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Action Imitation at 1 ½ Years is Better Than Pointing Gesture in Predicting Late Development of Language Production at 3 Years of Age

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Abstract

This study examined whether poor pointing gestures and imitative actions at 18 months of age uniquely predicted late language production at 36 months, beyond the role of poor language at 18 months of age. Data from the Norwegian Mother and Child Cohort Study were utilized. Maternal reports of the children's nonverbal skills and language were gathered for 42,517 children aged 18 months and for 28,107 of the same children at 36 months. Panel analysis of latent variables revealed that imitative actions, language comprehension, and language production uniquely contributed to predicting late development of language production, while pointing gestures did not. It is suggested that the results can be explained by underlying symbolic representational skills at 18 months.

Keywords

The Norwegian Mother and Child Cohort Study; pointing gestures; imitative actions; language comprehension; language production

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The relation between nonverbal and verbal modalities of communication is of special interest in research on language development (Acredolo & Goodwyn, 1988; Bates & Dick, 2002; Goldin-Meadow, 2006). Many studies have investigated whether or not nonverbal skills are early identifiers of later language and language delay (Crais, Watson, & Baranek, 2009; Rowe & Goldin-Meadow, 2009; Rowe, Ozcaliskan, & Goldin-Meadow, 2008; Thal, Tobias, & Morrison, 1991; Watt, Wetherby, & Shumway, 2006). This objective has practical implications with regard to detecting intervention needs early on, and provides knowledge about the nature and origins of the emergence and development of language in general.

Early *nonverbal skills* incorporate gestures and more general abilities related to social interaction and cognition, such as (joint) attention, perception, imitation, and symbolic processing (Bates & Dick, 2002). These are all considered vital for the identification of delays in communication and language (Crais et al., 2009; McCathren, Warren, & Yoder, 1996). Before language is acquired, children especially depend on *gestures* when communicating (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bleses et al., 2008). Gestures are expressed by fingers, hands, arms, facial features, or body motions (Crais et al., 2009). When first starting to communicate intentionally, toddlers typically use *deictic* gestures, such as pointing, showing, giving, or requesting (Bates et al., 1979; Camaioni, Aureli, Bellagamba, & Fogel, 2003; Capirci, Iverson, Pizzuto, & Volterra, 1996). These gestures can either involve intentions to request, or just declare, something, but do not have a precise referent (Capirci et al., 1996). Subsequently, a repertoire of *representational* gestures with concrete symbolic meanings or referents, like raising the palms to indicate ‘*all gone*’, appears (Camaioni et al., 2003; Crais et al., 2009). At the same time, children depend on other nonverbal skills, like actions with objects, imitation, and pretending to be an adult, in early social interactions. These skills are thought to express “a growing understanding of the world of objects and the use of things”, and are “the first true symbolic gestures” (Fenson et al., 2007, p. 10).

These nonverbal skills often emerge before linguistic skills and are then referred to as prelinguistic, but are maintained along with verbal communication after acquiring language. Throughout the second and third year of life, children’s abilities to comprehend and produce words and sentences increase dramatically (Luinge, Post, Wit, & Goorhuis-Brouwer, 2006; Watt et al., 2006). The growing complexity of language with increasing age may be viewed as successive milestones that are an expression of an underlying linguistic ability (Luinge et al., 2006), and prelinguistic skills could be its earliest expression. Along these lines, a link between simple actions, actions represented by gestures, and vocal representational skills has been proposed (Volterra, Caselli, Capirci, & Pizzuto, 2005).

Girls appear advantaged not only in the development of language (Bouchard, Trudeau, Sutton, Boudreault, & Denault, 2009; Fenson et al., 2007; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991), but also with regard to the use of early gestures (Acredolo & Goodwyn, 1988; Fenson et al., 2007). In contrast, boys show an increased liability for language impairment and delay (Campbell et al., 2003; Tomblin et al., 1997). *Liability* refers to vulnerability for undesirable outcomes or being at risk for impairment or delay. The gender disparity could result from a qualitatively different path, starting before the acquisition of language, or just from variability in the course of development.

To date, few studies have specifically compared how various aspects of nonverbal skills predict late language development in children older than 2 years of age. There is also limited knowledge of whether or not nonverbal skills contribute uniquely in predicting subsequent late language development, and whether or not the associations are different for boys and girls. Previous work has disentangled some of the links between aspects of children’s nonverbal skills and later language development and delay (Bavin et al., 2008; Laakso, Poikkeus, Katajamaki, & Lyytinen, 1999; Rowe & Goldin-Meadow, 2009; Thal et al., 1991). The results so far, point to underlying communicative intentions and symbolic representation capacities as likely explanations (Bates & Dick, 2002; Tomasello, 2003; Werner & Kaplan, 1963).

Relations Between Nonverbal Skills and Language Development

The MacArthur-Bates Communicative Development Inventories (CDI) is a parental report instrument (Fenson et al., 1994; Fenson et al., 2007), which has been widely used in research on associations between nonverbal skills (i.e., the *Actions* and *Gesture* section of

the MacArthur-Bates) and development of language comprehension and production. During the first one-and-a-half years of life, Action and Gesture productions show a high concurrent correlation with word comprehension, but a low correlation with word production (Dale & Goodman, 2005; Fenson et al., 1994; Fenson et al., 2007; Kern, 2007). A recent large community study using maternal reports based on the MacArthur-Bates found a similar difference in predictive impact; children's early Action and Gesture productions at 8 months predicted more variance in language comprehension (22.4%) than language production (14.3%) at 12 months (Bavin et al., 2008). The children's Action and Gesture productions at 12 months continued to explain 14.5% of the variance in language production at 2 years (Bavin et al., 2008), indicating a somewhat weaker, but prolonged, predictive relation.

The stronger relation of nonverbal skills with language comprehension compared to language production early on could be a matter of proximity in the emergence of these skills. At the same time, observational studies indicate differential relations between special aspects of nonverbal skills and development of language comprehension and production. Deictic gestures at 14 months uniquely predict language comprehension, but not language production at 3 years (Watt et al., 2006). Likewise, research has revealed that different types of joint attention skills are predictive of later language comprehension and language production (Laakso et al., 1999; Mundy & Gomes, 1998; Watt et al., 2006). For instance, infants' ability to imitate maternal actions and to follow and direct mothers' gaze at 14 months uniquely predicts language production at 2 years (Laakso et al., 1999).

Before the age of 2 years, representational gestures precede the linguistic production of the corresponding word on average by 3 months, and pave the way for word acquisition (Iverson & Goldin-Meadow, 2005). Representational gestures are especially frequent before children acquire language, and decrease as words referring to the same semantic content appear (Camaioni et al., 2003; Iverson, Capirci, & Caselli, 1994). Accordingly, representational gestures predict both the initial stages of vocabulary production (i.e., 10-word milestone), as well as later vocabulary comprehension size at 3.5 years (Rowe & Goldin-Meadow, 2009), but not more grammatical related aspects of language (Acredolo & Goodwyn, 1988; Rowe & Goldin-Meadow, 2009).

Deictic gestures, on the other hand, increase in the second year of life (Camaioni et al., 2003; Iverson et al., 1994), and seem to have a special role in the transition from one-word to two-word utterances (Goldin-Meadow & Butcher, 2003). Before children produce two-word sentences, they typically combine single gestures with single words when communicating (Volterra et al., 2005). The combination of a deictic pointing gesture and a referential word has been found to be the most produced cross-modal utterance at 16 and 20 months (Capirci et al., 1996). Thus, cross-modal productions pave the way to grammar, and are good indicators of the onset of two-word sentences (Butcher & Goldin-Meadow, 2000), and sentence complexity at 3.5 years (Rowe & Goldin-Meadow, 2009).

Regardless of these specific relations between concrete nonverbal skills and specific language outcomes, as mentioned by Fenson et al. (2007), early language comprehension has been found to best predict typical language development and persistent language impairment (Bates, Bretherton, & Snyder, 1988; Thal & Katich, 1996 for review; Watt et al., 2006). This raises the question of whether or not nonverbal skills can uniquely contribute to the prediction of late language development, when controlling for early language abilities, and especially language comprehension. The longitudinal correlation between deictic gestures around 1 year of age and language production at ages 2 and 3 years, of approximately .30, has been found not to contribute greatly in the unique prediction of late language development when initial language skills are included in the regression analyses (Bavin et al., 2008; Watt et al., 2006). However, a small follow-up study found that

production of gestures *and* poor language comprehension predicted who would continue to have language problems from the late talkers who caught up with their peers after a year (Thal et al., 1991). To further explore this association, larger samples are needed to compare the relative impact of the nonverbal and linguistic predictors. Another, large-scaled, study aimed at identifying children with severe language delay at 3 years using a screening version of the Swedish CDI that was implemented when the children were 18 months old found a cut-off of less than eight spoken words to be the best early indicator. The gesture and language comprehension components did not, however, efficiently identify the children (Westerlund, Berglund, & Eriksson, 2006). In sum, there is a need to further examine how diverse aspects of early nonverbal skills, in contrast to early language comprehension and production, impact the liability for late language development at 3 years.

Communicative Intentions and Symbolic Representation

Attempting to understand and explain the patterns of relations between nonverbal skills and later language outcomes is by now an historic endeavor with numerous proposals. Bates et al. (1979) made a distinction between early processes that underlie the emergence of (a) communicative intentions and more conventional signs (Lyytinen, Laakso, Poikkeus, & Rita, 1999; Tomasello, 2003), and (b) symbols that represents reality (Piaget, 1962; Werner & Kaplan, 1963). Both nonverbal skills and language offer a modality for intentionally conveying messages to others (i.e., communication; Blakar, 1984), and for symbolic representations essential for language, cognition, and social interactions. While the process of intentionally calling attention to something can be regarded as a deictic skill, use of concrete symbols can be regarded as a representational skill. These two aspects can explain the patterns of relations described in the aforementioned literature. The emergence of communicative intentions could inform on the strong early concurrent relation between Action/Gestures and language comprehension, while symbolic representations could explain the relation of Action/Gesture productions with the emergence of lexical words and two-word utterances (Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009). It is not necessarily contradictory that both the capacity for communicative intentions and for symbolic representation may explain the relations between deictic gestures and language. Deictic gestures can have different functions at different ages. The earliest deictic gestures are likely strongly related to the concrete reality of the child (Capirci et al., 1996), and immediate communicative needs: First, the need to request something, and then, the need to socially propose a common focus of attention. Later deictic gestures might function as precursors for deictic words, with more complex conceptual distinctions (Capirci et al., 1996).

Action/Gesture productions can additionally provide some sensorimotor components of object referents before the verbal symbols are available (Iverson et al., 1994), and represent a temporary bridge between language comprehension and language productions (Fenson et al., 1994).

The ability to imitate and copy others' actions has been argued to be essential when learning new sets of just graspable actions and sounds (Kagan, 1981). Ritualized routines and play interactions provide opportunities for learning context-bound imitative actions (Acredolo & Goodwyn, 1988; Volterra et al., 2005). These context-bound imitative actions subsequently get "*decontextualized*" (Werner & Kaplan, 1963): They become representational gestures with concrete meanings across settings, which ultimately develop into language (Acredolo & Goodwyn, 1988; Volterra et al., 2005). Imitation could promote the emergence of representational meaning, as advanced by Piaget (1962). Thus, the role of both gestures and imitative actions could represent vital processes for the transition to different linguistic milestones at different time points.

The Present Study

This study extends previous work by comparing the predictive role of two different aspects of nonverbal skills for the liability for late development of language production after the age of 2 years. We applied structural equation modeling using a population-based sample. The approach allows for concurrent investigation of several relations within and across time, and for comparison of the relative impact of different early indicators. We had two main questions. First, whether poor pointing gestures or poor imitative actions at 18 months best predict late development of language production from 18 to 36 months (path c versus d in Figure 1). Second, whether poor nonverbal behaviors or poor language at 18 months best predict late development of language production from 18 to 36 months (path c and d versus a and b).

We also addressed two additional issues. Since the design and sample was suited to investigate gender interactions with a small risk for Type II errors, we investigated whether or not the relations were different for boys and girls. Finally, we examined whether or not the strong cross-sectional relation previously found between children's language comprehension and nonverbal skills around 18 months, applied both to pointing gestures and imitative actions.

Method

The Norwegian Mother and Child Cohort Study

The Norwegian Mother and Child Cohort Study (MoBa) is a prospective population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health (Magnus et al., 2006). Between 1999 and 2008, pregnant women were invited to participate in connection with a routine ultrasound examination at 17–18 weeks of gestation (<http://www.fhi.no/moba-en>). The cohort includes over 100,000 children, with a participation rate around 43.5% (Nilsen et al., 2009). Informed consent was obtained upon recruitment, and the study was approved by The Regional Committee for Medical Research Ethics in South-Eastern Norway. Information on the health and background of the mothers and fathers, and the children's development, was collected through questionnaires at the 17th, 22nd and 30th weeks of gestation, and when the children were 6, 18, and 36 months of age (Magnus et al., 2006). The response rates were around 91–95% during pregnancy, 86% at 6 months, 75% at 18 months, and 62% at 36 months (Magnus, 2007). Mothers from a range of socioeconomic levels participated, but mothers in MoBa were on average older and more often living with a partner compared to all mothers who gave birth in Norway during the same period (Nilsen et al., 2009). When further compared on selected exposures and outcomes, prevalence estimates, but not estimates of associations between exposures and outcomes, was found to entail a risk for bias by self-selection (Nilsen et al., 2009).

The current study is based on version four of the quality-assured data files. Information on the children's nonverbal skills and language was derived from the maternally-reported questionnaires at 18 and 36 months. Other data about the children were from the questionnaires collected at the 17th gestational week, and 6, 18, and 36 months. Records on birth and health status at birth are from the Medical Birth Registry of Norway (Irgens, 2000).

Participants

The 18-months sample comprises 43,870 children born before February 2006, of whom 1,346 were excluded. Exclusion criteria were Down syndrome, cleft and/or lip palate, or serious malformation at birth; reports of severe syndromes or neurodevelopment difficulties at 18 months; of cerebral palsy at 18 or 36 months; or of autistic traits at 36 months. Seven

more children were excluded due to unknown gender. Of the remaining 42,517 children (20,902 girls and 21,615 boys), 1,372 were from multiple pregnancies. At 36 months, data was available for 28,107 (14,270 boys and 13,837 girls) of the children from the original 18 months sample.

Measures

MoBa includes items from several instruments that capture different aspects of social skills, communication, and language. At 18 months, a selection of questions originally derived from the Norwegian version of the Ages and Stages Questionnaires (ASQ; Janson & Squires, 2004), the Modified Checklist for Autism in Toddlers (MCHAT; Robins, Fein, Barton, & Green, 2001), and the Non-Verbal Communication Checklist (NVCC; Schjølberg, 2003) were utilized. From the 36 months questionnaire, selected questions from ASQ and the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003), and a question about the complexity and comprehensibility of child utterances with six response categories (Dale, Price, Bishop, & Plomin, 2003) were used. Items from M-CHAT and SCQ had two response categories (*yes / no*); NVCC and ASQ items had three (*yes or yes, usually / sometimes or rarely / not yet*).

Latent Variable Measurement Models

Questions measuring aspects of communication and language at 18 and 36 months from the measures mentioned earlier above were selected for face-validity consideration. Based on classifications by three clinical psychologists and researchers within the child development field and subsequent discussions with other researchers, selected items were assigned to: Four mutually exclusive constructs at 18 months indicating *liability for late* (1) *pointing gestures* (PG; i.e., deictic pointing gestures to indicate request or interest), (2) *imitative actions* (IA; i.e., imitations of parents faces and activities), (3) *language comprehension* (LC; i.e., understanding and appropriate responses to language utterances of others), (4) *language production* (LP; i.e., child's own production of language utterances); and one LP construct at 36 months. Ambiguous items capturing more general social and nonverbal communicative developmental delays, or items that were difficult to allocate solely to one category, were not included. Latent measurement models at 18 and 36 months were generated. Estimation of the model fit is described in detail in the Analysis section.

At 18 months, the items capture liabilities for being late using pointing gestures, imitative action, language comprehension, and language production skills. The abbreviations, PG, IA, LC, and LP used in the method and result sections, incorporate this liability for being late within each latent variable. Subsequently, when we used these 18 months measures to predict change in LP from 18 to 36 months, we predicted the liability to show late language development. There was only one item on LP at 18 months: Production of 8 or more words, in addition to “mama” and “dada.” The item originated from the Norwegian version of ASQ. A similar item has been used to detect late language development at 18 months in Swedish children (Eriksson, Westerlund, & Berglund, 2002).

Analyses

The analyses were conducted using Mplus version 6.0 (Muthén & Muthén, 2010). The response categories were treated as discrete levels on an ordinal scale, and we thus used confirmatory factor analysis (CFA) for ordinal data (Flora & Curran, 2004). Multiple-group analyses with boys and girls were performed to take into consideration sex differences, both when operationalizing the constructs into the observed variables, and when investigating the relations between these measures. We adjusted the standard errors upwards using the complex-sample option in Mplus in order to account for dependencies between siblings in

the sample. The statistical analyses involved two steps, described in the following two paragraphs.

Statistical fit of the measurement models—At 18 months, the LP item was used as a single indicator of a latent factor with variance and factor loading of unity, leading to a correlation of 1.00 between the LP item and the latent variable used in the analyses. There were only two indicator items for PG, and two for IA, and these items were set to be equal within each latent variable when testing the statistical fit at 18 months. A four-factor CFA, including the latent variables PG, IA, LC, and LP was employed. It was ensured that the items had factor loadings above .4 and no substantial cross-loadings indicated by the modification indices. The four-factor solution fit the data well (Hu & Bentler, 1999): Comparative Fit Index (CFI) = .985, Root Mean Square Error of Approximation (RMSEA) = .023. All factor loadings were above .52 (see Appendix A for complete set of items and factor loadings). We then tested whether the 18 months measurement model reached measurement invariance (MI) across boys and girls. The mean adjusted robust weighted least square estimator (WLSM) was used across the MI analyses (Flora & Curran, 2004; Muthén & Muthén, 2010). Table 1 shows the results of the MI tests. Due to the large sample size, we adopted the proposal by Cheung and Rensvold (2002) to rely not only on the $\Delta\chi^2$ but also to examine ΔCFI as an indication of MI. The ΔCFI of the measurement model constrained to scalar invariance (i.e., equal factor loadings and thresholds) had no worse fit to the data. Therefore, we concluded that latent factor covariance and mean comparisons across gender were meaningful.

The same procedure and criteria were employed with the 36 months model. The CFA involved the test of a one-factor solution of LP that fit the data well (Hu & Bentler, 1999): CFI = .993, RMSEA = .031. All loadings were above .62 (see Appendix B for items and factor loadings). Next, we tested whether or not the LP factor at 36 months reached MI across gender (Table 1). The measurement model constrained to scalar invariance had no worse data fit, permitting comparisons of latent factor covariances and means across gender at 36 months, too.

Regression analyses—The cross-sectional and longitudinal predictive relations including the models from both 18 and 36 months were estimated and tested in a structural equation model (see Figure 1). To estimate the latent factor variance for both girls and boys, the best items of LC at 18 months and LP at 36 months were set to 1, as were both the items in PG and IA, while the latent factor variance was estimated for both girls and boys. Measurement error for LP at 18 months could not be estimated, as there was only one item. This resulted in an underestimation of the associations of LP at 18 months with the other latent constructs, due to attenuation. The mean- and variance-adjusted robust weighted least square estimator (WLSMV) was used for the regression analyses (Flora & Curran, 2004; Muthén & Muthén, 2010), and the diff-test option in Mplus was used to test equality on specific parameters across gender and constructs.

Missing data—For missing observed data, we used the robust weighted least square approach in Mplus, appropriate for ordinal data with non-normal distributions (Flora & Curran, 2004). By estimating missing data within questionnaires and non-responses, cases with partial data are retained for analysis. This approach, as compared to listwise deletion, limits selection bias under the missing-at-random assumption (Graham, 2008). Missing data addressing how old the children were on the date the mothers filled out the questionnaires were imputed using information on date of return of the questionnaires, utilizing an estimation-maximization algorithm in SPSS 14.0 (SPSS, Inc, Chicago, IL). Due to missing data that could not be estimated, a total of 290 children were not included in the final

analysis. Thus, the final analysis sample consisted of 42,227 children (20,775 girls and 21,452 boys).

Adjusting variables—In the final analyses, we adjusted for the children's gestational age at birth, the age of the children in weeks when the mothers completed the questionnaires at 18 and 36 months, and whether or not at least one of the parents had a mother tongue other than Norwegian. Gestational age, determined using ultrasound examination or maternal reports when ultrasound information was lacking, was centralized to week 40. Age at questionnaire completion was centralized to the children's 18- and 36-month birthdays.

Results

Descriptive Results

Table 2 shows that at 18 months, the LP item was substantially correlated with LC, moderately correlated with IA, and weakly correlated with PG. LC, on the other hand, was strongly correlated with both LP and IA, and moderately correlated with PG. The measures of the nonverbal skills, PG and IA, also showed a moderate to strong correlation. Across time, LP at 36 months had strong correlations with all measures except with PG, which was moderate.

In table 3, the means and standard deviations of the latent measures for both girls and boys are presented. As expected, the boys had overall lower means than the girls on all variables at both time points, except for PG at 18 months. The gender differences reached significance for IA, LC, and LP at 18 months ($p < .000$), but not for LP at 36 months. The amount of individual differences within gender (i.e., variances) was not different across gender.

Predictive and Cross-Sectional Results

Figure 2 shows the cross-sectional and longitudinal analyses, with separate results for girls and boys. LP at 36-months was regressed on LP, LC, IA and PG at 18 months. Thus, the predictive paths of LC, IA, and PG can be considered to denote the prediction of change in, or an improvement of, LP from 18 to 36 months (i.e., deviation after taking LP at 18 months into account).

First, we examined whether PG or IA at 18 months predicted a positive change in LP between the ages of 18 and 36 months. As seen in Figure 2, IA predicted a change in LP, and accounted for roughly 2.5% and 7.5% unique variance of change in LP in boys and girls, respectively, adjusted for the explained variance mediated through the other factors at 18 months. The difference in the size of this correlation coefficient did not significantly differ across gender ($p = .08$). An IA variable with more items included would perhaps have provided more strength to find such an interaction. In comparison, PG did not predict a positive change in LP. When explicitly tested, IA predicted change in LP significantly stronger than PG (i.e., path c was stronger than path d; $p < .000$).

Next, we compared the predictive impact of the nonverbal variables, IA and PG, with the predictive impact of the two language variables, LC and LP, on LP at 36 months. LC accounted for the most unique variance in change in LP, approximately 13–15%, when adjusted for the other variables at 18 months. This prediction was significantly stronger than that of PG and LP in both girls and boys (i.e., path b was stronger than d and a; $p < .000$), and that of IA in boys (i.e., path b was stronger than c; $p < .05$). Similarly, the LP item at 18 months accounted for 3–4% of unique variance of change in LP, which was significantly weaker than the predicted change by IA for girls (i.e., path c was stronger than path a; $p < .$

01). However, since LP at 18 months only consisted of one item, this was not adjusted for measurement error, which could have made the influence of LP at 18 months larger.

Even if the girls and boys did not significantly differ on any of the predictive parameters, the explained variance (R^2) of the children's LP at 36 months was significantly larger for girls than boys ($p < .000$). This meant that the shared variance of the predictors at 18 months explained more of LP at 36 months in girls (total correlation [$R = .72$]), than in boys ($R = .64$).

All the adjusted concurrent associations at 18 months were significant (Figure 2). Except for the finding that the relation between IA and LC was stronger for the girls ($p = .05$), the boys and girls did not differ on these relations. LC was moderately correlated with PG and strongly correlated with IA, while the relations of PG and IA with LP were weak and moderate, respectively. In fact, both the children's PG and IA were significantly more related to their LC than their LP ($p = .005$ for boys; $p < .000$ for girls). Still, LP and LC were more related with each other than with both PG and IA ($p < .000$).

Discussion

First and foremost, it was of interest to find out whether the liability for late use of either pointing gestures or imitative actions at 18 months best predicted late development in language production from 18 to 36 months in a large population-based sample. While poor imitative actions at 18 months were a significant and strong predictor of late language production from 18 to 36 months, poor pointing gestures at 18 months had no unique predictive value. Thus, imitative actions at 1.5 years have been found to predict language production at 2 years (Laakso et al., 1999), and now also change in language production from 1.5 to 3 years.

Second, we investigated whether liability for late nonverbal behaviors (i.e., pointing gestures and imitative actions) or liability for late language (i.e., language comprehension and language production) was the best indicator at 18 months of late development in language production from 18 to 36 months. Poor language comprehension was the most influential predictor of a liability for late language development from 18 to 36 months. This effect was significantly stronger than all separate effects of the other predictors, except for imitative actions in girls. Thus, as shown before (Watt et al., 2006), late early language comprehension is *the* best indicator of late language development. Moreover, language production at 18 months accounted for more variance than pointing gestures, but not more than imitative actions.

The design and large sample was suited to investigate gender interactions. It was expected that boys would have lower means on all variables at both time points, but that their developmental patterns still would be similar to those of girls. The girls and boys did not differ significantly on the strength of any of the predictive parameters, except for a tendency for imitative actions to be more important for change in language production in girls, and the cross-correlation between language comprehension and imitative actions at 18 months was significantly larger in girls than in boys. Although, the extent of individual differences (i.e., variance) in general was equal for boys and girls, the boys had, except for pointing gestures, lower means at both time points. Even though the gender difference in language production at 36 months was not significant, the pattern fits the general picture of boys showing a liability for delays both at early (Acredolo & Goodwyn, 1988) and late stages of language development (Bouchard et al., 2009).

The explained variance of the children's language production at 36 months was significantly larger for girls than boys. Thus, the shared variance of the predictors at 18 months as a

whole explains more of language production at 36 months in the girls. Conversely, unknown etiological factors for the development in language production from 18 to 36 months that were not included in this study are of greater importance for boys than girls. Still, the lack of gender differences in the predictive parameters indicates that the role of the 18 months indicators as predictors of language production is not substantially different for girls and boys.

Finally, we investigated the cross-sectional relations at 18 months. Almost all cross-sectional correlations between the variables were high. The exception was a weak correlation between pointing gestures and language production. In accordance with previous research, we found that both imitative actions and pointing gestures were more strongly correlated with language comprehension than language production at 18 months (Fenson et al., 1994; Fenson et al., 2007). Moreover, pointing gestures were particularly more strongly related to language comprehension than language production. Nonetheless, at 18 months, the linguistic variables were most strongly related to each other.

The Predictive Role of Symbolic Representational Skills

After taking LP at 18 months into account, the predictive estimates of language comprehension, imitative actions, and pointing gestures at 18 months denoted the prediction of change in language production from 18 to 36 months. Even though prediction of change is not sufficient for establishing causality, it is indeed a *sine qua non*. This implies that pointing gestures at 18 months do not increase the liability for late language production at this age, but supports the possibility of language production, language comprehension, and imitative actions having such a role. This is in line with research showing that the majority of infants produce pointing gestures around 1 year of age, while imitative actions typically are produced later (Fenson et al., 1994; Fenson et al., 2007). Pointing gestures could be a better predictor of later language production if considered at an earlier age.

Imitative actions were the nonverbal latent variable with predictive validity in this study. When imitating mothers facial expressions, copying their actions, or pretending to do what they do, children express an understanding of objects, object use, and early symbolic gestures (Fenson et al., 2007, p. 10). As promoted by Piaget (1962), imitation could be a central action for the emergence of representational meaning. If imitation is crucial for acquiring a new linguistic repertoire (Kagan, 1981), this might well happen through a “decontextualization” process (Werner & Kaplan, 1963). These immediate imitative actions could be the earliest expressions of what develop into representational gestures and subsequently representational words (Acredolo & Goodwyn, 1988; Volterra et al., 2005). Thus, by providing children with a tool for converting actions to symbolic meanings, imitation could be the proposed link between real actions, actions represented by gestures, and vocal representational skills (Volterra et al., 2005). We did not have data on representative gestures, but we hypothesize that there would be specific relations between imitative skills and representative gestures. When late imitative actions at 18 months predict late language production at 36 months, this may be because the transition from actions to symbolic representation is hampered. In this sense, not only children’s acquired language, but their imitative actions, can be considered to reflect representational and symbolic skills at 18 months that predict the development of language production from 18 to 36 months of age (Acredolo & Goodwyn, 1988; Cruse, 1986; Volterra et al., 2005; Werner & Kaplan, 1963). Similarly, some symbolic representational aspects of language comprehension could be the underlying skills predicting later language production, as compared to more general intention-reading abilities. The high factor loadings of the three language comprehension items related to comprehension of names for familiar objects could reflect this. Both language comprehension and imitative action may well function as signs of early language delay, before language production is acquired.

Liability for late pointing gestures did not uniquely predict liability for late development of language production between 18 and 36 months. In the descriptive analyses, however, the significant and moderate correlation between pointing gestures at 18 months and language production at 36 months was, for girls and boys, .31. When estimating where this association goes in the predictive analyses, with girls as an example, we find that .14 is accounted for by imitative actions, .16 by language comprehension, and .03 by language production at 18 months. Subtracting the unique effect of pointing gestures (–.01), leaves us with approximately the observed association of .31. Other studies have also found associations between deictic gestures and language production of this size, that, after controlling for early skills, eventually provides little to no unique contribution (Bavin et al., 2008; Watt et al., 2006). We hypothesize that the reason is that pointing gestures that indicate interest and requests do not represent specific symbolic referents, but are rather indexes of strictly communicative intentions (Bates et al., 1979). The superior cross-sectional relations of language comprehension, compared to language production, with imitative actions and pointing gestures at 18 months can indicate that deictic gestures have different relations to different language components at different ages. This is supported by the study by Watt et al. (2006) reporting a unique contribution from early deictic gestures on language comprehension at 3 years. Furthermore, the predictive links found previously between deictic pointing gestures and development of language production seem specially apparent for deictic gestures that function as precursors for deictic words (Capirci et al., 1996; Goldin-Meadow & Butcher, 2003), thus involving a nonspecific but symbolic meaning. In this way, nonverbal skills can indeed still represent a bridge between language comprehension and language production (Fenson et al., 1994), by detaining symbolic components for communication until the children can produce linguistic forms. In sum, the results imply that, at 18 months, poor representational skills, both verbal and nonverbal, are what predict late development of language production from 18 to 36 months of age. Furthermore, imitation skills may provide valuable insights into how representative models with meaning are extracted from the social environment.

Limitations

Since the measures used are not standard, the construct validity of the latent variables is reflected by the statistical and theoretical criteria for convergent and discriminant validity. The measurement invariance and the differential predictive value of the measures are essential aspects of the validity of the measures (Watt et al., 2006). Still, the study would have benefited from having knowledge regarding correlations with corresponding measures.

Second, unreliability makes two observations seem more dissimilar than they really are. Thus, the measure on language production involving only one item could underestimate the importance of children's language production at 18 months for later liability for delay within the same skill. If the reliability of the item is 0.70 (i.e., the correlation between the item and the true score), the reported 0.18 stability of language production in girls would truly be 0.26 in the general population (0.18 divided by 0.70).

Third, the data is based on mothers' interpretations of their children's development and possibly subjected to random and systematic bias (Reilly et al., 2007). Still, parents are reliable informants about their children's expressive language up to age 3 years (Feldman et al., 2005), and the predictive validity of their reports on language comprehension is as good as observations (Bates, 1993; Watt et al., 2006). Random bias is adjusted for in latent measurement models, but the relations could be systematically biased since there is just one single source of information.

Fourth, although the moderate participation rate and the overrepresentation of older mothers living with a partner in the MoBa study biases mean and prevalence estimates more than

association estimates (Nilsen et al., 2009), future research should investigate the relations separately for children with different socioeconomic background.

Lastly, this study does not resolve which processes that underlie the association between poor early imitative actions and later liability for late language production. Further examinations of the role of underlying symbolic representational skills are needed.

Conclusions

When studying liabilities for developmental delays in the general child population it is of paramount importance to identify early specific risk factors. Poor imitative actions at 18 months significantly outperform poor pointing gestures as a nonverbal marker of a liability for late language production between 18 and 36 months of age. In addition, poor language, and especially poor language comprehension, at 18 months, provides a basis for early detection of risk for language delay. We interpret imitative actions at this age as part of the emerging capacity for symbolic representations. A practical implication of these population-based results is that screening of delayed language development at the age of 18 months could be most fruitful if it captures symbolic representational skills in both the nonverbal action and gestural, as well as in the linguistic, modalities.

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Appendix A

Latent Measurement Variables at 18 Months

		Factor loading	
Item	Latent variable	Girls	Boys
Pointing gestures			
1	Does your child ever use his/her index finger to point, to indicate interest in something?	.95	.97
2	Does your child ever use his/her index finger to point, to ask for something?	.95	.95
Imitative actions			
1	Does your child imitate you (e.g. you make a face - will your child imitate it?)?	.63	.64
2	Does your child copy the activities you do, such as wiping up a spill, sweeping, shaving or combing hair?	.63	.65
Language comprehension			
1	When you ask him/her, does your child go into another room to find a familiar toy or object? (When you ask, for instance: “Where’s your ball?,” “Go and get your coat,” or “Go and get your blanket”)	.73	.73
2	Without showing him/her first, does your child point to the correct picture when you say “Where is the cat” or “Where is the dog”?	.78	.80
3	When you look at a distant object and, surprised and excited, say, “Waoo...what’s that?” does he/she turn his/her head in the same direction as you?	.52	.54
4	When you enthusiastically say, “Where is the ball (or other toy)?” will your child point towards the toy, even if it is more than 1 meter away?	.81	.84
5	Does your child understand what people say?	.54	.56
Language production			
1	Does your child say eight or more words, in addition to “mama” and “dada”?	1.00	1.00

Note. The standardized factor loadings reported for girls and boys were all significant at $p < .001$.

Appendix B

Latent Language Production Variable at 36 Months

Item	Language production	Factor loading	
		Girls	Boys
1	Does your child use sentences made up of three or four words?	.94	.98
2	When looking at a picture book, does your child tell you what is happening or what action is taking place in the picture? (For example, "barking", "running", "eating" and "crying"?). You may ask, "What is the dog (or boy) doing?"	.78	.80
3	Can your child tell you at least two things about an object he/she is familiar with? If you say, for example, "Tell me about your ball," will your child answer by saying something like "It is round, I can throw it, it is big"?	.71	.75
4	Enter a cross for the option that best describes the way your child talks: 1. Not yet talking 2. He/she is talking, but you can't understand him/her 3. Talking in one-word utterances, such as "milk" or "down" 4. Talking in 2- to 3-word phrases, such as "me got ball" or "give doll" 5. Talking in fairly complete sentences, such as "I got a doll" or "can I go outside?" 6. Talking in long and complicated sentences, such as "when I went to the park, I went on the swings" or "I saw a man standing on the corner"	.86	.87
5	Does your child talk using short phrases or sentences?	.96	.94
6	Do you have a back-and-forth "conversation" with your child that involves taking turns or building on what you have said?	.85	.86
7	Does your child ever talk with you just to be friendly (rather than to get something)?	.62	.64

Note. The standardized factor loadings reported for girls and boys were all significant at $p < .001$.

Figure 1. Conceptual model with denominated cross-sectional relations and predictive pathways to be investigated.

Figure 2.

Standardized results on covariates and predictors of stability and change in language production from 18 to 36 months for girls / boys. The multiple group regression model was adjusted for the covariates gestational week, age of questionnaire completion, and whether at least one of the parents had a mother tongue other than Norwegian. Path represented by dotted lines was not significant. R^2 = explained variance (1 – error variance), and is presented for the dependent variable. Information on error terms and covariates are not shown but is available from first author.

^a significant difference between girls and boys.

*** $p < .001$.

Table 1

Tests of Measurement Invariance Across Gender

Model	CFI	RMSEA	ΔCFI	$\Delta \chi^2$	Δdf	p
18 months						
Free	.992	.021				
Metric (weak) invariance	.992	.020	-.001	26.496	4	.000
Scalar (strong) invariance	.991	.020	.000	40.168	6	.000
Residual (strict) invariance	.990	.020	.000	107.982	15	.000
36 months						
Free	.995	.040				
Metric (weak) invariance	.995	.033	.000	42.567	6	.000
Scalar (strong) invariance	.995	.034	.000	59.606	10	.000
Residual (strict) invariance	.995	.030	.000	91.415	17	.000

Note. CFI = Comparative fit index; RMSEA = Root mean square error of approximation; ΔCFI = Comparative fit index difference; $\Delta \chi^2$ = Chi square difference; Δdf = degrees of freedom difference.

Table 2

Intercorrelations for Latent Variables at 18 and 36 Months

Measure	1	2	3	4	5
1. Language production: T1	—	.59	.39	.20	.49
2. Language comprehension: T1	.61	—	.58	.41	.59
3. Imitative actions: T1	.40	.66	—	.47	.47
4. Pointing gestures: T1	.17	.41	.50	—	.31
5. Language production: T2	.52	.67	.60	.31	—

Note. Intercorrelations for boys are presented above the diagonal, and intercorrelations for girls are presented below the diagonal. All correlations are significant $p < .001$. The estimates are controlled for gestational week, age of completion of questionnaires, and whether at least one of the parents had another mother tongue than Norwegian. T1 = 18 months; T2 = 36 months.

Table 3

Means and Variance on Latent Variables for Girls and Boys

Measure	<i>M</i>		<i>SD</i>	
	Girls	Boys	Girls	Boys
18 months				
Language production	0.04	−0.36***	1.01	1.01
Language comprehension	0.04	−0.35***	0.81	0.78
Imitative actions	−0.03	−0.26***	0.62	0.64
Pointing gestures	0.00	−0.01	0.95	0.96
36 months				
Language production	0.06	−0.26	0.87	0.90

Note. Adjusted for gestational week, age of completion of questionnaires, and whether at least one of the parents had another mother tongue than Norwegian. Variance of language production at 18 months was fixed to 1 for both genders.

 $p < .001$.