford: Oxford University Press.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*, 1-143.

Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science, 1*, 98–101. doi:10.1111/1467-8721.ep10768783

Colonnesi, C., Stams, G. J. J. M., Koster, I., & Noom, M. J. (2010). The relation between pointing and language development: a meta-analysis. *Developmental review, 30*, 352-366. doi:10.1016/j.dr.2010.10.001

Conti-Ramsden, G., & Durkin, K. (2012). Language development and assessment in the preschool period. Neuropsychology Review, 22, 384–401. doi:10.1007/s11065-012-9208-z

Crais, E. R. (2011). Testing and beyond: Strategies and tools for evaluating and assessing infants and toddlers. *Language, Speech, and Hearing Services in Schools, 42,* 341-364. doi: 10.1044/0161-1461(2010/09-0061)

Darrah, J., Hodge, M., Magill-Evans, J., & Kembhavi, G. (2003). Stability of serial assessments of motor and communication abilities in typically developing infants – implications for screening. *Early Human Development, 72*, 97– 110. doi: 10.1016/S0378-3782(03)00027-6

Duncan, T. E., Duncan, S. C., & Strycker L. A. (2006). An introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications. (2nd ed.) Mahwah, NJ: Lawrence Erlbaum Associates.

Dunn, L. M & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test – Revised*. Circle Pines. MN: American Guidance Service.

Feldman, H. M., Dale, P. S., Campbell, T. F., Colborn, D. K., Kurs-Lasky, M., Rockette, H. E., &

Paradies, J. L. (2005). Concurrent and predictive validity of parent reports of child language at ages 2 and 3 years. *Child Development, 76*, 856-868. doi: 10.1111/j.1467-8624.2005.00882.x

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*, 5 (Serial No. 242).

Fernald, A. & Marchman, V. A. (2012). Individual differences in lexical processing at 18 months predict vocabulary growth in typically developing and late-talking toddlers. *Child Development, 83*, 203-222. doi: 10.1111/j.1467-8624.2011.01692.x

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics, 27,* 513-543. doi: 10.1017.S0142716406060383

Heimann, M., Strid, K., Smith, L., Tjus, T., Ulvund, S. E., & Meltzoff, A. N. (2006). Exploring the relation between memory, gestural communication, and the emergence of language in infancy: A longitudinal study. *Infant and Child Development, 15,* 233-249. doi: 10.1002/icd.462

Hu, L. & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55. doi: 10.1080/10705519909540118

Kadesjö, B., Janols, L.-O., Korkman, M., Mickelsson, K., Strand, G., Trillingsgaard, A., & Gillberg, C. (2004). The FTF (Five to Fifteen): The development of a parent questionnaire for the assessment of ADHD and comorbid conditions. *European Child and Adolescent Psychiatry, 13 (Suppl. 3)*, 3–13. doi:10.1007/s00787-004-3002-2

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test.* Philadelphia: Lea & Febiger

Korkman, M., Kirk, U., & Kemp, S. L. (1997). *Lasten neuropsykologinen tutkimus (NEPSY: A Developmental Neuropsychological Assessment.*). Helsinki, Finland: Psykologien kustannus Oy.

Korkman, M., Kirk, U., & Kemp, S. L. (2008). *NEPSY-II: Lasten neuropsykologinen tutkimus (NEPSY-II: A Developmental Neuropsychological Assessment, Second edition)*. Helsinki, Finland: Psykologien

kustannus Oy.

Korpilahti, P. (1996). *Lausetesti (Test for the language comprehension of sentences).* Helsinki: University Press.

Laakso, M.-L., Poikkeus, A.-M., & Eklund, K. (2011). *Lapsen esikielellisen kommunikaation ja kielen ensikartoitus* [The Infant-Toddler Checklist of Children's Prelinguistic Communication and Language]. Jyväskylä, Finland: Niilo Mäki Instituutti.

Laakso, M.-L., Poikkeus, A.-M., Katajamäki, J., & Lyytinen, P. (1999). Early intentional communication as a predictor of language development in young toddlers. *First Language, 19,* 207-231. doi: 10.1177/014272379901905604

Law, J., Garrett, Z., & Nye, C. (2003). Speech and language therapy interventions for children with primary speech and language delay or disorder. The Cochrane Database of Systematic Reviews. Issue 3. Art. No: CD004110. Retrieved from: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004110/full

Lyytinen, H. Erskine, J., Tolvanen, A., Torppa, M., Poikkeus, A.-M., & Lyytinen, P. (2006). Trajectories of reading development: a follow-up from birth to school age of children with and without risk for dyslexia. *Merrill-Palmer Quarterly, 52*, 514-546. doi: 10.1353/mpq.2006.0031

Lyytinen, P. (1999). *Varhaisen kommunikaation ja kielen kehityksen arviointimenetelmä* [Finnish Manual for Communicative Development Inventories]. Jyväskylän yliopiston lapsitutkimuskeskus ja Niilo Mäki Instituutti. Jyväskylä: Yliopistopaino

Lyytinen, P., Poikkeus, A.-M., Laakso, M.-L., Eklund, K., & Lyytinen, H. (2001). Language development and symbolic play in children with and without familial risk for dyslexia. *Journal of Speech, Language, and Hearing Research, 44,* 873-885. doi: 10.1044/1092-4388(2001/070)

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: comment on hypothesis-testing approaches for setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal, 11,* 320-341. doi:

10.1207/s15328007sem1103_2

McCathren, R. B., Warren, S. F., & Yoder, P. J. (1996). Prelinguistic predictors of later language development. In K. N. Cole, P. S. Dale, & D. J. Thal (Eds.), Assessment of communication and language (pp. 57–75). Baltimore, MD: Brookes

McKean, C., Mensah, F. K., Eadie, P., Bavin, E. L., Bretherton, L., Cini, E., & Reilly, S. (2015). Levers for language growth: characteristics and predictors of language trajectories between 4 and 7 years. PLoS ONE 10(8): e0134251. doi:10.1371/journal.pone.0134251

Miles, J. & Shevlin, M. (2007). A time and a place for incremental fit indices. *Personality and Individual Differences, 42*, 869-874. doi: 10.1016/j.paid.2006.09.022

Muthén, L. K. and Muthén, B. O. (1998-2010). *Mplus User's Guide.* Sixth Edition. Los Angeles, CA: Muthén & Muthén

Määttä, S., Laakso, M.-L., Tolvanen, A., Ahonen, T., & Aro, T. (2012). Developmental trajectories of early communication skills. *Journal of Speech, Language, and Hearing Research, 55*, 1083-1096. doi: 10.1044/1092-4388(2011/10-0305

Määttä, S., Laakso, M.-L., Tolvanen, A., Ahonen, T., & Aro, T. (2014). Children with differing developmental trajectories of prelinguistic communication skills: Language and working memory at age 5. *Journal of Speech, Language, and Hearing Research, 57*, 1026-1039. doi: 10.1044/2014_JSLHR-L-13-0012

Paavola, L., Kemppinen, K., Kumpulainen, K., Moilanen, I., & Ebeling, H. (2006). Maternal sensitivity, infant co-operation and early linguistic development: Some predictive relations. *European Journal of Developmental Psychology, 3*, 13-30. doi: 10.1080/17405620500317789

Reilly, S., Eadie, P., Bavin, E. L., Wake, M., Prior, M., Williams, J., … Ukoumunne, O. C. (2006). Growth of infant communication between 8 and 12 months: A population study. *Journal of Paediatrics and Child Health, 42,* 764–770. doi:10.1111/j.1440-1754.2006.00974.x

Reilly, S., Wake, M., Bavin, E. L., Prior, M., Williams, J., Bretherton, L., … Ukoumunne, O. C. (2007).

Predicting language at 2 years of age: A prospective community study. *Pediatrics, 120*, e1441-e1449. doi: 10.1542/peds.2007-0045

Reilly, S., Wake, M., Ukoumunne, O. C., Bavin, E., Prior, M., Cini, E., … Bretherton, L. (2010). Predicting language outcomes at 4 years of age: Finding from Early Language in Victoria Study. *Pediatrics, 126*, e1530-e1537. doi: 10.1542/peds.2010-0254

Rescorla, L., (2009). Age 17 language and reading outcomes in late-talking toddlers: Support for a dimensional perspective on language delay. *Journal of Speech, Language, and Hearing Research, 52*, 16–30. doi:10.1044/1092-4388(2008/07-0171)

Rescorla, L. (2013). Late-talking toddlers. A 15-year follow up. In L. A. Rescorla & P. S, Dale (Eds.), *Late Talkers – Language, Development, Intervention, and Outcomes* (pp. 219-239). Baltimore, MD: Brookes.

Rescorla, L., Mirak, J., & Singh, L. (2000). Vocabulary growth in late talkers: Lexical development from 2;0 to 3;0. *Journal of Child Language, 27,* 293–311. doi:10.1017/S030500090000413X

Rose, S. A, Feldman, J. R., & Jankowski, J. J. (2005). The structure of infant cognition at 1 year. *Intelligence, 33*, 231-250. doi: 10.1016/j.intell.2004.11.002

Rose, S. A, Feldman, J. R., Jankowski, J. J., & Van Rossem, R. (2008). A cognitive cascade in infancy: Pathways from prematurity to later mental development. *Intelligence, 36*, 367-378. doi: 10.1016/j.intell.2007.07.003

Rose, S. A, Feldman, J. R., & Jankowski, J. J. (2009). A cognitive approach to the development of early language. *Child Development, 80*, 134-150. doi: 10.1111/j.1467-8624.2008.01250.x

Rowe, M. L., Raudenbush, S. W., & Goldin-Meadow, S. (2012). The pace of vocabulary growth helps predict later vocabulary skill. *Child Development, 83,* 508-525. doi: 10.1111/j.1467-8624.2011.01710.x.

Salley, B., Panneton, R. K., & Colombo, J. (2013). Separable attentional predictors of language outcome. *Infancy, 18*, 462-489. doi: 10.1111/j.1532-7078.2012.00138.x

Thal, D. J., Bates, E., Goodman, J., & Jahn-Samilo, J. (1997). Continuity of language abilities: An exploratory study of late- and early-talking toddlers. *Developmental Neuropsychology, 13,* 239–273. doi:10.1080/87565649709540681

Watt, N., Wetherby, A., & Shumway, S. (2006). Prelinguistic predictors of language outcome at 3 years of age. *Journal of Speech, Language, and Hearing Research, 49,* 1224-1237. doi: 10.1044/1092-4388(2006/088)

Wechsler, D. (1995). *WPPSI-R Käsikirja* [Wechsler Preschool and Primary Scale of Intelligence: Revised. Manual for the Finnish Adaptation]. Helsinki: Psykologien kustannus Oy.

Wechsler, D. (1999). *WISC-III Käsikirja* [Manual for the Wechsler Intelligence Scale for Children–Third Edition. Manual for the Finnish Adaptation]. Helsinki: Psykologien kustannus Oy.

Wetherby, A. M., Allen, L., Cleary, J., Kublin, K., & Goldstein, H. (2002). Validity and reliability of the Communication and Symbolic Behavior Scales Developmental Profile with very young children. *Journal of Speech, Language, and Hearing Research, 45,* 1202-1218. doi: 10.1044/1092-4388(2002/097)

Wetherby, A. M., Brosnan-Maddox, S., Peace, V., & Newton, L. (2008).Validation of the Infant-Toddler Checklist as a broadband screener for autism spectrum disorders from 9 to 24 months of age. *Autism, 12,* 487-511. doi: 10.1177/1362361308094501

Wetherby, A. M., Goldstein, H., Cleary, J., Allen, L., Kublin, K. (2003). Early identification of children with communication disorders: Concurrent and predictive validity of the CSBS Developmental Profile. *Infants and Young Children, 16*, 161-174. Retrieved from http://journals.lww.com/iycjournal/

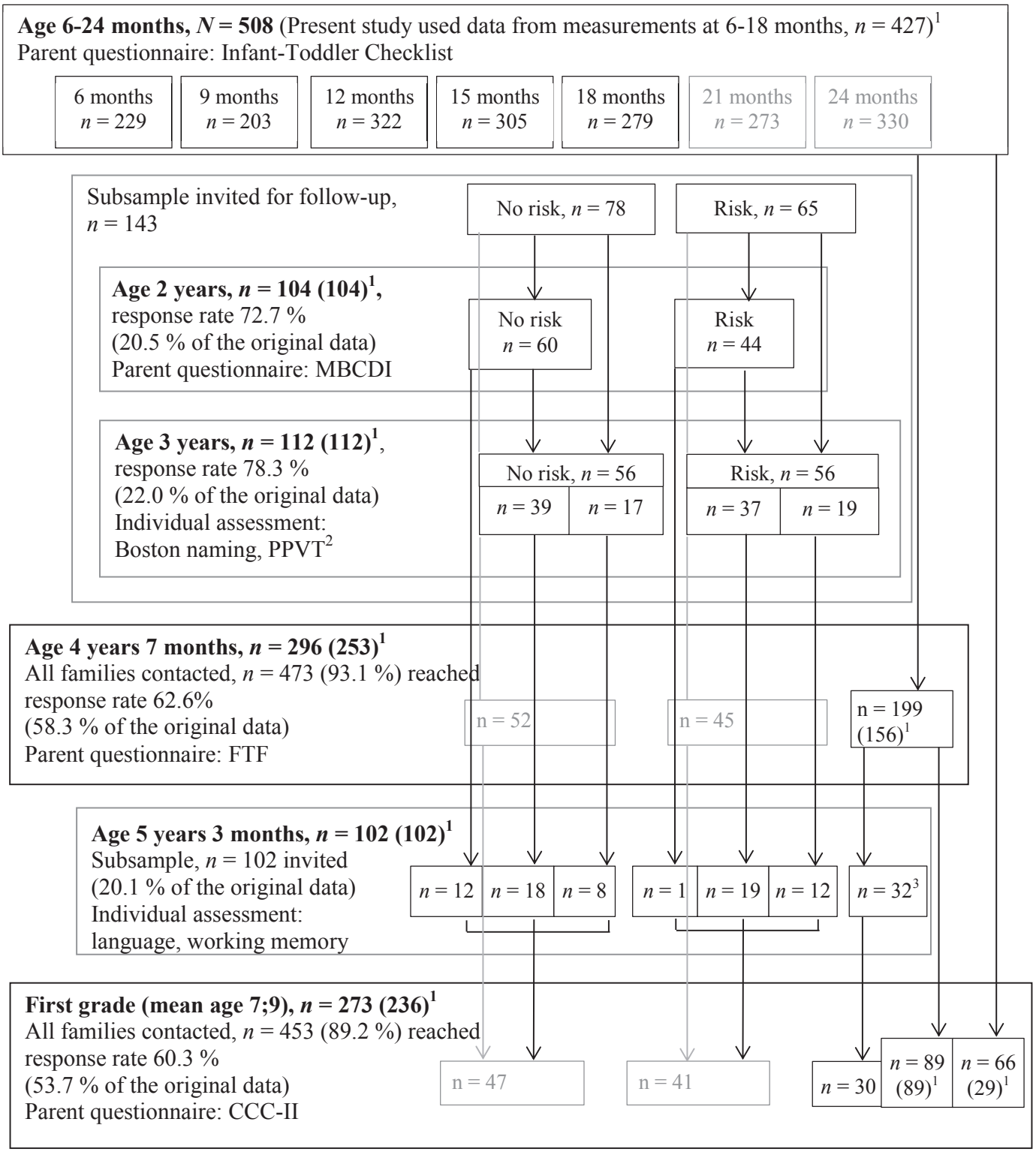
Wetherby, A. M., & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile* (1st normed ed.). Baltimore, MD: Brookes.

Yoder, P. J. & Warren, S. F. (1999). Maternal responsivity mediates the relationship between prelinguistic intentional communication and later language. *Journal of Early Intervention, 22*, 126-136. doi: 10.1177/105381519902200205

Figure captions.

Figure 1. Flowchart of the study participants. MBCDI = MacArthur-Bates Communicative Development Inventories; PPVT = Peabody Picture Vocabulary Test.
[1] The numbers of participants in the present study are given in parentheses.
[2] The *n* for PPVT was 111.
[3] Risk in language, attention or hyperactivity based on FTF 90th percentile cut-off.

Figure 2. Latent growth curve model for early communication skills. Standardized estimates are presented. The first time points of the slope factors are fixed to 0 and, along with nonsignificant paths, are omitted from the figure. Lev = level; Slo = slope (growth); Soc = social composite; Spe = speech composite; Sym = symbolic composite; Sf = specific factor. Numbers after soc, spe, sym, and sf represent age in months.


Age 6-24 months, *N* = 508 (Present study used data from measurements at 6-18 months, *n* = 427)[1]
Parent questionnaire: Infant-Toddler Checklist
6 months *n* = 229
9 months *n* = 203
12 months *n* = 322
15 months *n* = 305
18 months *n* = 279
21 months *n* = 273
24 months *n* = 330
Subsample invited for follow-up, *n* = 143
No risk, *n* = 78
Risk, *n* = 65
Age 2 years, *n* = 104 (104)[1],
response rate 72.7 %
(20.5 % of the original data)
Parent questionnaire: MBCDI
No risk *n* = 60
Risk *n* = 44
Age 3 years, *n* = 112 (112)[1],
response rate 78.3 %
(22.0 % of the original data)
Individual assessment:
Boston naming, PPVT[2]
No risk, *n* = 56
n = 39
n = 17
Risk, *n* = 56
n = 37
n = 19
Age 4 years 7 months, *n* = 296 (253)[1]
All families contacted, *n* = 473 (93.1 %) reached
response rate 62.6%
(58.3 % of the original data)
Parent questionnaire: FTF
n = 52
n = 45
n = 199 (156)[1]
Age 5 years 3 months, *n* = 102 (102)[1]
Subsample, *n* = 102 invited
(20.1 % of the original data)
Individual assessment:
language, working memory
n = 12
n = 18
n = 8
n = 1
n = 19
n = 12
n = 32[3]
First grade (mean age 7;9), *n* = 273 (236)[1]
All families contacted, *n* = 453 (89.2 %) reached
response rate 60.3 %
(53.7 % of the original data)
Parent questionnaire: CCC-II
n = 47
n = 41
n = 30
n = 89 (89)[1]
n = 66 (29)[1]

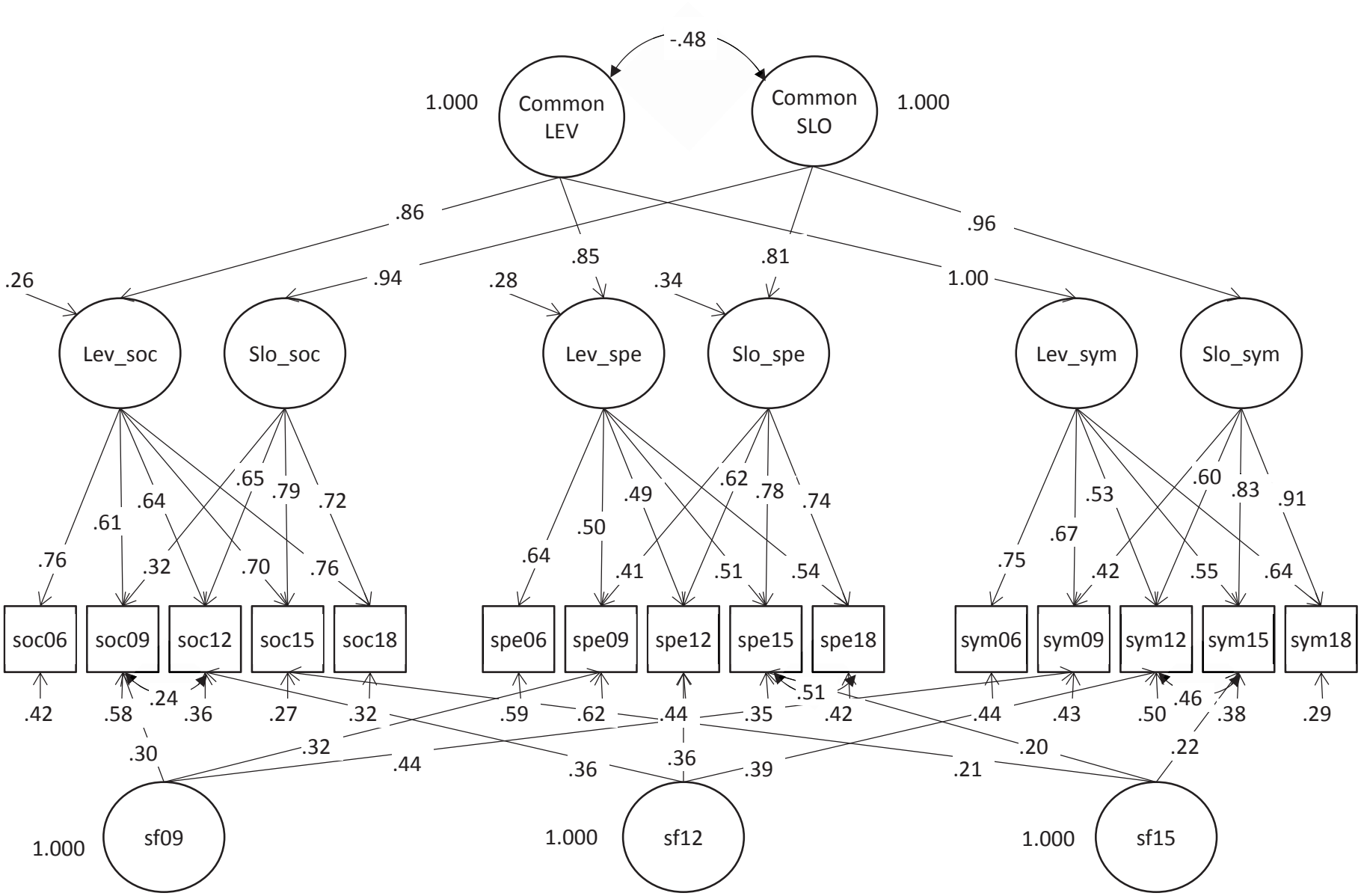

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Table 1.

Communication and Language Measures Used in the Study in Each Age Stage

Age	*n*	Source	Measure	Components	Scoring
6, 9, 12, 15, 18, 21, and 24 months	203-322	Parent report	Communication and Symbolic Behavior Scales – Infant Toddler Checklist (ITC)	Social	Sum of 13 ordinal items on the ITC measure (max. 26)
				Speech	Sum of five ordinal items on the ITC measure (max. 14)
				Symbolic	Sum of six ordinal items on the ITC measure (max. 17)
2 years	104	Parent report	MacArthur-Bates Communicative Development Inventories – Words and Sentences Inventory	Vocabulary	Number of words from a pre-specified list of 595 that the child says
				Inflections	Sum of noun and verb inflections the child uses (max. 16)
				Maximum sentence length	Average morpheme length of three sentences
3 years	112	Individual assessment	Boston naming	Expressive vocabulary	Sum of 60 binary items
			Peabody Picture Vocabulary Test	Receptive vocabulary	Sum of 166 binary items
4;7	253	Parent report	Five to Fifteen (FTF) – Language subscales	Comprehension	Mean of five ordinal items on the FTF measure
				Expressive	Mean of 13 ordinal items on the FTF measure
				Communication	Mean of three ordinal items on the FTF measure
5;3	98-102	Individual assessment	WPPSI-R – Similarities	Verbal reasoning	Sum of 12 binary and eight ordinal items (max. 28)
			Peabody Picture Vocabulary Test-Revised	Receptive vocabulary	Sum of 30 binary items
			Korpilahti Auditory Sentence Comprehension Test	Receptive grammar	Sum of 30 binary items
			NEPSY-II – Verbal Fluency	Verbal productivity	Sum of semantically correct words produced in 60 seconds
			WISC-III – Digit Span	Working memory	Sum of 12 (forward) and 10 (backward) binary items
			NEPSY – Repetition of Nonsense Words	Working memory	Sum of 16 binary items
			NEPSY-II – Sentence Repetition	Working memory	Sum of 17 ordinal items (max. 34)
1st grade	236	Parent report	Children's Communication Checklist - II	Language: Speech, Syntax, Semantics, Coherence	Four subscales, sum of seven ordinal items (5 addressing deficits, 2 strengths) in each scale (max. 112)
				Communication: Inappropriate initiation, Stereotyped language, Use of context, Non-verbal communication	Four subscales, sum of seven ordinal items (5 addressing deficits, 2 strengths) in each scale (max. 112)

Note. WPPSI-R = Wechsler Preschool and Primary Scale of Intelligence –Revised*;* NEPSY(-II) = A Developmental Neuropsychological Assessment (- Second edition); WISC-III = Wechsler Intelligence Scale for Children – Third edition.

Table 2

Means and Standard Deviations of the Early Communication and Follow-Up Measures

Early communication measures	Max.	**6 mo.** *n* = 229 *M (SD)*	**9 mo.** *n* = 203 *M (SD)*	**12 mo.** *n* = 322 *M (SD)*	**15 mo.** *n* = 305 *M (SD)*	**18mo.** *n* = 279 *M (SD)*
ITC Social	26	9.99 (2.78)	14.30 (3.63)	19.61 (3.42)	21.73 (3.01)	23.06 (2.59)
Speech	14	3.03 (1.75)	5.83 (2.30)	7.64 (2.34)	9.49 (2.26)	11.17 (2.12)
Symbolic	17	3.72 (1.60)	6.32 (1.81)	9.60 (2.31)	12.88 (2.16)	14.94 (1.79)
Follow-up measures		**2 y.**	**3 y.**	**4;7 y.**	**5;3 y.**	**1st grade**
	Max.	*n* = 104 *M (SD)*	*n* = 111-112 *M (SD)*	*n* = 253 *M (SD)*	*n* = 98-102 *M (SD)*	*n* = 236 *M (SD)*
MBCDI Vocabulary	595	325.10 (154.10)				
Inflections	16	10.36 (4.90)				
MSL		7.0 (3.62)				
Boston naming	60		14.88 (5.30)			
PPVT	166		23.87 (12.15)			
FTF[a] Comprehension	2			0.23 (0.29)		
Expressive	2			0.21 (0.28)		
Communication	2			0.26 (0.39)		
SI	28				16.42 (4.04)	
PPVT-R	30				16.67 (3.63)	
SC	30				21.25 (4.17)	
VF					15.56 (6.08)	
DS	22				6.55 (2.41)	
NWR	16				9.53 (2.72)	
SR	34				21.25 (4.68)	
CCC-II[a] Language	112					5.07 (8.50)
Communication	112					7.75 (9.06)

Note. All means are calculated from nonstandardized sum scores with the exception of the FTF subscales that are calculated from scale means due to missing items (nine subjects, maximum of three missing values). ITC = Infant-Toddler Checklist; MBCDI = MacArthur-Bates Communicative Development Inventories; MSL = Maximum Sentence Length; PPVT = Peabody Picture Vocabulary Test; FTF = Five to Fifteen; SI = Similarities; SC = Sentence Comprehension; VF = Verbal Fluency; DS = Digit span; NWR = Nonword Repetition; SR = Sentence Repetition; CCC-II = Children's Communication Checklist –Second Edition.

[a] = higher value represents more difficulties

Table 3.

Summary of the Regression Analyses Predicting Later Language Ability from Early Communication Development

Follow-up measure	Age (y)	*n*	Common			Specific associations[a]								
						Social		Speech		Symbolic		Age specific		
			Level	Growth		Level	Growth	Level	Growth	Level	Growth	Sf 09	Sf 12	Sf 15
			β		R^2 %	β		β		β		β		
MBCDI Vocabulary	2	104	0.32*	0.64***	32.4									0.29
Inflections	2	104	0.12	0.69***	41.1		-0.28	0.22						-0.26
MSL	2	104	0.17	0.74***	46.7									
Boston naming	3	112	0.17	0.58***	27.6				0.24					
PPVT	3	111	0.29*	0.33***	10.5									
FTF Comprehension	4;7	253	-0.28**	-0.43***	15.0									
Expressive	4;7	253	-0.26*	-0.50***	19.8		0.28		-0.23					
Communication	4;7	253	-0.32**	-0.51***	20.9									
Language (SI, PPVT, SC, VF)	5;3	102	0.24	0.65***	33.0									
Memory (DSf, DSb, NWR, SR)	5;3	102	0.03	0.74***	53.3		-0.50	0.47	0.45					-0.47
CCC-II Language	1st gr	236	-0.31*	-0.78**	48.2			-0.24	-0.20					0.23
Communication	1st gr	236	-0.24*	-0.70***	38.9			0.24	0.21					-0.17

Note. MBCDI = MacArthur-Bates Communicative Development Inventories; MSL = Maximum Sentence Length; PPVT = Peabody Picture Vocabulary Test; FTF = Five to Fifteen; SI = Similarities; SC = Sentence Comprehension; VF = Verbal Fluency; DS = Digit Span; NWR = Nonword Repetition; SR = Sentence Repetition; CB = Corsi Block task; CCC-II = Children's Communication Checklist – Second Edition; Sf = Specific factor (and age in months).

a. Each specific pathway was tested separately. The significance level was set to p<. 001.

*<.05. **<.01. ***.001.

Supplemental material description

Supplemental material includes a more detailed description of the study participants, measures, data, and analysis methods.

Continuity from prelinguistic communication to later language ability: a follow-up study from infancy to school age

Appendix S1

Method

Participants and procedure

The original sample of 508 children was recruited through community-based child health care clinics in the city of Jyväskylä, Central Finland. Child health care clinics provide free services for all families with children between ages 0 to 6. The services are focused on health promotion, risk assessment, and disease prevention. Visits are made to the clinic 10 to 15 times during the first two years of life, and thereafter annually or at 18 month intervals. The clinics are regularly attended by over 95 % of Finnish parents and their children (for a more detailed description of pre- and postnatal care for families, see Callister, Lauri, & Vehviläinen-Julkunen, 2000). All the clinics in the area (population base close to 100,000, and age cohort of about 900 at the time) volunteered to participate in the study. The Infant-Toddler Checklist (ITC, part of the Communication and Symbolic Behavior Scales – Developmental Profile, Wetherby & Prizant, 2002) was introduced to the families by the nurses at the clinics. Children were eligible for participation if aged between 6 and 24 months at time of recruitment.

After giving their consent and completing the first ITC questionnaire, parents were asked to fill in a new questionnaire every three months until the child was 24 months of age (i.e., a maximum of seven times; at ages 6, 9, 12, 15, 18, 21, and 24 months). The sample sizes for the measurement points were n = 229 at 6 months, n = 203 at 9 months, n = 322 at 12 months, n = 305 at 15 months, n = 279 at 18 months, n = 273 at 21 months, and n = 330 at 24 months of age. For the majority of the sample (67.9%), data were available from at least three measurement points. The total number of

forms filled in by parents depended on their child's age at the time of completing the first questionnaire and on how many of the subsequent questionnaires they completed. In the present study, the data from the measurements conducted between 6 and 18 months were used, yielding a total sample of 427 children.

After the early questionnaire data collection phase, subgroups of the original 508 participants were followed at ages 2 and 3 years (parent report and individual assessments), 4;7 (parent report), and 5;3 (individual assessment), and in the spring term of the first grade (age range 7;5 – 8;4, parent report). During the follow-ups at 2, 3, and 5;3, only a small subset of families were contacted due to time and resource limitations. Thus, the subgroups were constructed to include a sufficient number of children showing possible risks for language and communication development. This form of data collection enables also comparison of at-risk and typically developing children. At ages 4;7 and first grade, all the originally participating families were contacted. The group differences in the early ITC scores are summarized in table SM1. .

Demographic information by subsamples is presented in Table SM2. The Finnish population of 5.4 million is relatively homogeneous in ethnicity, culture, religion, and language. All the participating children were Caucasian and spoke Finnish as their native language. Data related to birth and family were collected at the initial recruitment stage (data available for 472 - 485 children). Fourteen children (2.9 %) had been born preterm (i.e., gestational age less than 36 weeks). Sample mean birth weight was 3.5 kg (*SD* = 0.6, range 1.1 -5.4). Slightly over half (*n* = 267, 56.6 %) the children were firstborns. At time of recruitment, 19 (3.9 %) families reported single parenthood. This is a markedly lower percentage than in the general population (= 14% of families with children aged 0-7 years during 2003, when the initial data were collected; Statistics Finland, 2013). However, the percentage of single parent families can be expected to be lower among the families of young infants.

Parental education was classified using a seven-point scale ranging from a basic level, 0 (*no*

vocational education), to advanced educational training, 6 (*higher-level university degree*). The sample was fairly representative of the Finnish population (Statistics Finland, 2013). The distribution of family educational level in the sample was as follows: 7% of mothers and 6% of fathers (general population 6%) had no vocational education, 58% of mothers and 66% of fathers (general population 64%) had at least some vocational degree, and 35% of mothers and 29% of fathers (general population 29%) had a master's or higher university degree. Finnish families are typically dual-earner families with both parents working full time (Salmi & Lammi-Taskula, 2014). State-funded parental leave lasts up to 10 months of age, after which child home-care allowances are provided for the first 1 to 3 years. Around 40% of mothers with children under the age of three years and 80% of mothers of children aged between 3 to 6 years work outside the home (Salmi & Lammi-Taskula, 2014). Child care is provided in day care centers or in family day care, the former of which is more commonly used (84% vs. 16%; Kekkonen, 2014). Rates of day care attendance vary according to the child's age. Around 30% of one-year-olds, 50% of two-year-olds, 70% of three-year-olds, 75% of four-year-olds, and 80% of five-year-olds are in day care. Family day care is more common in the youngest age groups. Children have a right to attend pre-school education the year before their compulsory education starts (the year they turn 6). Pre-school education is provided in day care centers and primary schools. The majority (98%) of children attend pre-school education (Statistics Finland, 2013). Compulsory schooling starts in the year of the child's seventh birthday.

There were small but significant differences in demographics between the children who had data from the last two follow-ups at age 5;3 and first grade (*n* range 100-102 and 230-234) and those who did not (*n* range 373-394 and 241-263): The participants in the last two follow-ups had slightly older and more educated mothers (mother's age: 30.9 vs. 29.6 at 5;3, $p = .031$, $\eta_p^2 = .009$; 30.4 vs. 29.4 in first grade, $p = .039$, $\eta_p^2 = .009$; mother's education: 4.1 vs. 3.7 at 5;3, $p = .050$, $\eta_p^2 = .008$; 4.1 vs. 3.6 in first grade, $p = .002$, $\eta_p^2 = .020$). However, only maternal education in the sample at first

grade remained significantly different after correcting for multiple comparisons (Bonferroni correction, nine comparisons). These results are in line with previous observations reported by longitudinal studies of language that attrition tends to be lower among children with older and more educated mothers (e.g., Henrichs et al., 2011; Reilly et al., 2010). No other significant differences between the subsamples were found.

By the end of the study, two children (information was available for 338 children) had received a diagnosis of language impairment and three children were reported as having broader developmental difficulties. In addition, based on parent report, health care providers had observed indications of delayed language development in 17 children (5.0 %). Parents reported the use of speech and language therapy services for language-related difficulties (excluding articulation and stuttering problems) for 11 (3.3 %) children. The discrepancy between the number of children with diagnosed language impairment and those attending speech and language therapy services is probably due to the service structure in Finland. Children do not need a formal diagnosis to be eligible for specialist services. Families are referred to these services if any concerns arise during their annual check-ups at their local child health care clinics. Very often, the first step is to see whether a more intensive follow-up together with family guidance or a few visits to a speech and language therapist is enough before referring the child for further assessments and formal diagnostic procedures.

Measures

Early communication measure. Early communication skills were assessed using the Finnish version of the ITC of the CSBS-DP (Laakso, Poikkeus, & Eklund, 2011; Wetherby & Prizant, 2002). The ITC is a parent-report screening tool that consists of 24 questions designed to measure relevant prelinguistic milestones of early communication and language development in children aged 6 to 24 months. The questions are organized into three composites and cover several areas of development, such as emotion and use of eye gaze, communication, and gestures (social composite, 13 questions);

sounds and words (speech composite, five questions); and understanding and object use (symbolic composite, six questions). The ratings are either on a three-point scale (0 = not yet, 1 = sometimes, 2 = often) or on scales that describe a series of numbers or ranges affording 0 to 4 points (e.g., 0 = none, 1 = 1-3, 2 = 4-10, 3 = 11-30, 4 = over 30). The Cronbach's αs over the age span of 6 to 18 months ranged from .80 to 89, and by age (6, 9, 12, 15, and 18 months; *n*s = 191-320) from .68 to .73 for the social composite, from .47 to .63 for the speech composite, and from .38 to .58 for the symbolic composite. The variations in the alpha values by age are probably due to the fact that the questions for each age are the same, meaning that some of the questions might behave differently at different age stages (such as the number of words spoken or understood).

Measures at 2 years of age. Children's expressive vocabulary was assessed with the Finnish version of the MacArthur-Bates Communicative Development Inventories Words and Sentences (Fenson et al., 1994; Lyytinen, 1999). The checklist contains four subscales that measure vocabulary, use of language, noun and verb inflections, and word combinations in children aged 16 to 30 months. Three of these subscales were used in this study. In the vocabulary scale, the parent indicates which of the predefined 595 words they have heard their child produce spontaneously. The words include nouns, verbs and adjectives that are commonly used by children of this age. A total number of words is calculated for each child. In the inflections scale, the parent indicates which of the 16 inflections (e.g., plural, verb tenses) are present in the child's spontaneous speech. The sum of the noun and verb inflections that the child uses is calculated for each child. In the third section, the parent writes verbatim the three longest sentences they have heard their child produce. Average sentence length, measured as morphemes, is calculated based on these three sentences.

Measures at 3 years of age. The children's single-word receptive vocabulary was assessed with the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981). The PPVT consists of 166 words accompanied by black-and-white line drawings. The child hears a word and

selects the picture that corresponds to the word from an array of four pictures. Total score of correct answers was used in the analyses.

Boston naming (Kaplan, Goodglass, & Weintraub, 1983) was used as a measure of single-word expressive vocabulary. The task consists of 60 pictures that the child has to name. If the child does not produce a word for the picture, he/she is prompted with a semantic cue. If the child fails to produce the word, a phonological cue is given (e.g., the first two sounds of the word). The total number of correct productions is calculated from the words the child produces either spontaneously or with the semantic cue.

Measures at 4;7. Language and communication related concerns were assessed with the Five to Fifteen questionnaire (FTF; Kadesjö et al. 2004). The FTF is a parent questionnaire developed for the elicitation of symptoms and problems typical of ADHD and its comorbidities. The FTF comprises 181 statements related to behavioral or developmental problems. The language domain of the questionnaire consists of 21 questions divided into three subscales. The comprehension subscale (five questions) measures difficulties in understanding words, explanations and stories. The expressive subscale (13 questions) measures difficulties in fluency, word retrieval and complexity of speech. The communication subscale (three questions) measures difficulties in social communication and narration. Ratings are made on a three-point scale (0 = does not apply, 1 = applies sometimes or to some extent, 2 = definitely applies). Due to missing values for some items, the means of the subscales were used in the analyses. The Finnish validation of the FTF for 5-year-olds (n = 769) reported the reliability of the whole language domain to be .89 (Korkman, Jaakkola, Ahlroth, Pesonen, & Turunen, 2004). Cronbach's αs of .84 for comprehension, .84 for expressive, and .75 for communication have been reported (Kadesjö et al., 2004). In the present data the corresponding values were .66, .87, and .71, respectively.

Language measures at 5;3. The language measures were selected to cover various areas of

language ability in both the expressive and receptive domains, as suggested by Conti-Ramsden and Durking (2012).

The Similarities (SI) subtest of the Wechsler Preschool and Primary Scale of Intelligence – Revised (Wechsler, 1995) was used to assess verbal abstract reasoning and conceptualization abilities. The test comprises three parts: In the first part, the child sees a stimulus picture and is asked to select a compatible picture from an array of four pictures (six items); in the second part, the child completes a sentence with an appropriate word (six items); and in the third part the child describes how two things are alike (eight items).

A 30-item shortened version of the PPVT-R (Dunn & Dunn, 1981) was used to assess the child's single-word receptive vocabulary. The items were selected on the basis of data drawn from another Finnish study, the Jyväskylä Longitudinal Study of Dyslexia (see Lyytinen et al., 2004; Lyytinen, Erskine, Tolvanen, Torppa, Poikkeus, & Lyytinen, 2006) where the full-scale version of the PPVT-R was administered to the control group.

The Korpilahti Auditory Sentence Comprehension test (SC; Korpilahti 1996) was used as a test for receptive grammar. The test assesses the ability to process semantic and syntactic information in sentences. The test comprises 30 sentences that increase in complexity and make increasing demands on verbal reasoning and auditory short-term memory. After each sentence the child is presented with three pictures and asked to choose the one that goes best with the sentence.

The Verbal Fluency, Semantic categories test (VFS; NEPSY-II; Korkman, Kirk, & Kemp, 2008) assesses verbal productivity and vocabulary. The child is asked to generate as many words as possible within specific semantic categories (animals, foods) in 60 s.

Working memory measures at 5;3. The working memory measures were selected to cover the relevant subsystems of Baddeley's (2003; 2012) model of working memory, following the conceptualizations of Archibald & Gathercole (2006) and Petruccelli, Bavin, & Bretherton (2012).

The Digit Span subtest of the Wechsler Intelligence Scale for Children – Third Edition (WISC-III; Wechsler, 1999) comprises two parts: In the first part, the child repeats a dictated series of digits verbatim (forward part), and in the second part the child repeats the series backwards (backward part). The series begin with two digits and increases in length with two trials at each length. As the forward part is regarded as tapping the phonological loop and the backward part as tapping both the phonological loop and the central executive (e.g., Vance, 2008), the two parts were treated as separate measures in the analyses.

Nonword repetition (NWR) ability was assessed with the Repetition of Nonsense Words test (NEPSY; Korkman, Kirk, & Kemp, 1997). In this test, the child imitates 16 nonwords that increase in length from one ("nas") to six ("skrikoflunaflistrop") syllables. The nonwords conform to the phonotactic rules of Finnish but are low in word likeness and phonotactic frequency. The test is regarded as tapping the phonological loop along with other language-related processes such as speech perception, phonological encoding and assembly, and articulation (Coady & Evans, 2008).

In the Sentence Repetition task (SR; NEPSY-II; Korkman et al., 2008), the child is read 17 sentences that increase in complexity and length, and asked to recall each sentence verbatim immediately after it is presented. The task requires the integration of information from phonological short-term memory with long-term linguistic knowledge, and thus is regarded as being a measure of the episodic buffer, which is responsible for storing chunks of such integrated information (Baddeley, 2000; Boyle, Lindell, & Kidd, 2013).

Measures in the first grade. The children's language and communication difficulties were assessed with the Finnish version of the Children's Communication Checklist – Second Edition (CCC-2; Bishop, 2003; Norbury, Nash, Baird, & Bishop, 2004). The CCC-2 is a parent questionnaire used to screen for general language impairments and pragmatic language impairment in children aged 4 to 16 years. The questionnaire includes four subscales that measure language abilities (speech,

syntax, semantics, and coherence) and four areas of pragmatics (inappropriate initiations, stereotyped language, use of context, and nonverbal communication). The two additional subscales (social relations and interests) were omitted in this study. Each scale comprises 5 questions on difficulties, and 2 questions on strengths (reversed scale). Parents rate the frequency of their child's language and communication behaviors on a four-point scale (0 = less than once a week, 1 = at least once a week, not every day, 2 = once or twice a day, 3 = several times a day/always). The Cronbach's αs for the separate subscales have been reported to be above .66 (Bishop, 2003). The αs in the current sample ranged between .57-.87 for the separate subscales and the αs for the combined language scales and combined pragmatics scales were .91 and .92 respectively.

Data analyses

The development of early communication skills was analyzed using a type of second-order multivariate Latent Growth Curve modeling called the factor-of-curves model (Duncan, Duncan, & Strycker, 2006, pp. 68-70; McArdle, 1988). Multivariate LGM is used to determine if development on one behavior covaries with development in other behaviors and it provides a "more dynamic view of the correlates of change, as development in one variable can be associated with development in another variable" (Duncan et al., 2006, p.63). In the factor-of-curves model it is examined whether a second-order factor adequately describes the covariances among lower order developmental functions (Duncan et al., 2006, p.68).

The analyses were performed using the Mplus statistical package (version 7; Muthén & Muthén, 1998-2010). The estimation method was the robust MLR which corresponds to the full-information maximum likelihood (FIML). In FIML there does not need to be the same number of items, observations, or variables for every individual as the log-likelihoods are written for each individual based on the individual's observed data (e.g. see Enders, 2010, pp. 88-92; Graham & Coffman, 2012, p. 282). The use of FIML over other methods such as listwise deletion is

recommended as FIML preserves key relationships among variables and better estimates the variability in the data yielding more valid results (see, Jeličić, Phelps, & Lerner, 2009). Thus, despite having different amount of data at different age stages, all available data between the ages 6 to 18 months was used (n = 203-322 at different ages, n = 427 in total) as it leads to improved accuracy of parameter estimates (Enders, 2010, p.92). The coverage of the elements in the covariance matrix is presented in Table SM4.

The goodness-of-fit of the estimated LGC models was evaluated using several fit indexes (χ^2 test, the Comparative Fit Index, the Tucker-Lewin Index, the Root Mean Square Error of Approximation, and Standardized Root Mean Square Error of Approximation; Hu & Bentler, 1999; Muthén & Muthén, 1998-2010). Specifications to the model were done based on the model modification indices and theoretical considerations. Modification indices above 4 were taken into account and each of them was considered from a theoretical standpoint. Only those indices that were deemed appropriate both statistically and theoretically were added to the model.

All analyses were conducted with raw data. As the follow-up subsamples were only partially overlapping, the regression analyses were conducted separately for each follow-up.

Results

A latent growth curve (LGC) model for early communication development

All correlations between the three ITC composites at different age stages are shown in Table SM3. All the successive measurements within the ITC composites correlated significantly with each other, as was expected due to the sequential nature of the data, and thus, were allowed to correlate with each other within the composites in the LGC model.

A LGC model for each of the three ITC composites (social, speech, symbolic) was estimated simultaneously. Based on visual inspection of the individual growth curves and the model modification indices, nonlinear growth was estimated. In the model specifications all loadings on first

order intercepts were fixed (at 1), while in the loadings of the first-order slopes, the first and last time points were fixed (at 0, and at 4), and age 9, 12, and 15 month loadings were estimated freely (*1, *2, *3). The modeling of unspecified trajectories using a two-factor model (only intercept and slope instead of a specified model) was chosen as the unspecified model might be able to provide better model fit and is somewhat easier to interpret. That is, the fitting of a quadratic and a cubic slope factor (i.e., a specified model), would lead to 9 and 12 first-order factors, respectively, which would lead to an unnecessarily complex model that would be more difficult to interpret and might lead to convergence problems. In addition, it has been suggested that unless there are solid theoretical justifications for another model, using unspecified model is recommended (see a simulation study by Welch, 2007). In this type of modeling, instead of a predefined shape of growth (i.e., adding a quadratic or cubic factor), the data is allowed to determine the shape of growth (Duncan et al., 2006, pp.31-35).

The correlations between the first-order level factors and between the first-order growth factors were significant (r =.57-.81, p <.001 between the social, speech, and symbolic level factors, and r = .48 - .67; p <.001 - .010 between the social, speech, and symbolic growth factors). Thus, a second-order factor structure (common level and common slope) was added to the model to describe these relationships between the composite-specific first-order factors (i.e., explain the covariances among the first-order factors; Duncan et al., 2006, pp. 68-69). The symbolic composite was used as the reference scaling for the second order structure (fixed at 1; Duncan et al., 2006, p. 69; McArdle, 1988) and the other factor loadings were estimated freely.

The residual correlations were strong between the different measures at the same time point (i.e., social, speech, and symbolic at age 9 month, age 12 months, and age 15 months) indicating that there is some age-specificity in development at these ages that is not captured by the first- and second-order factors. Thus, specific age factors were added to explain this between-individual variation that is

specific to the time points measured and not related to development over the measured time period. These specific factors were not allowed to correlate with each other or with the first- and second-order factors. The model fitted the data well: $\chi^2(73) = 87.405$, $p = .120$, CFI =.991 , TLI =.987, RMSEA = .021 and SRMR =.083.

Figure 2 depicts the LGC model and reports the standardized estimates. These estimates should be interpreted to depict effect sizes. In line with the observed means across the 6 to 18 month period (reported in Table 2), the LGC model showed growth throughout the measured time period in all three ITC composites, which was indicated by increases in the model produced mean values over time. The correspondence between the observed and the model estimated mean values was good. The first-order loadings on growth factors represent the individual differences present at a certain time point. Thus, a higher standardized loading for example at age 15 months compared to the loading at age 18 months in social and speech composites (see Figure 2) indicate that the largest individual differences are present at this age.

Early communication development and later language and communication skills

The model fit indices for the longitudinal models between the early LGC model and the follow-up measurements at ages 2, 3, 4;7, 5;3 and first grade are summarized in Table SM5.

The model modification indices suggested several skill- and age-specific pathways from the level of the speech composite, from the growth factor of the social and speech composites, and from the age-specific factor at 15 months of age. More specifically, the suggested pathways included: from the growth factor of the social composite to MCDI inflections at 24 months ($p = .040$), FTF expressive language at 55 months ($p = .217$), and the memory factor at 63 months ($p = .274$); from the level of the speech composite to MCDI inflections at 24 months ($p = .136$), the memory factor at 63 months ($p = .019$), and the first-grade language ($p = .034$) and communication ($p = .024$) factors; and from the growth factor of the speech composite to expressive vocabulary at 36 months ($p = .050$), FTF

expressive language at 55 months (p = .063), the memory factor at 63 months (p = .002), and the first-grade language (p = .007) and communication (p = .023) factors. Age-specific paths were suggested from the specific age factor at 15 months to MCDI vocabulary (p = .012) and inflections (p = .024) at 24 months, the memory factor at 63 months (p = .090), and the first-grade language (p = .007) and communication (p = .011) factors. None of these paths were significant at the .001 level, and thus no specific paths were added to the regression models.

References

Archibald, L.M.D. & Gathercole, S.E. (2006). Short-term and working memory in specific language impairment. *International Journal of Language and Communication Disorders, 41*, 675-693. doi: 10.1080/13682820500442602

Baddeley, A. (2000). The episodic buffer: a new component of working memory? Trends in Cognitive Sciences, 4, 417-423. doi: 10.1016/S1364-6613(00)01538-2

Baddeley, A. (2003). Working memory and language: an overview. *Journal of Communication Disorders, 36,* 189-208. doi: 10.1016/S0021-9924(03)00019-4

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63,* 1-29. doi: 10.1146/annurev-psych-120710-100422

Bishop, D. V. M. (2003). *The Children's Communication Checklist* (Vol 2). London: Harcourt Assessment.

Boyle, W., Lindell, A.K., & Kidd, E. Investigating the role of verbal working memory in young children's sentence comprehension. Language Learning, 63, 211-242. doi: 10.1111/lang.12003

Callister, L.C., Lauri, S., & Vehviläinen-Julkunen, K. (2000). A description of birth in Finland. *The American Journal of Maternal/Child Nursing, 25,* 146-150.

Coady, J.A. & Evans, J.L. (2008). Uses and interpretations of non-word repetition tasks in children with and without specific language impairments (SLI). *International Journal of Language & Communication Disorders, 43*, 1-40. doi: 10.1080/13682820601116485

Conti-Ramsden, G. & Durkin, K. (2012). Language development and assessment in the preschool period. *Neuropsychology Review, 22,* 384-401. doi: 10.1007/s11065-012-9208-z

Duncan, T. E., Duncan, S. C., & Strycker L. A. (2006). An introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications. (2nd ed.) Mahwah, NJ: Lawrence Erlbaum Associates.

Dunn, L.M & Dunn, L.M. (1981). *Peabody Picture Vocabulary Test – Revised*. Cirle Pines. MN: American Guidance Service.

Enders, C. K. (2010). *Applied missing data analysis*. New York: Guilford Publications.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. & Pethick, S. (1994). *Variability in early communicative development*. *Monographs of the Society for Research in Child De6elopment*, 59, 5 (Serial No. 242).

Graham, J. W. & Coffman, D. L. (2012). Structural equation modeling with missing data. In R. H. Hoyle (Ed.), Handbook of Structural Equation Modeling (pp. 277-295). New York: Guilford Press.

Henrichs, J., Rescorla, L., Schenk, J.J., Schimdt, H.G., Jaddoe, V.W.V., Hofman, A., … Tiemeierc, H. (2011). Examining continuity of early expressive vocabulary development: The Generation R study. Journal of Speech, Language, and Hearing Research, 54, 854-869. doi: 10.1044/1092-4388(2010/09-0255)

Hu, L. & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55. doi: 10.1080/10705519909540118

Jeličić, H., Phelps, E., & Lerner, R. M. (2009). Use of missing data methods in longitudinal studies: The persistence of bad practices in developmental psychology. Developmental Psychology, 45, 1195-1199. doi: 10.1037/a0015665

Kadesjö, B., Janols, L.-O., Korkman, M., Mickelsson, K., Strand, G., Trillingsgaard, A., & Gillberg, C. (2004). The FTF (Five to Fifteen): The development of a parent questionnaire for the assessment of ADHD and comorbid conditions. *European Child and Adolescent Psychiatry, 13 (Suppl. 3)*, 3–13. doi:10.1007/s00787-004-3002-2

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test.* Philadelphia: Lea & Febiger

Kekkonen, M. (2014). Perheiden lastenhoitojärjestelyt ja tyytyväisyys päivähoitopalveluihin. [The day care arrangements of families and their contentment with the services]. In J. Lammi-Taskula & S. Karvonen (eds). Lapsiperheiden hyvinvointi 2014. [The well-being of families with children in 2014]. National Institute of Health and Welfare. Tampere: Suomen Yliopistopaino Oy.

Korkman, M., Jaakkola, M., Ahlroth, A., Pesonen, A.-E., & Turunen, M.-M. (2004). Screening of developmental disorders in five-year-olds using the FTF (Five to Fifteen) questionnaire: A validation study. European Child and Adolescent Psychiatry, 13(Suppl. 3), 31–38. doi:10.1007/s00787-004-3005-z

Korkman, M., Kirk, U., & Kemp, S.L. (1997). *Lasten neuropsykologinen tutkimus (NEPSY: A Developmental Neuropsychological Assessment.*). Helsinki, Finland: Psykologien kustannus Oy.

Korkman, M., Kirk, U., & Kemp, S. L. (2008). *NEPSY-II: Lasten neuropsykologinen tutkimus (NEPSY-II: A Developmental Neuropsychological Assessment, Second edition).* Helsinki, Finland: Psykologien kustannus Oy.

Korpilahti, P. (1996). *Lausetesti; Test for the language comprehension of sentences.* Helsinki: University Press.

Laakso, M.-L., Poikkeus, A.-M., & Eklund, K. (2011). *Lapsen esikielellisen kommunikaation ja kielen ensikartoitus* [The Infant-Toddler Checklist of Children's Prelinguistic Communication and Language]. Jyväskylä, Finland: Niilo Mäki Instituutti.

Lyytinen, H., Ahonen, T., Eklund, K., Guttorm, T., Kulju, P., Laakso, M-L., … Viholainen, H. (2004). Early Development of children at familial risk for dyslexia – Follow-up from birth to school age. *Dyslexia, 10*, 146-178. doi: 10.1002/dys.274

Lyytinen, H. Erskine, J., Tolvanen, A., Torppa, M., Poikkeus, A-M.,, & Lyytinen, P. (2006). Trajectories of reading development: a follow-up from birth to school age of children with and without risk for dyslexia. *Merrill-Palmer Quarterly, 52*, 514-546. doi: 10.1353/mpq.2006.0031

Lyytinen, P. (1999). *Varhaisen kommunikaation ja kielen kehityksen arviointimenetelmä (Finnish Manual for Communicative Development Inventories)*. Jyväskylän yliopiston lapsitutkimuskeskus ja Niilo Mäki Instituutti. Jyväskylä: Yliopistopaino

McArdle, J. J. (1988). Dynamic but structural equation modeling of repeated measures data. In R.B. Cattell & J. Nesselroade (Eds.), Handbook of multivariate experimental psychology (2nd ed., pp. 561-614). New York: Plenum.

Muthén, L. K. and Muthén, B. O. (1998-2010). *Mplus User's Guide.* Sixth Edition. Los Angeles, CA: Muthén & Muthén

Norbury, C. F., Nash, M., Baird, G., & Bishop, D. V. M. (2004). Using a parental checklist to identify diagnostic groups in children with communication impairment: a validation of the Children's Communication Checklist – 2. *International Journal of Language and Communication Disorders, 39,* 345-364. doi: 10.1080/13682820410001654883

Petruccelli, N., Bavin, E.L., & Bretherton, L. (2012). Children with specific language impairment and resolved late talkers: Working memory profiles at 5 years. *Journal of Speech, Language, and Hearing Research, 55,* 1690-1703. doi: 10.1044/1092-4388(2012/11-0288)

Reilly, S., Wake, M., Ukoumunne, O. C., Bavin, E., Prior, M., Cini, E., … Bretherton, L. (2010). Predicting language outcomes at 4 years of age: Finding from Early Language in Victoria Study. *Pediatrics, 126*, e1530-e1537. doi: 10.1542/peds.2010-0254

Salmi, M. & Lammi-Taskula, J. (2014). Lapsiperheiden vanhemmat työelämässä. [Parents in the working life]. In J. Lammi-Taskula & S. Karvonen (eds). Lapsiperheiden hyvinvointi 2014. [The well-being of families with children in 2014]. National Institute of Health and Welfare, Tampere: Suomen Yliopistopaino Oy.

Statistics Finland (2013). Retrieved from Statistics Finland website: http://www.tilastokeskus.fi

Vance, M. (2008). Short-term memory in children with developmental language disorder. In C.F.

Norbury, J. B. Tomblin, & D. Bishop (Eds.), *Understanding Developmental Language Disorders: from theory to practice*, (pp. 23-38). East Sussex: Psychology Press.

Wechsler, D. (1995). *WPPSI-R Käsikirja (Wechsler Preschool and Primary Scale of Intelligence: Revised. Manual for the Finnish Adaptation*). Helsinki: Psykologien kustannus Oy.

Wechsler, D. (1999). *WISC-III Käsikirja (Manual for the Wechsler Intelligence Scale for Children–Third Edition. Manual for the Finnish Adaptation*). Helsinki: Psykologien kustannus Oy.

Welch, G. W. (2007). Model Fit and Interpretation of Non-Linear Latent Growth Curve Models. (Doctoral dissertation). Retrieved from http://d-scholarship.pitt.edu/8769/1/WelchGreg Dissertation_ 080707.pdf

Wetherby, A. M., & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile* (1st normed ed.). Baltimore, MD: Brookes.

Table SM1

Comparisons of the ITC scores at ages 12, 15, and 18 months of age between the children participating and not participating in the follow-ups

	ITC at age 12 months				ITC at age 15 months				ITC at age 18 months			
	n (data/ no data)	Soc	Spe F	Sym	n (data/ no data)	Soc	Spe F	Sym	n (data/ no data)	Soc	Spe F	Sym
2 years	99/223	*n.s.*	*n.s.*	*n.s.*	101/204	*n.s.*	17.6*	*n.s.*	98/181	*n.s.*	*n.s.*	*n.s.*
3 years	109/213	*n.s.*	*n.s.*	*n.s.*	108/197	12.3*	15.3*	*n.s.*	105/174	*n.s.*	12.9*	*n.s.*
4;7	206/116	*n.s.*	*n.s.*	*n.s.*	208/97	*n.s.*	*n.s.*	*n.s.*	191/88	*n.s.*	*n.s.*	*n.s.*
5;3	93/229	*n.s.*	*n.s.*	*n.s.*	97/208	*n.s.*	*n.s.*	*n.s.*	88/191	*n.s.*	*n.s.*	*n.s.*
1st grade	190/132	*n.s.*	*n.s.*	*n.s.*	193/112	*n.s.*	*n.s.*	*n.s.*	171/108	*n.s.*	*n.s.*	*n.s.*

Note. ITC = Infant-Toddler Checklist; Soc = Social composite; Spe = Speech composite; Sym = Symbolic composite.
*$p < .001$

Table SM2

Demographic Information for the Original Sample, the Sample in the Early LGC Model, and the Follow-Up Subsamples

	Original sample	Early LGC model	Follow-up 2 years	Follow-up 3 years	Follow up 4;7	Follow-up 5;3	Follow-up first grade
N	508	427	104	111	253	102	236
Males/females, %	50.2/49.8	50.8/49.2	54.8/45.2	56.8/43.2	51.4/48.6	52.0/48.0	51.7/48.3
Preterm birth (< 36 wk), *n* (%)	14 (2.9)	14 (3.4)	3 (2.9)	5 (4.5)	6 (2.4)	3 (2.9)	6 (2.6)
Birth weight, *M* (*SD*), kg	3.5 (0.6)	3.5 (0.6)	3.6 (0.6)	3.6 (0.6)	3.5 (0.5)	3.5 (0.6)	3.6 (0.5)
Birth order, first born, *n* (%)	267 (56.6)	216 (54.8)	49 (50.0)	51 (48.6)	134 (57.8)	50 (51.0)	115 (52.5)
Single parents[a], *n* (%)	19 (3.9)	15 (3.6)	2 (2)	3 (2.7)	7 (2.9)	0 (0)	5 (2.1)
Parent's education[a], *M* (*SD*)							
Mother	3.9 (2.0)	3.8 (1.9)	4.1 (1.8)	4.1 (1.9)	3.9 (1.9)	4.1 (2.0)	4.1 (1.9)[b]
Father	3.6 (2.0)	3.6 (1.8)	3.5 (1.8)	3.8 (1.7)	3.6 (1.9)	3.8 (1.8)	3.6 (1.8)
Parent's age[a] *M* (*SD*), y							
Mother	29.8 (5.4)	29.7 (5.4)	30.4 (5.1)	30.6 (5.2)	30.0 (5.3)	30.9 (5.2)	30.4 (5.2)
Father	32.1 (6.3)	32.0 (6.4)	32.5 (6.0)	32.7 (5.7)	32.3 (6.1)	32.5 (5.8)	32.4 (6.3)

Note. Coverage of the demographic data varied between 472-494 in the original sample, 394-416 in the early LGC model sample, 98-104 at 24 months, 105-111 at 36 months, 232-249 at 55 months, 98-102 at 63 months, and 219-235 in the first grade. The percentages are calculated from the available data. LGC = latent growth curve.

[a] At time of initial recruitment.

[b] Significantly different compared to the original sample ($p < .01$)

Table SM3.

Correlations between the ITC composites at different ages.

		Soc06	Soc09	Soc12	Soc15	Soc18	Spe06	Spe09	Spe12	Spe15	Spe18	Sym06	Sym09	Sym12	Sym15
Soc09	*r*	.471***													
	n	202													
Soc12	*r*	.386***	.560***												
	n	142	135												
Soc15	*r*	.302***	.477***	.619***											
	n	151	142	277											
Soc18	*r*	.278***	.404***	.594***	.721***										
	n	149	140	234	246										
Spe06	*r*	.304***	.236***	.182*	.070	.115									
	n	229	202	142	151	149									
Spe09	*r*	.225***	.281***	.162	.220**	.148	.340***								
	n	202	203	135	142	140	202								
Spe12	*r*	.220**	.406***	.439***	.342***	.403***	.257**	.484***							
	n	142	135	322	277	234	142	135							
Spe15	*r*	.099	.216**	.345***	.431***	.385***	.180*	.425***	.529***						
	n	151	142	276	304	246	151	142	276						
Spe18	*r*	.098	.203*	.330***	.380***	.384***	.132	.407***	.468***	.786***					
	n	149	140	234	246	279	149	140	234	246					
Sym06	*r*	.509***	.368***	.188*	.109	.099	.369***	.256***	.168*	.072	.086				
	n	229	202	142	151	149	229	202	142	151	149				
Sym09	*r*	.352***	.493***	.419***	.322***	.250**	.278***	.389***	.385***	.274***	.289***	.402***			
	n	202	203	135	142	140	202	203	135	142	140	202			
Sym12	*r*	.181*	.309***	.501***	.445***	.334***	.250**	.251**	.443***	.388***	.339***	.189*	.496***		
	n	142	135	322	277	234	142	135	322	276	234	142	135		
Sym15	*r*	.156	.287***	.466***	.530***	.386***	.149	.234**	.339***	.477***	.406***	.067	.457***	.666***	
	n	151	142	277	305	246	151	142	277	304	246	151	142	277	
Sym18	*r*	.157	.366***	.482***	.553***	.487***	.138	.284***	.363***	.429***	.465***	-.009	.331***	.501***	.683***
	n	149	140	234	246	279	149	140	234	246	279	149	140	234	246

Note. Soc = Social composite; Spe = Speech composite; Sym = Symbolic composite. Numbers after soc, spe, and sym represent age in months.

*<.05. **<.01. ***.001.

Table SM4

The coverage of the elements in the covariance matrix in the LGC model and follow-up assessments (% of the total sample of 427).

Age (months)	**Early communication**	Age in months					Age (years; months)				
		6	9	12	15	18	2	3	4;7	5;3	7;9
6	ITC	53.6									
9	ITC	47.3	47.5								
12	ITC	33.3	31.6	75.4							
15	ITC	35.4	33.3	64.9	71.4						
18	ITC	34.9	32.8	54.8	57.6	65.3					
(years)	**Follow-up measures**										
2	MBCDI Vocabulary	8.7	8.2	23.2	23.7	23.0	24.4				
2	Inflections	8.4	8.2	23.0	23.4	22.7	24.1				
2	MSL	8.2	8.0	22.2	22.7	22.0	23.4				
3	Boston naming	10.8	10.8	25.5	25.3	24.6		26.2			
3	PPVT	10.5	10.5	25.3	25.1	24.4		26.0			
4;7	FTF	27.7	25.3	43.8	44.3	40.6			63.0		
5;3	SI	11.0	10.8	20.8	21.8	19.7				23.0	
5;3	PPVT-R	11.0	10.8	21.3	22.2	20.1				23.4	
5;3	SC	11.5	11.2	21.8	22.7	20.6				23.9	
5;3	VF	11.0	10.8	20.6	21.5	19.4				22.7	
5;3	DSf	11.5	11.2	21.5	22.5	20.4				23.7	
	DSb	11.0	10.8	20.8	21.8	19.7				23.2	
5;3	NWR	11.0	10.8	20.8	21.8	19.7				23.0	
5;3	SR	11.2	11.0	21.3	22.2	20.1				23.4	
7:9	CCC-II	27.8	25.6	40.9	41.6	36.9					58.8

Note. ITC = Infant-Toddler Checklist; MBCDI = MacArthur-Bates Communicative Development Inventories; MSL = Maximum Sentence Length; PPVT = Peabody Picture Vocabulary Test; FTF = Five to Fifteen; SI = Similarities; SC = Sentence Comprehension; VF = Verbal Fluency; DS = Digit span; NWR = Nonword Repetition; SR = Sentence Repetition; CCC-II = Children's Communication Checklist –Second Edition.

Table SM5

The Model Fit Indices for the LGC Model and the Regression Models of the Follow-Up Measurements.

Age	LGC model	χ^2	df	*p*	CFI	TLI	RMSEA	RMSEA 90% CI	SRMR
12 to 18 months	Early communication development	87.405	73	0.1198	0.991	0.987	0.021	0.000 0.037	0.083
	Outcome variables								
2 years	MCDI: vocabulary, inflections, MSL	153.548	112	0.0056	0.979	0.971	0.029	0.017 0.040	0.091
3 years	Boston, PPVT	119.435	99	0.0793	0.988	0.984	0.022	0.000 0.035	0.083
4;7	FTF expressive, receptive, communication	136.459	112	0.0579	0.987	0.982	0.022	0.000 0.033	0.078
5;3	Psychometric tests: Language, memory	258.160	207	0.0090	0.973	0.967	0.024	0.018 0.033	0.089
1st grade	CCC-II: Language, communication	236.476	206	0.0714	0.991	0.988	0.018	0.000 0.028	0.071

Note. A nonsignificant chi-square test (p >.05), CFI and TLI values at or above .95, RMSEA below .06, and SRMR below .08 serve as guidelines for determining good model fit (Hu & Bentler, 1999; Marsh, Hau, & Wen, 2004). LGC = latent growth curve; CFI = comparative fit index; TLI = Tucker-Lewin index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square error of approximation; MCDI = MacArthur-Bates Communicative Development Inventories; MSL = Maximum Sentence Length; PPVT = Peabody Picture Vocabulary Test; FTF = Five to Fifteen; CCC-II = Children's communication Checklist –Second Edition.

II

DEVELOPMENTAL TRAJECTORIES OF EARLY COMMUNICATION SKILLS.

by

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Developmental Trajectories of Early Communication Skills

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Abstract

Purpose: This study focused on early developmental trajectories of prelinguistic communication skills and their connections to later language difficulties reported by parents.

Method: The participants represent a subset of a community-based sample of 508 children. Data include parent reports of prelinguistic communication skills at 12, 15, 18 and 21 months, and language difficulties at 4;7 years of age. Latent Profile Analysis (LPA) was used to identify groups of children with differing developmental trajectories of prelinguistic communication skills (n = 271). The relations between these groups and follow-up data of parent-reported concerns of language development (n =187) as well as the role of gender were examined.

Results: Six meaningful prelinguistic communication groups were identified with the LPA and they showed connections to later parent-reported concerns of language difficulties. Delayed early expressive language and a minor delay of overall performance together with symbolic difficulties appeared as predictors of later language difficulties. Nearly 80% of the children whose parents reported language-related concerns at the follow-up stage could already be identified before their second birthday.

Conclusions: The results support the potential of early screening in identifying children at risk of developing language difficulties, particularly when screening includes repeated surveillance of more than one area of communication skills.

Keywords: prelinguistic communication, developmental trajectories, language difficulties, early predictors, person-oriented approach

Developmental Trajectories of Early Communication Skills

Early language difficulties concern a considerable percentage of children, prevalence estimates ranging from 2 to 19% (Law, Boyle, Harris, Harkness, & Nye, 2000a). Research indicates that these difficulties are frequently precursors of school-age language, academic, social, behavioral, and psychiatric problems (e.g., Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Beitchman, Wilson, Brownlie, Walters, Inglis, et al., 1996; Brinton & Fujiki, 1999; Noterdaeme & Amorosa, 1999) which have been shown to often persist into adulthood (e.g., Clegg, Hollis, Mawhood, & Rutter, 2005). The strong evidence for the long-term repercussions of delayed early language development, along with the notion that early intervention is likely to lead to better language outcomes in at-risk children (Warren, 2000), implies that there is a need to identify possible risk trajectories of early language development as early as possible and to understand the implications that early development has for later language outcomes more thoroughly. Our study aims to contribute to this important-yet-lacking field of research in language development by identifying developmental trajectories from longitudinally collected data of prelinguistic communication skills and exploring their possible connections to follow-up data of parent reported concerns of language development.

The fundamental challenge for clinicians is to identify at an early age those individuals who might be already at risk of developing persistent language difficulties. Identification is complicated due to the fact that a great deal of individual variability and instability is normal in the early stages of communication and language development as children vary in their rate of development (Bates, Dale, & Thal, 1995; Darrah, Hodge, Magill-Evans, & Kembhabi, 2003; Fenson et al., 2000; Thal, Bates, Goodman, & Jahn-Samilo, 1997). In addition to inter-individual variation, there is also substantial intra-individual variation between the different components of early language development and even within single language domains (Bates et al., 1995; Darrah et al., 2003). Darrah and colleagues (2003) studied the stability of

communication scores among children aged 13-21 months and concluded that typical development seems to be nonlinear rather than occurring at a constant rate, as a result of which fluctuations in an individual infant's scores may not necessarily be an indicator of developmental deviance. In light of the prognostic value of early assessments, this indicates that a developmental perspective using multiple assessment points would be more suitable than only assessing the skill level a single time.

In addition to assessing both skill level and development over time, it is important to consider which skills should be assessed. There is a vast amount of research indicating that individual differences in several skills of prelinguistic communication predict later language development (for review, see McCathren, Warren, & Yoder, 1996). The attested skills include joint attention, gestures, early vocalizations, symbolic play, language comprehension, vocabulary size, and background of language-related problems in the family (e.g., Laakso, Poikkeus, Katajamäki, & Lyytinen, 1999; Lyytinen, Poikkeus, Laakso, Eklund, & Lyytinen, 2001; Rescorla, 2002; Watt, Wetherby, & Shumway, 2006; Wetherby & Prizant, 2002). The results suggest that different aspects of prelinguistic communication may contribute distinctively to subsequent language development and that the predictive power varies according to age (Heimann et al., 2006; Watt et al., 2006; Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002; Wetherby, Goldstein, Cleary, Allen, & Kublin, 2003).

Regardless of the fairly large amount of research regarding prelinguistic predictors of language development, there is still a need for more research in order to create a convergent understanding of developmental processes and individual differences. The majority of prediction studies have concentrated on only one or two skills measured at one point in time, and it is still uncertain which skills are the most relevant in ascertaining which children are at risk of developing language difficulties later on (Law, Boyle, Harris, Harkness, & Nye, 2000b). The few relatively comprehensive studies on risk factors of later language impairment point to

the direction of cumulative risks, indicating that instead of examining the predictive power of a single skill, an approach including multiple domains of language and communication is more suitable (e.g., Darrah et al., 2003; Law et al., 2000a; Lyytinen et al., 2001; Thal et al., 1997; Thal & Katich, 1996; Wetherby et al., 2002). The established prelinguistic predictors may not map one-on-one with later language skills, but instead, as Bates (2004) has suggested, the initial skills converge onto later developmental milestones that correlate with the emergence of language. In other words, language appears to emerge from the interactions of many cognitive processes such as speech sound perception and production, object recognition and categorization, imitation, joint reference, and intentionality that act as prerequisites to language (Bates, Thal, Finlay, & Clancy, 2002). This implies that studying the early development of language requires that several of the involved components are considered together, and their development is regarded as a system over time, which is the basic theoretical idea behind the person-oriented approach (Bergman, Magnusson, & El-Khouri, 2003; Bergman & Trost, 2006).

The person-oriented approach emphasizes the uniqueness and individuality of development, but states at the same time that there is lawfulness in development which can be described by patterns of the involved factors (Bergman et al., 2003; Bergman & Trost, 2006; von Eye & Bogat, 2006). It considers the possibility of distinct subgroups within a population and states that there are typically only a limited number of typical patterns (i.e., subgroups). The approach suggests that the key to understanding the developmental processes, and individual differences in those processes, is to search for typical patterns of development, that is, developmental trajectories of the individuals. Thus, examining developmental trajectories of prelinguistic communication over time and over different skills may provide additional insight into the rate and synchrony of language development (Conti-Ramsden, Crutchley, & Botting, 1997; Darrah et al., 2003; Ellis Weismer, Murray-Branch, & Miller, 1994; Hoff, 2006). It is possible that children with a specific profile of skills, or a particular pattern of

development over time, are subject to a greater probability of experiencing ongoing difficulties (Darrah et al., 2003; Rescorla, Mirak, & Singh, 2000; Wetherby & Prizant, 2002).

In the present study, we first asked whether meaningful individual developmental trajectories can be found by studying the development of children in several areas of early language and communication skills in a relatively large population-based sample. The prelinguistic skills were measured longitudinally using parent ratings of children aged between 12 and 21 months. Parent-report measures of language and communication skill development have been shown to be reliable and valid, and to correlate to concurrent behavioral measures as well as to be sensitive indicators of language delays in young children (Feldman et al., 2005; Heilmann, Ellis Weismer, Evans, & Hollar, 2005; Korkman, Jaakkola, Ahlroth, Pesonen, & Turunen, 2004; Laakso et al., 1999; Rescorla & Alley, 2001; Wetherby et al., 2002). Currently, one of the most comprehensive parent-report screening tools of prelinguistic and early language skills is the *Infant-Toddler Checklist* (ITC), which is part of the Communication and Symbolic Behavior Scales Developmental Profile assessment method (CSBS-DP, Wetherby & Prizant, 2002). The ITC has been shown to have good concurrent and predictive validity for both receptive and expressive language up to the age of 3 years (Watt et al., 2006; Wetherby et al., 2002; Wetherby et al., 2003). It has been shown that the ITC is able to detect developmental growth and to produce relatively stable rankings of children over short periods of time (Reilly et al., 2006; Wetherby et al., 2002). However, studies using the ITC longitudinally to depict development are still few in number (however, see Darrah et al., 2003).

Efforts have been made to distinguish different subgroups of children with delayed language skill development (for review, see Tomblin, Zhang, Weiss, Catts, & Ellis Weismer, 2004). However, the majority of research on subgroups has focused on specific language impairment (SLI) and is limited to children who are of preschool age or older. The earliest attempts to identify distinct subgroups of children with early language delay can be found in

the literature on late talkers. This group of children has been identified between 18 and 32 months of age by using mainly expressive language measures (such as vocabulary size, word combinations) (Kelly, 1998; Rescorla, 2002; Thal & Tobias, 1992). Within this group, a division between those who are truly delayed and those who seem to catch up (so called "late bloomers") has been suggested retrospectively, based on the children's receptive language skills, use of gestures, and symbolic skills (Thal & Tobias, 1991, 1992; Wetherby & Prizant, 2002). However, groupings of young children according to several early language skills or prelinguistic communication skills are still almost completely lacking (however, see Desmarais, Sylvestre, Meyer, Bairati, & Rouleau, 2010). The skills included in the present study have a strong theoretical background in regard to their being seen as early predictors of language development. On the basis of previous research on late talkers (e.g., Desmarais et al., 2010; Thal & Tobias, 1991, 1992; Wetherby & Prizant, 2002), in addition to typically developing children, we expected to find children who were delayed only in early expressive language and children who had more broad delays. However, because of the lack of research on subgroups of prelinguistic communication skill development, we did not have a clear basis for predictions of specific subgroups in the current research.

Second, we examined the connections of the early trajectories to the occurrence of later language difficulties as reported by parents when the children reached the age of 4 years and 7 months. For older children, there is currently no language screening tool using parent reporting that is as comprehensive, or has been studied as much, as the ITC (for review, see Pickstone, Hannon, & Fox, 2002; and Sturner et al., 1994). The screening questionnaire *Five-to-Fifteen* (FTF, Kadesjö et al., 2004) used in this study is a commonly used method applied in clinical settings, in Scandinavia. A validation study with 5-year-old Finnish children showed that the FTF is a valid method of developmental screening (Korkman et al., 2004). Our aim was to see whether the different early developmental trajectories have different developmental outcomes.

Deficits in a single language domain will likely lead to different developmental outcomes than those associated with multiple deficits (Hulme & Snowling, 2009). For example, studies of late talkers have suggested that the long-term outcome is worse among children who are delayed in several early communication and language skills than among those delayed only in expressive language (e.g., Rescorla, 2002; Wetherby & Prizant, 2002).

Third, the role of gender was examined. Along with individual differences in language skills, reliable gender differences have been reported. It has been stated consistently that boys outnumber girls in the group of children with language difficulties (Heilmann et al., 2005; Law et al., 2000a). However, regarding prelinguistic skills the gender differences are not as clear-cut. For example Wetherby and Prizant (2002) did not find any substantial gender differences in the standardization sample of the ITC. The differences were negligible or small, though they went in a direction parallel to older children, that is, girls scored higher (Wetherby & Prizant, 2002). In addition, the results concerning the gender differences in the persistence of language problems are conflicting (Bornstein, Hahn, & Haynes, 2004; Dale, Price, Bishop, & Plomin, 2003). More research is needed to establish to what extent gender is a risk factor in different subgroups of the population (Law et al., 2000a). In this study, the role of gender was taken into account in exploring both the composition of the subgroups as well as the predictive connections of early-to-late development.

Method

Participants and Procedure

The participants of the present study represent subsets of a community-based sample collected in a longitudinal study of early language and communication development in the city of Jyväskylä, Central Finland. The recruitment of participants was carried out through child health care clinics, where the families having a child between 6 and 24 months of age were invited to participate. Child health care clinics are regularly attended by over 95% of Finnish

parents and their children from birth to school age. After giving their consent and completing the first questionnaire, the families were asked to fill in a new questionnaire every three months until their child was 24 months of age. Altogether, 508 children (50.2% boys, 49.8% girls) participated in the study. It was possible to collect data for at least three time points for the majority of the children (67.9%). The total number of forms filled in by parents depended on the age of their child at the time of completing the first questionnaire and on how many of the subsequent questionnaires they completed. All of the families that had originally participated were contacted again for the follow-up when their child reached the age of 4 years and 7 months; they were sent a new questionnaire to assess their child's expressive language, language comprehension, and communication skills, among other skills, and of the 508 families, 473 were reached and 296 (62.6%) of them returned the questionnaire.

The data used in this study represent a subset of the 508 children who originally participated. In the analyses of early communication skill development, using the ITC, the data on children aged 12 to 21 months were used. Furthermore, to ensure the reliability of the developmental aspect of the analysis, children were excluded from these analyses if their data were missing for two of the age points measured, either at 12 and 15 months, or 18 and 21 months, or 12 and 21 months of age; this resulted in the *early development subset* consisting of 271 selected children in total. This early development subset was used as a sample from which more specific groups of Early Communication Development (ECD) were extracted. The follow-up data (the FTF) was available for 187 children; this *follow-up subset* was used when comparing the ECD groups' later language outcomes.

All of the families were Caucasian and all of the children spoke Finnish as their native language. Parental education was classified using a 7-point scale ranging from a basic level to advanced educational training; more specifically, from 1 (*comprehensive school education without any vocational education*) to 7 (*master or doctoral-level university degree*). There

were small but significant ($p<.05$) differences in demographics between the included (n=271) and excluded (n=237) children – the included children had somewhat older parents and their mothers were more educated. The parents' age and mean levels of education according to subsets are presented in Table 1. There were no significant differences in demographics between the early development subset (n=271) and the follow-up subset (n=187).

Insert Table 1 about here

Measures

Early development measures. Early communication skills were assessed using the Finnish version of the *Infant-Toddler Checklist* (ITC) of the *Communication and Symbolic Behavior Scales Developmental Profile* (CSBS-DP, Wetherby & Prizant, 2002; Laakso, Poikkeus, & Eklund, 2011), a screening tool using parent reporting in order to measure the relevant prelinguistic milestones of early communication and language development in children aged 6 to 24 months. The ITC is to be completed by a caretaker who nurtures the child on a daily basis, and it takes about 5 to 10 minutes to complete. The ITC consists of 24 questions that measure seven communication clusters which are organized into three composites. The Social composite consists of questions concerning emotion and the use of eye gaze (4 questions), communication (4 qs.), and gestures (5 qs.). The Speech composite surveys sounds (3 qs.) and words (2 qs.). And the Symbolic composite explores understanding (2 qs.) and object use (4 qs.). The ratings are either on a 3-point scale of *not yet / sometimes / often*, giving 0, 1 or 2 points respectively, or on a scale describing a series of numbers or ranges affording 0 to 4 points. The Cronbach's alphas for the three composites and total score combined over the age span of 6 to 24 months range from .87 to .93, indicating a high degree of internal consistency (Wetherby & Prizant, 2002). In the present data, the Cronbach's alphas by age (12,

15, 18, and 21 months, n ranged from 269 to 320) ranged from .70 to .74 for the Social composite, from .46 to .63 for the Speech composite, and from .47 to .58 for the Symbolic composite. The sensitivity and specificity of the ITC, based on concurrent face-to-face evaluation and follow-up testing of language skills, have been reported to be 80-89% and 70-79% respectively, indicating fairly good validity (Wetherby et al., 2003). Currently there are no Finnish norms available for the ITC, which is why the standardization was done using the sample means and standard deviations for each age group. A cut-off of -1 SD (standard deviation) was used as an indicator of developmental risk.

Follow-up measures. Language difficulties were assessed using the parental questionnaire *Five-to-Fifteen* (FTF) (Kadesjö et al., 2004). The questionnaire was developed for the elicitation of symptoms and problems typical of ADHD and its comorbidities. All in all, the FTF is comprised of 181 statements related to behavioral or developmental problems. The rating is conducted on a 3-point scale of *does not apply / applies sometimes or to some extent / definitely applies*, with 0, 1 or 2 points given respectively. The Language domain of the questionnaire consists of 21 questions divided into three subdomains. The Comprehension subdomain (5 qs.) surveys how the child understands explanations, word meanings, abstract concepts, and ability to follow a story. The Expressive Language subdomain (13 qs.) taps into areas of articulation, fluency, word retrieval, and the complexity of speech. And the Communication subdomain (3 qs.) considers social and narrative ability (e.g., "difficulty carrying on a conversation"). Kadesjö and colleagues (2004) report the Cronbach's alphas for the Language domain and the three subdomains to be .91, .84, .84 and .75, respectively. The Finnish validation of the FTF for five-year-olds (n=769) reports the reliability of the Language domain to be .89 (Korkman et al., 2004). For the present data, the Cronbach's alphas were .89 for the Language domain and .67, .87 and .69 for the subdomains, respectively. The suggested cut-off for screening purposes is the 90^{th} percentile, which indicates a heightened risk for

developmental difficulties (Korkman et al., 2004). Overall sensitivity and specificity, based on concurrent neuropsychological testing (NEPSY, a Developmental Neuropsychological Assessment, Korkman, Kirk, & Kemp, 1997), are reported to be 93% and 35% respectively using the 90% cutoff (Korkman et al., 2004). This indicates a rather high rate of false positives. However, the FTF provides a means for parents to express concerns they may have regarding their child. Thus, the FTF may identify children with not necessarily clinical impairments but milder difficulties that also merit clarification (Korkman et al., 2004).

Data Analyses

The theoretical basis for the analyses of the present study is the person-oriented approach. According to von Eye and Bogat (2006), three criteria can be specified for the person-oriented research: (1) the sample is analyzed under the assumption that it was drawn from more than one population and the formed groups differ in parameters such as means and variances; (2) the groups are examined using other variables than the ones used to create the groups in order to attempt to establish external validity; (3) the groups must either have a plausible a priori meaning or be interpretable with reference to substantive theory.

In the present study the repeated measures of early communication skills (the composites of the ITC) were analyzed using Latent Profile Analysis (LPA), a type of finite mixture analysis. The aim was to find latent subgroups that have different developmental trajectories that differ from each other regarding the mean values of the observed variables. In line with the person-oriented approach (von Eye & Bogat, 2006), this modeling is based on the idea that the observed data can represent subpopulations, i.e. latent classes, and that these classes can be identified and their parameters estimated (Muthén & Shedden, 1999; Muthén, 2001). In the LPA, a latent group has a common mean trajectory and all individual deviation from the mean trajectory is expected to consist of residuals that are normally distributed (Nagin, 2005). The LPA is comparable to the classic cluster analysis, but the advantage of the

LPA is that, unlike the traditional cluster analyses, it is based on and permits the use of statistical criteria for deciding the number of latent classes.

Analysis was performed using the MLR (Maximum Likelihood with Robust Standard Errors) estimation method implemented in the Mplus program version 5.1 (Muthén & Muthén, 1998-2007). The estimation is performed step by step, starting from 1 class solution and continuing to estimate the parameters for 2, 3,..., *k*-class solutions. To ensure the validity of each class solution, it is recommended to use a large set of random starting values for the parameters. In this analysis, 500 starting values were used. To achieve a reliable solution, it has to be produced with several different starting values (Muthén & Muthén, 1998-2007).

Statistical fit information is calculated for each model and then used as statistical criteria to decide the number of latent classes. The criteria used in this study are Bayesian Information Criterion, BIC (Schwartz, 1978) and the parametric Bootstrapped Likelihood Ratio Test, BLRT (Muthén & Muthén, 1998-2007). Our choice of these two criteria is based on simulation studies in which the BIC and BLRT have been found to be the most consistent criteria in identifying the best fitting solution (Nylund, Asparouhov, & Muthén, 2007; Tolvanen, 2007). The lower the value of the BIC is, the better the model fits the data. Using the BLRT, a *p*-value lower than .05 suggests that a number of latent classes defined in terms of *k* fits the data better than *k*-1. The BLRT is based on a certain number of replications of simulated data, determined during estimation, and estimates the k and k-1 class solutions for each simulated set of data. As in the initial estimation, the same k and k-1 solutions have to be produced using several different starting values in order for the BLRT to be valid.

To evaluate the statistical quality of the classification (i.e., how well the model classifies individuals into subgroups), estimates of Entropy and Average Latent Class Posterior Probabilities (AvePP) were used (Muthén & Muthén, 1998-2007). The values of Entropy and AvePP vary between 0 and 1. The higher the value of Entropy is, the clearer is the solution.

Also, the higher the values of AvePP are, the more distinguishable the latent groups are from each other. An AvePP greater than .70 is used as a rule of thumb to indicate that the found solution can be interpretable using the mean trajectories (Nagin, 2005). In addition to statistical evaluation, the selection of the final model was based on substantive theory.

The external validity of the latent subgroups, i.e. Early Communication Groups (ECD), was examined by exploring whether there were systematic or gender differences in the composition of the groups and whether there were differences in the group outcomes in the follow-up at the age of 4 years and 7 months. For this purpose, crosstabulation and chi-square tests (using Monte Carlo simulations or exact tests) were applied. Analyses were performed using IBM SPSS Statistics for Windows, version 19.0.0.1.

Results

Early Communication Development (ECD) groups

A data sample of 271 children (54.2% boys, 45.8% girls) aged 12 to 21 months was used in the analyses of early communication skill development. The means and standard deviations according to composites, age and gender are shown in Table 2. There was a significant difference between boys and girls in each composite at most stages of age, but effect sizes (Cohen, 1992) were very small (0.06-0.13).

Insert Table 2 about here

Latent Profile Analysis was executed on the ITC composite variables (Social, Speech, Symbolic) in order to form the Early Communication Development (ECD) groups. A combination of statistical considerations and substantive theory was used in determining the best-fitting solution. First, the reliability of the solutions was inspected using the different starting values. In the two- to six-class solutions, a variety of different starting values ended up

with the same solution, whereas from the seven-class solution onwards, the result depended strongly on the particular set of starting values and thereby indicated some degree of instability. The fit information for one- through nine-class solutions is summarized in Table 3. The BIC values decreased up to the six-class solution and increased from the seven-class solution onwards, indicating that either the six- or seven-class solution was the best fitting model. In contradiction to this, the BLRT showed that the model fit increases when increasing the number of latent classes up to nine classes. After careful consideration, the six-class solution was chosen for further analyses; its classes were clearly distinguishable based on Entropy (.891) and AvePP (range .90-.99), and, for the most part, interpretable based on theory.

Insert Table 3 about here

The ECD groups are depicted in Figure 1. Of the 271 children included in the analysis, 89 children (33.9%, AvePP = .93) were members of Group 1, "Average" (A), which was the largest group. In this group, the development was stable and the children performed at the same level (within +/-0.5 SD) in each early communication composite (Social, Speech, Symbolic). Group 2, "Above average" (AA), was the second biggest group, consisting of 69 children (24.3%, AvePP = .90). The skills of these children were consistently at a higher level (+0.5 SD) and the development was stable across all three composites. The 20 children (8.0%, AvePP = .95) in Group 3, "Average with fluctuating social skills" (A+So), possessed typically developing expressive and communication skills, but their development was unstable in the Social composite, in which they showed a temporary drop in performance down to -1.5 SD at the age of 18 months. Group 4, "Below average with symbolic difficulties" (BA+Sy), was comprised of 57 children (19.6%, AvePP = .91). Their development was stable and within one standard deviation in the Social and Speech composites, but they consistently performed at a

lower level than the children in Group 1 (A). In addition, there were indications of a delay in their development of Symbolic skills: From the age of 18 months onwards, they performed -1 SD lower in the Symbolic composite compared to their peers. Group 5, "Expressive difficulties" (ED), consisted of 24 children (9.6%, AvePP = .97) who were delayed in the development of the Speech composite but had social and symbolic skills at the average level. Group 6, "Broad difficulties" (BD), included 12 children (4.6%, AvePP .99) who showed a consistently low skill level in each early communication composite. By the age of 21 months, these children seemed to start to catch up with their peers in their social and symbolic development, but they continued to fall behind in speech development.

Insert Figure 1 about here

There were no significant differences between the ECD groups in regard to socio-demographic variables (age of the parent, parental education). The gender differences in the ECD groups were explored using crosstabulation. The chi-square test for crosstabulation showed that, statistically, the profiles differed significantly from each other in gender, $\chi^2(5) = 17.12$, $p = .004$. A closer look at the cell percentages and adjusted residuals (see Table 4, Adj. Res.) showed that there were proportionately more girls than boys in Group 2 (AA). In addition, the percentages clearly indicated that there were more boys than girls in the groups having difficulties with speech or symbolic skills (groups BD, ED, BA+Sy). However, due to the relatively small group sizes, these differences did not reach statistical significance.

Insert Table 4 about here

The ECD groups and follow-up data

The data for the ECD groups and the follow-up were available for 187 children (51.3% boys, 48.7% girls). The *follow-up* subset did not differ significantly in the ITC composite scores from the remaining part of the *early development* subset not included in the follow-up (n=84). Descriptive data for this follow-up sample are presented in Table 5. There was a significant difference between boys and girls in each composite of the ITC at most stages of age. In the FTF, a significant gender difference could be seen in regard to expressive language, with boys having received higher scores indicating more language-related difficulties reported by parents. The effect sizes (Cohen, 1992) for all significant differences were very small (0.10-0.14). The correlations between the total scores of the ITC when the children were 12, 15, 18 and 21 months of age, and the FTF total scores at the age of 4 years and 7 months, were significant and medium in magnitude (Cohen, 1992) at each age point, suggesting that there was a connection between the early communication data and the later language difficulties.

Insert Table 5 about here

In examining the connections between the ECD groups and the follow-up data, the children were first divided into two groups (*concern* and *no-concern*) according to the parent-reported concerns at the follow-up using the suggested 90th percentile cut-off (Korkman et al., 2004). The crosstabulation of the ECD groups and the follow-up groups showed that there were associations between the early groups and parent reported concerns regarding language development, as shown in Table 6. The chi-square test was statistically significant, $\chi^2(5) = 27.65$, $p = .000$. The adjusted residuals showed that there were significantly more children than expected in the *no-concern* group stemming from the two typically developing ECD groups A and AA (Adj. Res. = 2.3 and 2.1). In turn, there were significantly more children than expected in the *concern* group stemming from the ECD groups BA + Sy (Adj. Res. = 2.6) and ED (Adj.

Res. = 3.7). Next, a crosstabulation was executed separately for each FTF language subdomain. The cut-off scores for separate subdomains are not available in the Finnish standardization and thus the 90th percentile of the current data was used. The chi-square test did not reach statistical significance for Comprehension, $\chi^2(5) = 7.86$, $p = .155$, but was significant for Expressive language, $\chi^2(5) = 15.87$, $p = .012$, and Communication, $\chi^2(5) = 24.75$, $p = .001$. The children from the ECD group BA+Sy were overrepresented in the concern group for both Expressive language (Adj. Res. = 2.5) and Communication (Adj. Res. = 4.0), as shown by the adjusted residuals in Table 6. In addition, the children from the ECD group ED were overrepresented in the concern group of Expressive language (Adj. Res. = 2,5), and there were no children from the ECD group AA in the concern group of Communication (Adj. Res.= -2,9).

Insert Table 6 about here

The crosstabulation of the FTF language domain was executed separately for boys and girls. The chi-square test did not reach significance for boys (n=96), $\chi^2(5) = 9.59$, $p = .086$, but was significant for girls (n=91), $\chi^2(5) = 24.20$, $p = .004$. The girls in the ECD groups BA+Sy and ED ended up in the parental concern group more often than expected (Adj. Res. = 2,3 and 4,0, respectively). None of the girls in the remaining ECD groups ended up in the concern group. For boys, the trend ran parallel to the girls, but there was more dispersion; from each of the ECD groups, some boys ended up in the follow-up concern group.

Discussion

The purpose of this study was to conduct research on developmental trajectories of prelinguistic skills in order to deepen the understanding of developmental processes of language development and to find out whether certain trajectories reflect possible developmental risks for later language difficulties. The theoretical basis for the research was

the person-oriented approach which suggests that the search for developmental trajectories is the key to understanding developmental processes and individual differences in those processes (Bergman et al., 2003; Bergman & Trost, 2006). A great deal of individual variability and instability is normal in the early stages of communication and language development, which makes accurate predictions of persistent difficulties a challenge. However, as the person-oriented approach suggests, there is lawfulness in development and this can be described by typical patterns of development which are often few in number. We were able to find meaningful groups that showed relatively good stability right from the earliest ages onward and that ended up having different outcomes at the age of 4 years and 7 months. There was an inclination of early communication difficulties leading to an increased rate of parent-reported concerns of language difficulties. However, a word of caution is needed in interpreting and generalizing these results as the outcome measure was a parent-report screener, and some of the groups were relatively small and further contracted by attrition at the follow-up. Regardless the limitations, the results suggest that the early identification of at-risk children calls for the repeated surveillance of more than one area of communication development.

The children's prelinguistic skills were measured using the ITC (Infant-Toddler Checklist, Wetherby & Prizant, 2002) parent questionnaire which examines three composites of early language and communication skills. The Social composite covers the communication skills of children, the Speech composite their early expressive language, and the Symbolic composite understanding and object use. The development of skills within a single composite over time was relatively stable in the majority of groups. Despite fluctuations in some groups, the groups generally retained their order relative to each other across the 12 to 21 months age period. Thus, the possible risk status of some groups was recognizable as early as 12 to 15 months of age and remained stable up to 21 months of age. In tracking the development across the three composites, it became apparent that the groups differed from each other in two ways.

First, there were groups that showed a stable profile across the three composites, but these groups differed from each other in their overall developmental levels, ranging from *above average* (Group 2, AA) to *average* (Group 1, A) and *below average* (Group 6, BD). Second, there were groups with specific profiles showing differences between the composites. The overall performance of Group 4 (BA+Sy) was somewhat below average and the development in the Symbolic composite indicated delay. In Group 3 (A+So), the development in the Social composite differed from the overall average level. And in Group 5 (ED), there was a clear delay in the Speech composite while the two other composites were at an average level.

The follow-up at the age of 4 years and 7 months was executed using the FTF (Five-to-Fifteen, Kadesjö et al., 2004) parent-report screening questionnaire, which includes questions about receptive, expressive and communication skills. The 90th percentile was used as a cut-off indicating a heightened risk for developmental difficulties. According to this cut-off, the children were divided into two groups: those with parental concerns of language development and those without. Interesting connections were found when comparing the follow-up outcomes of the ECD groups. For the ECD Groups 1 (A) and 2 (AA), performing consistently at an average or an above average level in all three composites, the outcome was as expected. Parents did not report any concerns regarding language development for 96.9% of children in Group 1 and for 97.9% of children in Group 2. Thus, uniformly average or above average prelinguistic skills seem to be reliable indicators of unproblematic later language development.

A low level of early expressive language indicated a risk for later language difficulties. ECD Group 5 (ED) and Group 6 (BD) both performed at a significantly low level in the composite measuring early expressive language and neither of the groups showed indications of catching up in this composite by 21 months of age. Combined, for 35% of the children in these two groups parents reported language-related concerns at the time of the follow-up. This is somewhat lower than previous research results, obtained with diagnostic tools, showing that

roughly 40 to 60% of children with delayed early expressive language still manifest language difficulties in later years (Dale et al., 2003; Law et al., 2000a). What is noteworthy in the present study is the markedly early age at which these children showed clear differences compared to their peers; the lower levels of expressive language were detected as early as at 12 months of age for the BD group and from 15 months of age onwards for the ED group. In the majority of previous studies, children with late expressive language were identified at ages 24 to 30 months (e.g., Dale et al., 2003; Girolametto, Wiigs, Smyth, Weitzman, & Pearce, 2001; Rescorla, Roberts, & Dahlsgaard, 1997).

What was surprising was that the initial poor skills of the BD group did not come forth distinctly in the parental concerns at the follow-up. The BD and ED groups differed in their early development relating to the Social and Symbolic composites, with the BD group performing at a low level also in these two composites while the ED group showed difficulties solely in early expressive language. Based on previous research on late talkers, the children with delays in more than one area of communication development (i.e., the BD group in the present study) are presumed to be at higher risk of having persistent language difficulties (Rescorla, 2002; Rutter, 2008). Furthermore, according to Wetherby and Prizant (2002) as well as others (Lyytinen et al., 2001; Thal & Katich, 1996), for those children who are delayed only in expressive language, such as the ED group in the present study, there seems to be no reason for serious concern. Thus, it was expected that our BD group would show a higher percentage of difficulties than the ED group at the age of 4 years and 7 months. However, the results were the opposite: For the ED group, parents reported concerns of language development for 41.7% of the children, while the comparable percentage for the BD group was 25%.

The comparatively high percentage of parent-reported difficulties in the ED group at the time of the follow-up could be understood in light of the studies by Rescorla and colleagues (Rescorla, 2002; Rescorla et al., 1997), suggesting that early expressive language delay with

normal receptive language development may reflect a predisposition to slower language acquisition that continues to be evident not necessarily as a clinical impairment but as slightly poorer language performance in later childhood. However, this does not explain the outcome of the BD group. One possible explanation is the notably small group size. There were initially 12 children in the BD group and eight of them remained in this group in the follow-up. We do not know the developmental outcome of the four children that dropped out of the study. With such small numbers of children, attrition may have a large impact on the outcome results.

On the basis of the composite measuring early expressive language, we were able to detect 36.8% of the children whose parents reported concerns of their child's language development at the age of 4 years and 7 months, i.e., the ECD groups ED and BD. The percentage rose to 78.9% when ECD Group 4 (BA+Sy) was also taken into consideration as an at-risk group. This group performed close to average in the Speech composite, and in the lower bound of the average range in the Social composite. In the Symbolic composite, the developmental trend was downward and the performance fell below 1 SD from the age of 18 months onwards. When the children reached the age of 4 years and 7 months, the parents reported language-related concerns for 21.6% of the children in the BA+Sy group. Thus it seems that the predisposition to language difficulties does not always come forth as delayed expressive language, particularly so in the early stages of development. This is supported by the findings of Wetherby and colleagues (2002), who examined the predictive validity of the three composites of the CSBS DP at different age points. When the children were 12 to 17 months of age, the Social and Symbolic composites were the strongest predictors of both expressive and receptive language development at the age of 2 years (Wetherby et al., 2002). This implies that several skills should be assessed in order to improve predictive power.

The children in the BA+Sy group seemed to fall behind their peers in their development of language comprehension and object use, which have been shown to be reliable predictors of

both expressive and receptive language acquisition during the second year of life (Lyytinen et al., 2001; Thal & Katich, 1996; Wetherby et al., 2002; Watt et al., 2006). It is interesting that, in addition to receptive and expressive difficulties at the time of follow-up, for 29.7% of the children in the BA+Sy group the parents reported concerns of communicative language. Early intentional communication, such as joint attention and social use of gestures, together with symbolic skills are shown to predict later social communicative competence (Chiat & Roy, 2008). It may be possible, that among the group of children with weaker early social and symbolic skills, later language difficulties do not manifest themselves as distinctly as expressive or receptive language difficulties, but are rather revealed in pragmatic language.

On grounds of the early profile and later outcome of the BA+Sy group, it seems that a rather minor delay from the age group might indicate a risk for later development. The result is congruent with the observations by Dale and colleagues (2003), as well as Darrah and colleagues (2003), suggesting that an at-risk profile may not be the one showing the most severe initial difficulties or consistently below average scores. Thus, for the identification of some at-risk children, a more refined developmental surveillance may be necessary. Another result supporting the need for long-term monitoring is the performance of Group 3 (A+So) in our study. This group showed fluctuating development in the Social composite, performing below 1 SD at the age of 18 months. However, their outcome at the age of 4 years and 7 months was similar to those of the A and AA groups, that is, for over 90% of the children the parents did not report any concerns of language development. This supports the notion of Darrah and colleagues (2003) that fluctuations in performance over time do not necessarily indicate deviance, and it further suggests that finding a deviance in performance at only one measurement point with an otherwise average performance should be interpreted with caution.

The third aim of our study was to determine the role of gender in children's language development. Consistent with previous research (for review, see Law et al., 2000a), there were

indications of gender differences within the composition of the groups. There were more boys in each of the ECD risk groups (64.9 to 75% in BA+Sy, ED and BD), although the differences did not reach statistical significance due to small group sizes. These gender ratios are comparable to those reported in earlier studies (range 1.2-2.3:1, Dale et al., 2003; Law et al., 2000a). Conversely, the highest performing ECD group (AA) included statistically significantly more girls. Nonetheless, when examining the contribution of gender to the predictability of early trajectories, no clear differences were found between boys and girls. This is in line with the results of Bornstein and colleagues (2004), who found no systematic gender differences in assessments of the stability of individual differences in language skills.

The objective of this study was not only to determine latent subgroups, but also to identify the possible risk trajectories predicting later language difficulties. We were able to find meaningful early developmental groups that showed connections to parent-reported language outcomes when the children were 4 years and 7 months of age. The groups BA+Sy, ED and BD were identified as "at-risk" groups based on their early development, and almost 80% of the children whose parents reported some concerns of language development belonged to one of these three groups. On the other hand, there was a high rate of false positives, as only 26% of the children in these groups did have parent-reported difficulties at the follow-up. The results were clearer regarding the children without the early risk status (the ECD groups A, AA, and A+So): Only 3% of their parents reported any language-related concerns.

There were several limitations that complicated the accurate identification of at-risk children and call for particular caution in interpreting and generalizing the results, especially when comparing the follow-up outcomes of the ECD groups. First, the number of children in some of the groups was small and attrition further complicated the comparison of the group outcomes. The attrition in the groups ranged from 15 to 50% and was most prominent in the ECD at-risk groups (ED 50%, BA+Sy 35%, and BD 33%). As the ED and BD groups were

also the smallest groups, the impact of attrition cannot be underestimated in the interpretation of the outcomes. Second, this study examined language difficulties solely as reported by parents through questionnaires meant for screening purposes. Screening tools using parental reporting have been recognized as having validity, but they lack the specificity necessary for fine-grained analysis of language difficulties. It appears that the children with early language delay often have difficulties later on in more diversely detailed areas of language development, such as morphology and syntax, or with higher-level linguistic tasks such as pragmatic, narrative and discourse skills (Girolametto et al., 2001; Rescorla, Dahlsgaard, & Roberts, 2000). Hence, a more detailed assessment of language skills is needed to better understand the development of the different ECD groups. This is why we continue the research by looking at the connections between the ECD groups and neuropsychologically assessed language skills. Finally, due to the lack of precise hypotheses, our Latent Profile Analysis was exploratory in nature, and thus, these results should be interpreted with caution. In addition, other than what the screeners provided, we had rather limited information about the development of the children, and because of missing data some of the children had to be excluded to ensure the reliability of the analysis. Thus, replication of the early subgroups with more comprehensive information about the participants and with a more intact data is necessary in order to provide a stronger basis for the validation and a more detailed comparison of the subgroups, and the generalization of the results.

Several previous studies have used prelinguistic measures in predicting later language development. However, to the best of our knowledge, this is the first study to research specific developmental risk profiles of such an extensive variety of early language and communication skills this early on in children's development and with such a lengthy follow-up period. Despite the limitations, it is remarkable that almost 80% of the children whose parents reported language-related concerns when their child reached the age of 4 years and 7 months could be

identified as early as in the second year of their lives. The results have important implications for early screening procedures of language difficulties, showing that reliable screening should assess a variety of skills at more than one point in time. However, more research is needed to untangle the specific developmental pathways leading to persistent language difficulties.

References

Bates, E. A. (2004). Explaining and interpreting deficits in language development across clinical groups: Where do we go from here? *Brain and Language, 88*, 248-253. doi: 10.1016/S0093-934X(03)00102-0

Bates, E., Dale, P. S., & Thal, D. (1995). Individual differences and their implications for theories of language development. In P. Fletcher & B. MacWhinney (Eds.), *Handbook of Child Language* (pp.96–151). Oxford: Basil Blackwell.

Bates, E., Thal, D., Finlay, B. L., & Clancy, B. (2002). Early language development and its neural correlates. In F. Boller & J. Grafman (Series Eds.) & S.J. Segalowitz & I. Rapin (Vol. Eds.), *Handbook of neuropsychology, Vol. 8: Child neurology* (2nd ed., pp.109-176). Amsterdam: Elsevier Science.

Beitchman, J. H. ,Wilson, B., Brownlie, E. B., Walters, H., & Lancee, W. (1996a). Long-term Consistency in Speech/Language Profiles: I. Developmental and Academic Outcomes. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 804–814. doi: 10.1097/00004583-199606000-00021

Beitchman, J. H., Wilson, B., Brownlie, E. B., Walters, H., Inglis, A., & Lancee, W. (1996b). Long-term Consistency in Speech/Language Profiles: II. Behavioral, Emotional, and Social Outcomes. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 815–825. doi: 10.1097/00004583-199606000-00022

Bergman, L. R., Magnusson, D., & El-Khouri, B.M. (2003). Studying individual development in an interindividual context: A person-oriented approach. Mahwah, NJ: Lawrence Erlbaum Associates.

Bergman, L. R. & Trost, K. (2006). The person-oriented versus the variable-oriented approach: Are they complementary, opposites, or exploring different worlds? *Merrill-Palmer Quarterly, 52,* 601-632. doi: 10.1353/mpq.2006.0023

Bornstein, M. H., Hahn, C.-S., & Haynes, O. M. (2004). Specific and general language performance across early childhood: Stability and gender considerations. *First Language, 24*, 267–304. doi: 10.1177/0142723704045681

Brinton, B. & Fujiki, M. (1999). Social interactional behaviors of children with specific language impairment. *Topics in Language Disorders, 19*(2), 49–69. Retrieved from http://journals.lww.com/topicsinlanguagedisorders/

Chiat, S. & Roy, P. (2008). Early phonological and sociocognitive skills as predictors of later language and social communication outcomes. *Journal of Child Psychology and Psychiatry, 49*, 635-645. doi: 10.1111/j.1469-7610.2008.01881.x

Clegg, J., Hollis, C., Mawhood, L., & Rutter, M. (2005). Developmental language disorders – a follow-up in later adult life. Cognitive, language and psychosocial outcomes. *Journal of Child Psychology and Psychiatry, 46,* 128–149. doi: 10.1111/j.1469-7610.2004.00342.x

Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science, 1*(3), 98–101. Retrieved from http://cdp.sagepub.com/

Conti-Ramsden, G., Crutchley, A. & Botting, N. (1997). The extent to which psychometric tests differentiate subgroups of children with SLI. *Journal of Speech, Language & Hearing Research, 40*(4)*,* 765–777. Retrieved from http://jslhr.asha.org/

Dale, P. S., Price, T. S., Bishop, D. V. M., & Plomin, R. (2003). Outcomes of early language delay: I. Predicting persistent and transient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research, 46,* 544–560. doi: 10.1044/1092-4388(2003/044)

Darrah, J., Hodge, M., Magill-Evans, J., & Kembhavi, G. (2003). Stability of serial assessments of motor and communication abilities in typically developing infants – implications for screening. *Early Human Development, 72,* 97–110.doi:10.1016/S0378-3782(03)00027-6

Desmarais, C., Sylvestre, A., Meyer, F., Bairati, I., & Rouleau, N. (2010). Three profiles of

language abilities in toddlers with an expressive vocabulary delay: Variations on a theme. *Journal of Speech, Language, and Hearing Research,53*, 699-709. doi: 10.1044/1092-4388(2009/07-0245)

Ellis Weismer, S., Murray-Branch, J., & Miller, J. F. (1994). A prospective longitudinal study of language development in late talkers. *Journal of Speech & Hearing Research, 37*(4), 852–867. Retrieved from http://jslhr.asha.org/

Feldman, H. M., Dale, P. S., Campbell, T. F., Colborn, D. K., Kurs-Lasky, M., Rockette, H. E., & Paradise, J. L. (2005). Concurrent and predictive validity of parent reports of child language at ages 2 and 3 years. *Child Development, 76*: 856–868. doi: 10.1111/j.1467-8624.2005.00882.x

Fenson, L., Bates, E., Dale, P., Goodman, J., Reznik, J. S., & Thal, D. (2000). Measuring variability in early child language: Don't shoot the messenger. *Child Development, 71,* 323–328. doi: 10.1111/1467-8624.00147

Girolametto, L., Wiigs, M., Smyth, R., Weitzman, E. & Pearce, P. S. (2001). Children with a history of expressive vocabulary delay: Outcomes at 5 years of age. *American Journal of Speech-Language Pathology, 10,* 358–369. doi: 10.1044/1058-0360(2001/030)

Heilmann, J., Ellis Weismer, S., Evans, J., & Hollar, C. (2005). Utility of the MacArthur-Bates Communicative Development Inventory in identifying language abilities of late-talking and typically developing toddlers. *American Journal of Speech-Language Pathology, 14,* 40–51. doi:10.1044/1058-0360(2005/006)

Heimann, M., Strid, K., Smith, L., Tjus, T., Ulvund, S. E., & Meltzoff, A.N. (2006). Exploring the relation between memory, gestural communication, and the emergence of language in infancy: A longitudinal study. *Infant and Child Development, 15*, 233–249. doi: 10.1002/icd.462.

Hoff, E. (2006). The uses of longitudinal data and person-centered analyses in the study of

cognitive and language development. *Merrill-Palmer Quarterly, 52*, 633-644. doi: 10.1353/mpq.2006.0028

Hulme, C. & Snowling, M. J. (2009). Specific language impairment. In C. Hulme & M. J. Snowling. *Developmental Disorders of Language Learning and Cognition* (pp.129–171). Chichester: Wiley-Blackwell.

Kadesjö, B., Janols, L.-O., Korkman, M., Mickelsson, K., Strand, G., Trillingsgaard, A., & Gillberg, C. (2004). The FTF (Five to Fifteen): the development of a parent questionnaire for the assessment of ADHD and comorbid conditions. *European Child and Adolescent Psychiatry, 13*, Supplement 3, 3–13. doi: 10.1007/s00787-004-3002-2

Kelly, D. J. (1998). A clinical synthesis of the "late talker" literature: Implications for service delivery. *Language, Speech, and Hearing in Schools, 29*, 76-84. Retrieved from http://lshss.asha.org/

Korkman, M., Jaakkola, M., Ahlroth, A., Pesonen, A.-E., & Turunen, M.-M. (2004). Screening of developmental disorders in five-year-olds using the FTF (Five to Fifteen) questionnaire: a validation study. *European Child and Adolescent Psychiatry, 13*, Supplement 3, 31–38. doi: 10.1007/s00787-004-3005-z

Korkman, M., Kirk, U., & Kemp, S. L. (1997). NEPSY. Lasten neuropsykologinen tutkimus [NEPSYA. Developmental Neuropsychological Assessment.]. Helsinki, Finland: Psykologien kustannus.

Laakso, M.-L., Poikkeus, A.-M., & Eklund, K. (2011). Lapsen esikielellisen kommunikaation ja kielen Ensikartoitus [The Infant-Toddler Checklist of children's prelinguistic communication and language]. Jyväskylä: Niilo Mäki Instituutti.

Laakso, M.-L., Poikkeus, A.-M., Katajamäki, J. & Lyytinen, P. (1999). Early intentional communication as a predictor of language development in young toddlers. *First language, 19,* 207–231. doi: 10.1177/014272379901905604

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000a). Prevalence and natural history of primary speech and language delay: findings from a systematic review of the literature. *International Journal of Language and Communication Disorders, 35,* 165–188. doi: 10.1080/136828200247133

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000b). The feasibility of universal screening for primary speech and language delay: findings from a systematic review of the literature. *Developmental Medicine & Child Neurology, 42,* 190–200. doi: 10.1111/j.1469-8749.2000.tb00069.x

Lyytinen, P., Poikkeus, A.-M., Laakso, M.-L., Eklund, K., & Lyytinen, H. (2001). Language development and symbolic play in children with and without familial risk for dyslexia. *Journal of Speech, Language, and Hearing Research, 44,* 873–885. doi: 10.1044/1092-4388(2001/070)

McCathren, R. B., Warren, S. F., & Yoder, P. J. (1996). Prelinguistic predictors of later language development. In. K. N. Cole, P. S. Dale, & D. J. Thal (Eds.), *Assessment of communication and language* (pp. 57–75). Baltimore: Paula H. Brookes.

Muthén B. O. (2001). Latent Variable Mixture Modelling. In: G.A. Marcoulides & R. E. Schumacker (Eds.). *New developments and techniques in structural equation modelling*. Mahwah NJ:Lawrence Erlbaum Associates.

Muthén, L. K., Muthén, B. O. (1998–2007). Mplus User's guide. Fifth edition. Los Angeles, CA: Muthén & Muthén.

Muthén B. & Shedden K. (1999). Finite mixture modelling with mixture outcomes using the EM algorithm. *Biometrics, 55*, 463–469. doi: 10.1111/j.0006-341X.1999.00463.x

Nagin D.S. (2005). Group-Based Modeling of Development. Cambridge, Massachusetts, Harward University Press.

Noterdaeme, M. & Amorosa, H. (1999). Evaluation of emotional and behavioral problems in

language impaired children using the Child Behavior Checklist. *European Child & Adolescent Psychiatry, 8,* 71–77. doi: 10.1007/s007870050087

Nylund, K. L., Asparouhov, T., & Muthén B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. *Structural equation modeling, 14*, 535–569. doi: 10.1080/10705510701575396.

Pickstone, C., Hannon, P., & Fox, L. (2002). Surveying and screening preschool language development in community-focused intervention programmes: a review of instruments. *Child: Care, Health & Development, 28*, 251–264. doi: 10.1046/j.1365-2214.2002.00270.x

Reilly, S., Eadie, P., Bavin, E. L., Wake, M., Prior, M., Williams, J., … Ukoumunne, O. C. (2006). Growth of infant communication between 8 and 12 months: A population study. *Journal of Paediatrics and Child Health, 42,* 764–770. doi: 10.1111/j.1440-1754.2006.00974.x

Rescorla, L. (2002). Language and reading outcomes to age 9 in late-talking toddlers. *Journal of Speech, Language, and Hearing Research, 45,* 360–371. doi: 10.1044/1092-4388(2002/028)

Rescorla, L. & Alley, A. (2001). Validation of the Language Development Survey (LDS): A parent report tool for identifying language delay in toddlers. *Journal of Speech, Language, and Hearing Research, 44*, 434-445. doi: 10.1044/1092-4388(2001/035)

Rescorla, L., Dahlsgaard, K., & Roberts, J. (2000). Late-talking toddlers: MLU and IPSyn outcomes at 3;0 and 4;0. *Journal of Child Language, 27*, 643–664. doi: 10.1017/S0305000900004232

Rescorla, L., Mirak, J., & Singh, L. (2000). Vocabularly growth in late talkers: lexical development from 2;0 to 3;0. *Journal of Child Language, 27,* 293–311. doi: 10.1017/S030500090000413X

Rescorla, L., Roberts, J., & Dahlsgaard, K. (1997). Late talkers at 2: Outcome at age 3. *Journal of Speech, Language & Hearing Research, 40*(3), 556–566. Retrieved from http://jslhr.asha.org/

Rutter, M. (2008). Diagnostic concepts and risk processes. In C. F. Norbury, & J. B. Tomblin (Eds.), Understanding Developmental Language Disorders: from theory to practice, (pp. 205–215). East Sussex: Psychology Press.

Schwartz G. (1978). Estimating the dimension of a model. *The Annals of Statistics, 6*(2), 461–464. Retrieved from http://www.imstat.org/aos/

Sturner, R. A., Layton, T. L., Evans, A. W., Heller, J. H., Funk, S. G., & Machon, M. W. (1994). Preschool speech and language screening: A review of currently available tests. *American journal of speech-language pathology, 3*(1), 25–36. Retrieved from http://ajslp.asha.org/

Thal, D. J., Bates, E., Goodman, J., & Jahn-Samilo, J. (1997). Continuity of language abilities: An exploratory study of late- and early-talking toddlers. *Developmental Neuropsychology, 13,* 239–273. doi: 10.1080/87565649709540681

Thal, D. J. & Katich, J. (1996). Predicaments in early identification of specific language impairment: Does the early bird always catch the worm?. In K. N. Cole, P. S. Dale & D. J. Thal (Eds.), *Assessment of communication and language* (pp. 1–28). Baltimore: Paul H. Brookes.

Thal & Tobias (1991). Language and gesture in late talkers: A 1-year follow-up. *Journal of Speech and Hearing Research, 34*(3), 604-612. Retrieved from http://jslhr.asha.org/

Thal & Tobias (1992). Communicative gestures in children with delayed onset of oral expressive vocabulary. *Journal of Speech and Hearing Research, 35*(6), 1281-1289. Retrieved from http://jslhr.asha.org/

Tolvanen, A. (2007). *Latent growth mixture modeling: a simulation study.* (Doctoral dissertation, Department of Mathematics and Statistics, University of Jyväskylä, Finland) Retrieved

from http://urn.fi/URN:ISBN:951-39-2971-8

Tomblin, J. B., Zhang, X., Weiss, A., Catts, H., & Ellis Weismer, S. (2004). Dimensions of individual differences in communication skills among primary grade children. In M. L. Rice & S. F. Warren (Eds.), *Developmental Language Disorders: From Phenotypes to Etiologies* (pp. 53–76). Mahwah NJ: Lawrence Erlbaum Associates.

von Eye, A. & Bogat, G.A. (2006). Person-oriented and variable-oriented research: Concepts, results, and development. *Merrill-Palmer Quarterly, 52*, 390-420. doi: 10.1353/mpq.2006.0032

Warren, S. F. (2000). The future of early communication and language intervention. *Topics in early childhood special education, 20,* 33–37. doi: 10.1177/027112140002000106

Watt, N., Wetherby, A., and Shumway, S. (2006). Prelinguistic predictors of language outcome at 3 years of age. *Journal of Speech, Language and Hearing Research, 49,* 1224–1237. doi: 10.1044/1092-4388(2006/088)

Wetherby, A. M., Allen, L., Cleary, J., Kublin, K., & Goldstein, H. (2002). Validity and reliability of the Communication and Symbolic Behavior Scales Developmental Profile with very young children. *Journal of Speech, Language and Hearing Research, 45,* 1202–1218. doi: 10.1044/1092-4388(2002/097)

Wetherby, A. M., Goldstein, H., Cleary, J., Allen, L., & Kublin, K. (2003). Early identification of children with communication disorders: Concurrent and predictive validity of the CSBS Developmental Profile. *Infants and Young Children, 16*(2), 161–174. Retrieved from http://journals.lww.com/iycjournal/

Wetherby, A. M. & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile (First normed edition.)* Baltimore: Paul H. Brookes.

Table 1

Summary of Demographic Information for Early Communication and Follow-up Subsets

	Early communication subset (n = 271)	Follow-up subset (n = 187)
	M (SD)	M (SD)
Parent's education		
Mother	4.1 (2.0)	4.2 (2.0)
Father	3.8 (2.0)	3.9 (1.9)
Parent's age at child's birth in years		
Mother	30.3 (5.2)	30.5 (5.2)
Father	32.6 (6.5)	32.7 (6.3)
Percentage of males	54.2%	51.3%

Table 2

Descriptive Data of the Early Communication Subset by Composite, Age and Gender

		Boys		Girls		Group comparisons
ITC composite	Age (months)	n	M (SD)	n	M (SD)	t
SOC	12	133	19.11 (3.59)	115	20.26 (3.20)	-2.64*
	15	137	21.40 (3.05)	117	22.49 (2.17)	-3.30**
	18	137	22.80 (2.48)	118	23.66 (2.13)	-2.96*
	21	136	23.85 (2.24)	118	24.53 (1.93)	-2.63*
SPE	12	133	7.29 (2.26)	115	8.30 (2.27)	-3.48**
	15	137	9.10 (2.20)	117	10.03 (2.10)	-3.39**
	18	137	11.04 (1.99)	118	11.56 (2.05)	-2.03
	21	136	12.66 (1.61)	118	13.08 (1.42)	-2.16
SYM	12	133	9.30 (2.08)	115	10.24 (2.36)	-3.35**
	15	137	12.58 (2.02)	117	13.39 (2.10)	-3.16**
	18	137	14.73 (1.61)	118	15.47 (1.38)	-3.93***
	21	136	15.90 (1.14)	118	16.43 (0.95)	-3.99***

Note. ITC = Infant-Toddler Checklist; SOC = Social composite of the ITC; SPE = Speech composite of the ITC; SYM = Symbolic composite of the ITC. The *p*-values are Bonferroni corrected for four measurement points of each Composite ($p^{corr} = 4 \times p$). The effect sizes were small (range 0.06 – 0.13) in all of the significant gender differences.

* p < .05. ** p < .01. *** p < .001.

Table 3

The Fit Information of the Latent Profile Analysis of the Early Communication Subset

Class	BIC	BLRT	Entropy
1	13116.80	-	-
2	12450.91	.0000	0.88
3	12296.34	.0000	0.84
4	12231.75	.0000	0.88
5	12160.62	.0000	0.87
6	12142.80	.0000	0.89
7	12142.14	.0000	0.90
8	12154.50	.0000	0.88
9	12171.45	.0000	0.88

Note. BIC = Bayesian Information Criterion; BLRT = Parametric Bootstrapped Likelihood Ratio Test

Table 4

The Distribution of Gender in the Early Communication Development (ECD) Groups

	Boys			Girls		
ECD group	n	%	Adj. Res.	n	%	Adj. Res.
1. A	51	57.3	0.7	38	42.7	-0.7
2. AA	24	34.8	-3.8	45	65.2	3.8
3. A+So	10	50.0	-0.4	10	50.0	0.4
4. BA+Sy	37	64.9	1.8	20	35.1	-1.8
5. ED	16	66.7	1.3	8	33.3	-1.3
6. BD	9	75.0	1.5	3	25.0	-1.5

Note. Adjusted residuals that have an absolute value over 1.96 are considered to be significant. ECD group = Early Communication Development group; A = Average; AA = Above average; A+So = Average with fluctuating social skills; BA+Sy = Below average with symbolic difficulties; ED = Expressive difficulties; BD = Broad difficulties.

Table 5

Descriptive Data of the Follow-up Subset by Gender

		Boys		Girls		Group comparisons
Measure	Age	n	M (SD)	n	M (SD)	t
ITC composite						
SOC	12	85	19.09 (3.59)	85	20.36 (3.12)	-2.46
	15	92	21.42 (3.11)	86	22.63 (2.16)	-3.01*
	18	89	22.73 (2.57)	86	23.69 (2.11)	-2.70*
	21	89	23.82 (2.30)	88	24.63 (1.79)	-2.60*
SPE	12	85	7.33 (2.21)	85	8.29 (2.34)	-2.76*
	15	92	9.21 (2.01)	86	10.02 (2.16)	-2.62*
	18	89	11.27 (1.91)	86	11.47 (2.06)	-0.65
	21	89	12.79 (1.56)	88	13.03 (1.39)	-1.11
SYM	12	85	9.34 (2.02)	85	10.15 (2.31)	-2.44
	15	92	12.66 (2.03)	86	13.48 (2.23)	-2.55*
	18	89	14.74 (1.68)	86	15.56 (1.32)	-3.59***
	21	89	15.92 (1.06)	88	16.44 (0.97)	-3.42**
FTF subdomain						
Comprehension	55	96	0.24 (0.26)	91	0.23 (0.33)	0.15
Expressive	55	96	0.28 (0.34)	91	0.16 (0.23)	2.84**
Communication	55	96	0.32 (0.45)	91	0.26 (0.34)	0.96

Note. ITC = Infant-Toddler Checklist; SOC = Social composite of the ITC; SPE = Speech composite of the ITC; SYM = Symbolic composite of the ITC; FTF = Five to Fifteen questionnaire. The *p*-values are Bonferroni corrected for four measurement points of each Composite ($p^{corr} = 4 \times p$).The effect sizes were small (range 0.10 – 0.14) in all of the significant gender differences.

* p < .05. ** p < .01. *** p < .001.

Table 6

A Crosstabulation of the Early Communication Development Groups and Parental Concerns Reported at the Follow-up Stage

		ECD Group																	
		1. A (n=65)			2. AA (n=48)			3. A+So (n=17)			4. BA+Sy (n=37)			5. ED (n=12)			6. BD (n=8)		
FTF domain	Parental concern	n	%	Adj. Res.	n	%	Adj. Res.	n	%	Adj. Res.	n	%	Adj. Res.	n	%	Adj. Res.	n	%	Adj. Res.
Total language	Yes	2	3.1	-2.3	1	2.1	-2.1	1	5.9	-0.6	8	21.6	2.6	5	41.7	3.7	2	25.0	1,4
	No	63	96.9	2.3	47	97.9	2.1	16	94.1	0.6	29	78.4	-2.6	7	58.3	-3.7	6	75.0	-1.4
Comprehension	Yes	6	9.2	-0.1	1	2.1	-2.1	1	5.9	-0.5	7	18.9	2.1	2	16.7	0.9	1	12.5	0.3
	No	59	90.8	0.1	47	97.9	2.1	16	94.1	0.5	30	81.1	-2.1	10	83.3	-0.9	7	87.5	-0.3
Expressive	Yes	2	3.1	-1.5	1	2.1	-1.5	0	0	-1.2	6	16.2	2.5	3	25.0	2.5	1	12.5	0.6
	No	63	96.9	1.5	47	97.9	1.5	17	100	1.2	31	83.8	-2.5	9	75.0	-2.5	7	87.5	-0.6
Communication	Yes	4	6.2	-1.6	0	0	-2.9	1	5.9	-0.7	11	29.7	4.0	3	25.0	1.6	2	25.0	1.3
	No	61	93.8	1.6	48	100	2.9	16	94.1	0.7	26	70.3	-4.0	9	75.0	-1.6	6	75.0	-1.3

Note. Adjusted residuals that have an absolute value over 1.96 are considered to be significant. The parental concern groups for the FTF Total language were created using the standardized 90th percentile cut-off, and for the separate FTF domains using the 90th percentile of the current data. ECD group = Early Communication Development group; A = Average; AA = Above average; A+So = Average with fluctuating social skills; BA+Sy = Below average with symbolic difficulties; ED = Expressive difficulties; BD = Broad difficulties; FTF = Five to Fifteen questionnaire.

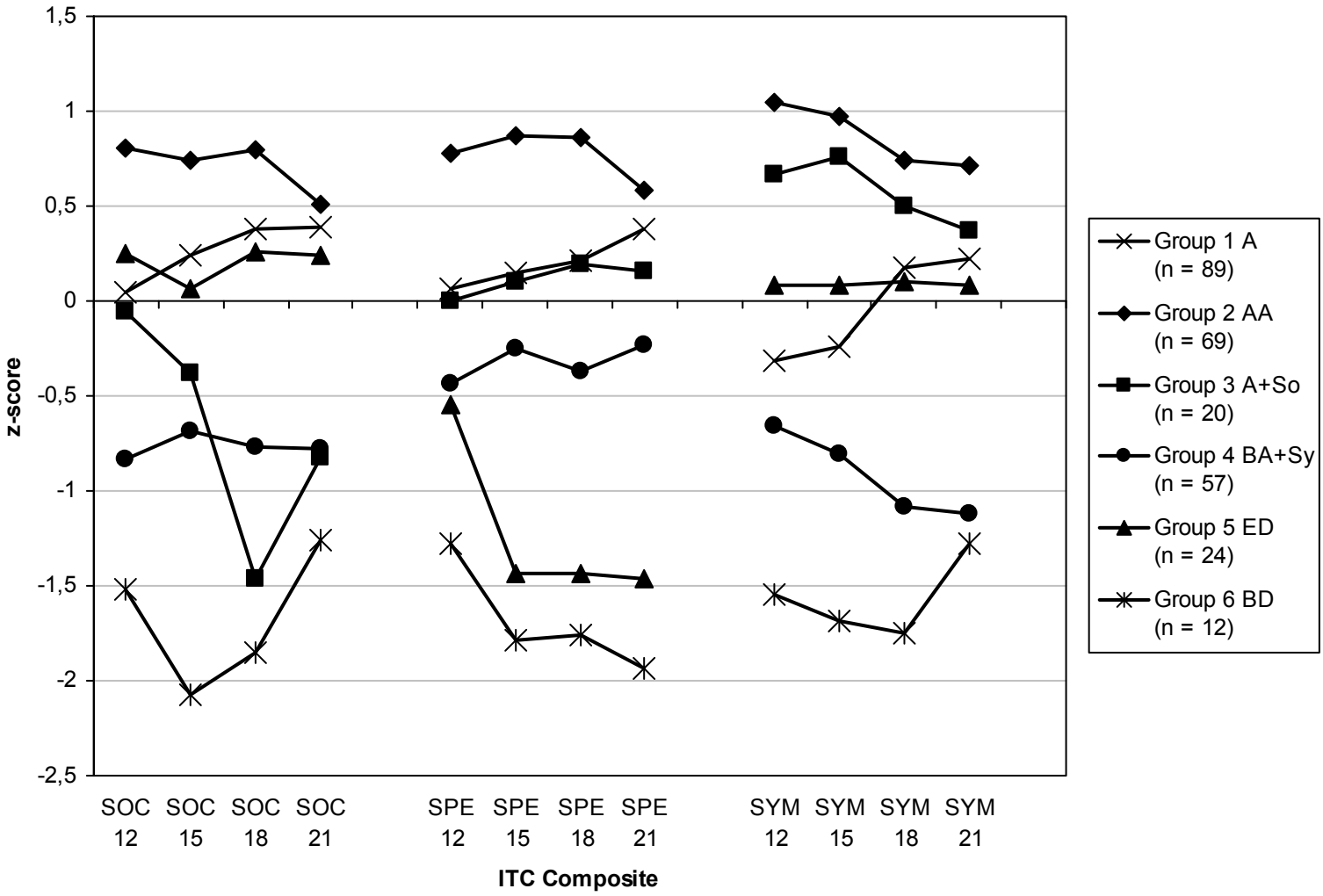

Figure 1. The profiles of the Early Communication Development (ECD) groups. Profiles are based on the standardized estimated means. Standardization was done using the sample means and standard deviations of each age stage. ITC = Infant-Toddler Checklist; SOC = Social composite of the ITC; SPE = Speech composite of the ITC; SYM = Symbolic composite of the ITC; A = Average; AA = Above average; A+So = Average with fluctuating social skills; BA+Sy = Below average with symbolic difficulties; ED = Expressive difficulties; BD = Broad difficulties.

III

CHILDREN WITH DIFFERING DEVELOPMENTAL TRAJECTORIES OF PRELINGUISTIC COMMUNICATION SKILLS: LANGUAGE AND WORKING MEMORY AT AGE 5.

by

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