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BRIEF RESEARCH REPORT

# Walking, pointing, talking – the predictive value of early walking and pointing behavior for later language skills

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**Abstract**

Both walking abilities and pointing gestures in infants are associated with later language skills. Within this longitudinal study we investigate the relationship between walk onset and first observed index-finger points and their respectively predictive value for later language skills. We assume that pointing as a motor as well as a communicative skill is a stronger predictor of later language development than walk onset. Direct observations, parent questionnaires, and standardized tests were administered in 45 children at ages 1;0, 2;0, 3;0, and 4;0. Results show that both walk onset and early index-finger pointing predict language abilities at age 2;0, but only early index-finger pointing predicts language skills at ages 3;0 and 4;0. Walk onset seems to contribute to an initial increase in language acquisition without a sustained advantage. The predictive value of first observed index-finger points, however, is strong and lasts at least until age 4;0.

**Keywords:** language acquisition; walking; pointing; gestures

The onset of independent walking is recognized as a significant milestone in children's overall development. With independent walking, infants' point of view changes and the occasions for experiencing and interacting with their physical and personal environment increase (Campos *et al.*, 2000; Iverson, 2010). In contrast to crawling infants, walking infants more frequently observe distal objects and people (Kretch, Franchak, & Adolph, 2014), travel further and faster across a room to reach these distal objects, and interact with their caregivers about those objects (Karasik, Tamis-LeMonda, & Adolph, 2011). As a consequence, walking infants receive more verbal responses from their caregivers than their crawling peers (Karasik, Tamis-LeMonda, & Adolph, 2014). Furthermore, the upright position of walking frees the hands while locomoting for communicative gesturing and object carrying. The transition from crawling to walking thus extends opportunities for learning and support for the infant as a more active and salient communication partner (cf. Clearfield, 2011; Karasik *et al.*, 2014). This

could explain the close association between walk onset and language skills (e.g., Clearfield, 2011; He, Walle, & Campos, 2015; Longobardi, Spataro, & Rossi-Arnaud, 2014; Oudgenoeg-Paz, Volman, & Leseman, 2012; Walle & Campos, 2014; West, Leezenbaum, Northrup, & Iverson, 2019). Oudgenoeg-Paz *et al.* (2012), as well as Walle and Campos (2014), found increased language growth following the onset of walking in typically developing children. This finding was recently confirmed by West *et al.* (2019) for typically developing children and – to a smaller extent – for children who went on to receive a diagnosis of language delay at a later age.

Other researchers looked more closely at gestures as a combined fine motor and communicative skill for the prediction of language development (Clearfield, 2011; Longobardi *et al.*, 2014). Clearfield (2011) analyzed the use of deictic gestures (pointing and showing) in independent walking infants and same-aged crawling infants in a baby-walker. The baby-walker enabled infants to move in an upright position and use their hands for gesturing. However, Clearfield found that infants who walked independently produced more gestures accompanied by a gaze to an interaction partner, spent more time in interactions, and used more vocalizations compared to infants who were not yet able to walk independently, but used the baby-walker. Longobardi *et al.* (2014) went a step further in demonstrating that the use of representational gestures (e.g., holding an empty fist to the ear for 'telephone') at 12 months mediated the relationship between motor skills at 12 months and lexical skills at 16 to 23 months.

These two studies hint at highly complex interdependencies between gross motor skills, gestural communication, and language. To date, there is no evidence on the specific relationship between walk onset, first observations of pointing gestures, and later language skills. This is particularly relevant since pointing gestures are known as one of the most important precursors of language acquisition (e.g., Bates, Camaioni, & Volterra, 1975; Colonnesi, Stams, Koster, & Noom, 2010).

Pointing to objects and directing the attention of communication partners typically emerge towards the end of the first year of life (Liszkowski, 2011). Colonnesi *et al.* (2010) demonstrated with their meta-analysis that children who used many pointing gestures at a young age had better language skills at a later age compared to children who used fewer pointing gestures. This finding about the predictive value of pointing gestures for later language skills is also supported by more recent research (e.g., Kuhn, Willoughby, Wilbourn, Vernon-Feagans, & Blair, 2014).

Children produce pointing gestures with the whole hand at about 7 months of age (Lock, Young, Service, & Chandler, 1990). About 3 months after using whole-hand points, children also begin to point with their abducted index finger (Lock *et al.*, 1990). The first index-finger point is interpreted as an important milestone in social-cognitive, communicative, and language development (Liszkowski & Tomasello, 2011; Lüke, Grimminger, Rohlfing, Liszkowski, & Ritterfeld, 2017). Liszkowski and Tomasello (2011) showed that 12-month-old children who used the index finger for pointing understood the communicative intentions of others better, pointed more frequently, and accompanied their pointing more often with vocalizations compared to 12-month-olds who pointed only with their whole hand. Recent findings indicate that children who pointed exclusively with their whole hand at 12 months had significantly lower language skills and a higher risk of language delay at 24 months than children who also pointed with the index finger at 12 months (Lüke, Grimminger *et al.*, 2017).

The importance of walk onset for children's language acquisition has received much attention within the last years (e.g., Clearfield, 2011; He *et al.*, 2015; Longobardi *et al.*,

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2014; West *et al.*, 2019). Building on this research, we aim to compare the predicitive values of independent walking to the ability of index-finger pointing, with the latter being well known as predictive for language skills (for a meta-analysis, see Colonnesi *et al.*, 2010). We further ask whether the predictive values of walk onset and of pointing gestures for later language skills are grounded in the same underlying process of motor development, and whether the combined motor and communication skills of early index-finger pointing are a stronger predictor than independent walking.

## Method

### *Participants*

Forty-five children (24 boys, 21 girls) and their primary caregivers (96% mothers) participated in this longitudinal study. At the first measurement, mean age of the children was 12 months and 5 days ($SD = 12$ days, *R*: 344–402 days). All children were raised as monolingual German speakers. Their general development was rated by pediatricians and measured at the beginning of the study with a standardized test that included cognitive, motor, language, social, and emotional development (*Entwicklungstest für Kinder von 6 Monaten bis 6 Jahren*, ET 6-6 [Developmental test for children aged 6 months to 6 years], Petermann, Stein, & Macha, 2008). According to pediatricians, as well as standardized test results, all children were developing typically. Information about the socioeconomic status of the family and the birth order of the children were collected via parent reports. On average, the children were being raised by parents with a rather high educational level (see Table 2 for maternal and paternal years of education) and an average household income (compared to the median family income in Germany in the same year: Statistisches Bundesamt Deutschland, 2013).

### *Design and procedure*

All children and their primary caregivers have been participating in a larger longitudinal study incorporating a total of 14 observation sessions (12, 14, 16, 18, 21, 24, 30, 36, 42, 48, 54, 60, 66, and 72 months; cf. Lüke, Grimminger, *et al.*, 2017; Lüke, Ritterfeld, Grimminger, Liszkowski, & Rohlfing, 2017) over the course of five years. Here, we refer to data when the children were between ages 1;0 and 4;0.

#### *Eliciting and coding of pointing gestures*

The gestural behavior of the children was monitored during observation sessions between 12 and 21 months. A semi-natural setting within a room equipped with interesting objects and pictures (cf. Liszkowski & Tomasello, 2011) was used to elicit spontaneous pointing gestures in children. Caregivers were instructed to engage with their children while carrying them for 6 minutes, and to look at various items without touching them. Caregivers were not aware of the aim of the study, and that gestures were being analyzed. Four cameras recorded the scene from each corner of the room. Two research assistants used the annotation tool ELAN (EUDICO Linguistic Annotator; Lausberg & Sloetjes, 2009) to code the videos for the occurrence of pointing. Pointing was defined as an extension of the hand and the arm at least more than halfway toward an object or picture without grabbing or touching it. Pointing gestures were coded either as index-finger points – when the index finger was clearly extended relative to all other fingers – or as hand points – when the index

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finger was not clearly extended relative to the other fingers. Based on this procedure we obtained the individual age of the first objective observation of index-finger pointing.

To assess inter-rater reliability, a random 10% of the collected data was coded independently by the two coders for each time of measurement. For all five times of measurement, the inter-rater reliability for infants' pointing was very good (Krippendorff's $\alpha$: 12 months = .968, 14 months = .932, 16 months = .980, 18 months = .966, 21 months = .892; cf. Krippendorff, 2013).

### *Measuring independent walking*

To assess the onset of independent walking, parental reports were used at the first date of data collection. If the infant was not independently walking at 12 months, this was asked again at the following dates of data collection until the infant was able to walk independently. Independent walking was defined based on previous investigations as the infant locomoting a distance of 10 feet without falling or requesting help (cf. Adolph, 1997).

### *Measuring language development*

To capture the language development of the children at ages 1;0, 2;0, 3;0, and 4;0, two commonly used parent questionnaires (German versions of the MacArthur–Bates Communicative Development Inventories MCDI; Fenson *et al.*, 2007) and various standardized tests were used. Table 1 gives an overview of the parental reports and tests used and the linguistic components addressed.

## Results

On average, the first observations of index-finger pointing ($M = 12.58$, $SD = 1.20$ months) were recorded earlier than walk onset ($M = 13.44$, $SD = 2.11$ months, $t(44) = -3.04$, $p = .004$). All descriptive data of the measured variables are presented in Table 2.

Walk onset significantly correlated with the first observation of index-finger pointing, as well as with the productive vocabulary size of the children, their results in sentence comprehension, and word and sentence production tests at age 2;0 (Table 3). No correlations were found between walk onset and language skills of the children at ages 3;0 and 4;0, whereas the first observation of index-finger points correlated with all measures for language skills at ages 2;0, 3;0, and 4;0 (Table 3).

To test the predictive power of the first observation of index-finger pointing and walk onset for later language skills, we conducted multiple, stepwise regression analyses. In addition to walk onset and the first observation of index-finger pointing as predictor variables, we controlled for predictors of language skills that had been shown relevant for explaining variance: the SOCIOECONOMIC STATUS OF THE FAMILY (SES, operationalized via a principal components analysis of maternal and paternal years of education and household income), SEX, BIRTH ORDER, and PRODUCTIVE VOCABULARY SIZE AT AGE 1;0. To check for multicollinearity we proofed the variance inflation factor (VIF) for all models. VIF values < 1.146 indicate no collinearity within the data.

The first observation of index-finger pointing was confirmed to be predictive for all measured language skills of the children at ages 2;0, 3;0, and 4;0 (Figure 1; see Supplementary materials for more detailed statistics, available at <https://doi.1017/S0305000919000394>). Pointing alone explained 16% of the variance in the word comprehension test and – together with other predictor variables – up to 51% of the variance in the measured language abilities. Walk onset was only predictive for the

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**Table 1.** Parental reports and standardized tests used to measure language skills

| Linguistic component | Age | 1;0 | 2;0 | 3;0 | 4;0 |
|---|---|---|---|---|---|
| Productive vocabulary size | | ELFRA 1 | FRAKIS | | |
| Word comprehension | | | SETK-2 | | |
| Sentence comprehension | | | SETK-2 | SETK 3-5 | |
| Word production | | | SETK-2 | PDSS | P-ITPA |
| Sentence production | | | SETK-2 | SETK 3-5 | |
| Grammar production | | | | | P-ITPA |

*Notes*. ELFRA 1: *Elternfragbogen für die Früherkennung von Risikokindern* [Parent Questionnaire for Early Detection of Children at Risk; German MCDI-version for children at 12 months], Grimm & Doil, 2006; FRAKIS: *Fragebogen zur frühkindlichen Sprachentwicklung* [Questionnaire for Early Language Acquisition; German MCDI-version for children between 18 and 30 months], Szagun, Stumper, & Schramm, 2009; SETK-2: *Sprachentwicklungstest für zweijährige Kinder* [Language Acquisition Test for 2-year-old Children], Grimm, 2000; SETK 3-5: *Sprachentwicklungstest für drei- bis fünfjährige Kinder* [Language Acquisition Test for 3- to 5-year-old Children], Grimm, 2001; PDSS: *Patholinguistische Diagnostik bei Sprachentwicklungsstörungen* [Patholinguistic Diagnostics for Language Impairments], Kauschke & Siegmüller, 2010; P-ITPA: *Potsdam-Illinois Test für Psycholinguistische Fähigkeiten* [Potsdam-Illinois Test of Psycholinguistic Abilities], Esser & Wyschkon, 2010.

**Table 2.** Descriptive results

| Variable | *N* | *M* | *SD* |
|---|---|---|---|
| Maternal years of education | 45 | 15.11 | 2.43 |
| Paternal years of education | 44 | 14.39 | 2.55 |
| Household income in € | 43 | 3034.88 | 1120.14 |
| First observation of index-finger pointing in months | 45 | 12.58 | 1.20 |
| Walk onset in months | 45 | 13.44 | 2.11 |
| Productive vocabulary size age 1;0[a] | 45 | 2.71 | 3.20 |
| Productive vocabulary size age 2;0[a] | 45 | 285.84 | 173.03 |
| Word comprehension age 2;0[b] | 43 | 53.70 | 10.10 |
| Sentence comprehension age 2;0x[b] | 42 | 47.90 | 12.00 |
| Word production age 2;0[b] | 45 | 46.91 | 12.61 |
| Sentence production age 2;0[b] | 39 | 46.77 | 10.22 |
| Sentence comprehension age 3;0[b] | 37 | 50.08 | 10.69 |
| Word production age 3;0[b] | 39 | 46.18 | 6.88 |
| Sentence production age 3;0[b] | 38 | 50.63 | 10.69 |
| Word production age 4;0[b] | 41 | 51.80 | 10.13 |
| Grammar age 4;0[b] | 39 | 55.26 | 8.15 |

*Notes*. *N*: Since few children did not participate in all testing the exact number of tested children is reported. [a] Results are presented in number of words. [b] Results are presented in standard T-scores ($M = 50$, $SD = 10$).

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**Table 3.** Correlations between the walk onset, the first observations of index-finger points, and language skills

| | First observation of index-finger points | Walk onset |
|---|---|---|
| First observation of index-finger points | | 0.435** |
| Walk onset | 0.435** | |
| Productive vocabulary size age 1;0 | –0.211 | –0.198 |
| Productive vocabulary size age 2;0 | –0.603*** | –0.514*** |
| Word comprehension age 2;0 | –0.431** | –0.185 |
| Sentence comprehension age 2;0 | –0.499** | –0.361* |
| Word production age 2;0 | –0.594*** | –0.409** |
| Sentence production age 2;0 | –0.541*** | –0.469** |
| Sentence comprehension age 3;0 | –0.417* | –0.019 |
| Word production age 3;0 | –0.445** | –0.042 |
| Sentence production age 3;0 | –0.421** | –0.099 |
| Word production age 4;0 | –0.402** | –0.164 |
| Grammar age 4;0 | –0.374* | –0.103 |

*Notes*. First observation of index-finger points and walk onset are reported in months with high values indicating higher age and therefore slower development, whereas high numbers in the linguistic variables represent higher skills and therefore faster development; negative correlations between index-finger pointing and walk onset with linguistic skills are expected; *$p$ < .05, **$p$ < .01, ***$p$ < .001.

productive vocabulary of the children at age 2;0. Together with the first observation of index-finger pointing ($\beta = -0.438^{***}$) and the size of the productive vocabulary of the children at age 1;0 ($\beta = 0.304^{*}$), walk onset ($\beta = -0.275^{*}$) explained 51% of the variance of the productive vocabulary.

## Discussion

The aim of the current study was to investigate the links between walking, index-finger pointing, and language acquisition in children between ages 1;0 and 4;0. We found that walk onset and first observation of index-finger points are associated with each other and with language skills at age 2;0. This result is in line with earlier findings showing that the onset of walking is accompanied with an increase in vocabulary growth (Oudgenoeg-Paz *et al.*, 2012; Walle & Campos, 2014; West *et al.*, 2019). The onset of walking had previously been described as a catalyst that provides a multitude of learning and interacting opportunities, which in turn might facilitate language development (cf. Iverson, 2010; Walle & Campos, 2014; West *et al.*, 2019). However, since we found no correlations between walk onset and language skills at ages 3;0 or 4;0, and walk onset only predicted productive vocabulary at age 2;0, it seems that the early achievement of independent walking is no main driving force for long-term language acquisition. But, a more detailed approach to the measurement of walk onset might possibly lead to slightly different conclusions (see for this the discussion in the 'Limitations' section). In contrast, index-finger pointing, a fine-motor as well as a communicative skill, was found to be predictive for all measured language skills until age 4;0. In comparison to walk onset and other influences on language acquisition,

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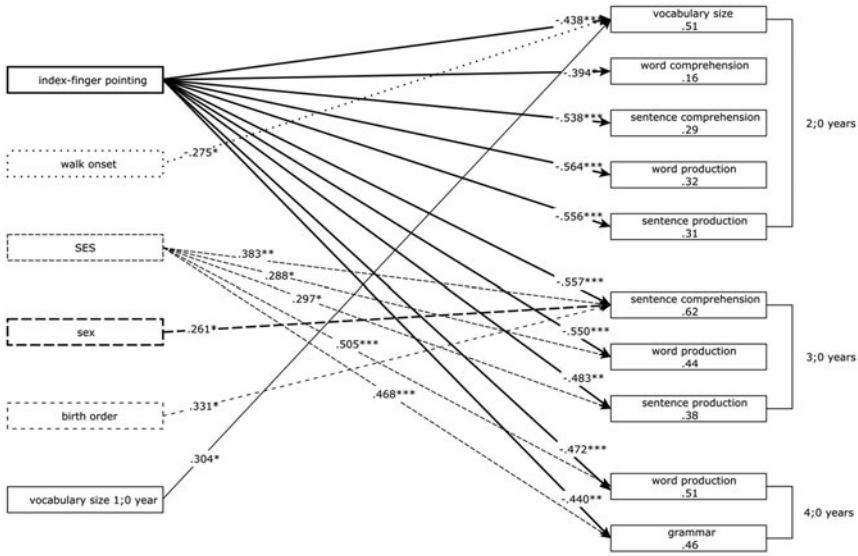


**Figure 1.** Final models of 10 stepwise regressions with the independent variables first observation of index-finger pointing, walk onset, SES, sex, birth order, and productive vocabulary size at age 1;0, and the dependent variables vocabulary size, word and sentence comprehension, word and sentence production at age 2;0, sentence comprehension, word and sentence production at age 3;0, and word production and grammar skills at age 4;0. Predictor variables were included if they could significantly ($p < .05$) improve the ability of the models to predict the outcome variables. Presented are standardized betas of the predictor variables and the $R^2$ of the final models, $^*p < .05$, $^{**}p < .01$, $^{***}p \leqslant .001$. Detailed statistics are presented in the see online Supplementary materials.

such as the SES of the family (e.g., Horwitz *et al.*, 2003; Tomblin, Smith, & Zhang, 1997), or the sex of the children (e.g., Horwitz *et al.*, 2003; Law, Rush, Schoon, & Parsons, 2009; Tomblin *et al.*, 1997), first observation of index-finger points turned out to be the strongest predictor for later language skills. This is in line with a multitude of earlier findings indicating that the use of pointing gestures is strongly predictive for later language skills (see, for a meta-analysis, Colonnesi *et al.*, 2010; for more recent work, e.g., Kuhn *et al.*, 2014; Lüke, Grimminger *et al.*, 2017). Our findings extend the available research in confirming that the age of first observed index-finger points, and not just the frequency of pointing as has been analyzed so far, predict language skills until age 4;0. This highly predictive value of first observed index-finger points can be explained with the nature of pointing as one of the first means of intentional communication (Liszkowski, 2011), which might be driven by the same developmental domain as language acquisition. Further studies aiming at analyzing the predictive value of index-finger points should observe the infants at an even younger age to capture the real onset of index-finger pointing.

Besides the determination of language skills through early pointing gestures, we found indication for an impact of SES, which becomes even more significant with the age of the children. The impact of SES on linguistic skills at three and four years is in line with earlier findings (e.g., Levine *et al.*, in press), but beyond our findings the impact of SES on language skills was also found in younger children (e.g., Hoff, 2003).

In earlier research it was found that representational gestures at 12 months mediate the relationship between motor skills at 12 months and lexical skills at 16 to 23 months (Longobardi *et al.*, 2014). Based on this finding, one might assume that index-finger

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pointing also mediates the relation between walk onset and later language skills. Our data do not allow putting this assumption to the test, since in this sample the onset of walking occurred after the first observations of index-finger points.

Further research should measure the relevant fine and gross motor, communicative, and language skills again at an earlier age and in shorter intervals. In addition, even earlier skills within the domains of motor and communicative development should be considered. The onset of sitting and babbling seem to be especially important precursors of language skills, too (Libertus & Violi, 2016; Stoel-Gammon, 2011). In younger children also, the first productions of gestures with the whole hand might be predictive for later communicative and language skills. Within such further studies a detailed analyze of infants' eye-gaze behavior should be considered, too, since controlling for adults' attention during pointing is a clear marker for infants' communicative intention (Bates *et al.*, 1975).

### Limitations

Limitations of this work should be noted. First, we used parental reports to assess the onset of walking. This was administered first at the first date of data collection, when the infants were 12 months old, and again at the following dates of data collection until each infant was able to walk independently. We verified the reports of the parents via experimenter observations in our laboratory, but only in quite large intervals of two months, starting at the age of 12 months. Observations starting at an earlier age and at shorter intervals in a laboratory would be a more valid method to assess the onset of walking. Another alternative could be giving the participating parents the task to track in a calendar the gross motor development of their child starting at the age of 8 or 9 months. Influences on the findings based on our method cannot be excluded. In particular, we do not know if the onset of walking measure was sensitive enough.

Second, we ran our analyses with the variable of first experimenter observation of index-finger pointing starting at 12 months. Therefore, we cannot rule out that our findings might be slightly different if we had started our observations before the age of 12 months to capture the real onset of index-finger pointing.

Third, we used only a rough measure of fine motor skills at the age of 12 months (*Entwicklungstest für Kinder von 6 Monaten bis 6 Jahren*, ET 6-6 [Developmental test for children aged 6 months to 6 years], Petermann *et al.*, 2008) to identify severe motoric disorders, and as a consequence to exclude those children from the study. In further research a substantial assessment of gross and fine motor skills (e.g., Mullen, 1995) should be implemented. This might lead to deeper insight and help us to understand the relation between gross and fine motor skills, communicative, and language skills.

### Conclusion

Compared to other variables (e.g., sex, birth order, walk onset), first observed productions of index-finger points – a combined fine motor and communicative skill – is the strongest predictor for different linguistic skills between ages 2;0 and 4;0. The ability to walk independently, a gross motor skill, is also of high importance for children's development, because it provides children with a multitude of new possibilities to perceive and interact with their physical and social environment. Regarding children's language development, it seems that the onset of walking contributes to a temporary increase, but not to long-term gains.

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**Supplementary materials.** For Supplementary materials for this paper, please visit <https://doi.org/10.1017/S0305000919000394>.

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## References

**Adolph, K. E.** (1997). Learning in the development of infant locomotion. *Monographs of the Society for Research in Child Development*, *62*(3), i–vi, 1–158.

**Bates, E., Camaioni, L., & Volterra, V.** (1975). The acquisition of performatives prior to speech. *Merrill-Palmer Quarterly of Behavior and Development*, *21*, 205–26.

**Campos, J. J., Anderson, D. I., Barbu-Roth, M. A., Hubbard, E. M., Hertenstein, M. J., & Witherington, D.** (2000). Travel broadens the mind. *Infancy*, *1*(2), 149–219.

**Clearfield, M. W.** (2011). Learning to walk changes infants' social interactions. *Infant Behavior & Development*, *34*, 15–25.

**Colonnesi, C., Stams, G. J. J., Koster, I., & Noom, M. J.** (2010). The relation between pointing and language development: A meta-analysis. *Developmental Review*, *30*, 352–66.

**Esser, G., & Wyschkon, A.** (2010). *P-ITPA: Potsdam-Illinois Test für Psycholinguistische Fähigkeiten* [Potsdam-Illinois Test of Psycholinguistic Abilities]. Göttingen: Hogrefe.

**Fenson, L., Dale, P., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P. *et al.*** (2007). *MacArthur-Bates Communicative Development Inventories: user's guide and technical manual* (2nd ed.). Baltimore, MD: Paul H. Brookes.

**Grimm, H.** (2000). *SETK-2. Sprachentwicklungstest für zweijährige Kinder* [Language Acquisition Test for 2-year-old Children]. Göttingen: Hogrefe.

**Grimm, H.** (2001). *SETK-3-5. Sprachentwicklungstest für drei- bis fünfjährige Kinder* [Language Acquisition Test for 3- to 5-year-old Children]. Göttingen: Hogrefe.

**Grimm, H., & Doil, H.** (2006). *ELFRA. Elternfragebögen für die Früherkennung von Risikokindern* [Parent Questionnaire for Early Detection of Children at Risk]. Göttingen: Hogrefe.

**He, M., Walle, E. A., & Campos, J. J.** (2015). A cross-national investigation of the relationship between infant walking and language development. *Infancy*, *20*(3), 283–305.

**Hoff, E.** (2003). The specificity of environmental influence: socioeconomic status affects early vocabulary development via maternal speech. *Child Development*, *74*(5), 1368–78.

**Horwitz, S. M., Irwin, J. R., Briggs-Gowan, M. J., Bosson Heenan, J. M., Mendoza, J., & Carter, A. S.** (2003). Language delay in a community cohort of young children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *42*, 932–40.

**Iverson, J. M.** (2010). Developing language in a developing body: the relationship between motor development and language development. *Journal of Child Language*, *37*(2), 229–61.

**Karasik, L. B., Tamis-LeMonda, C. S., & Adolph, K. E.** (2011). Transition from crawling to walking and infants' actions with objects and people. *Child Development*, *82*, 1199–209.

**Karasik, L. B., Tamis-LeMonda, C. S., & Adolph, K. E.** (2014). Crawling and walking infants elicit different verbal responses from mothers. *Developmental Science*, *17*, 388–95.

**Kauschke, C., & Siegmüller, J.** (2010). *Patholinguistische Diagnostik bei Sprachentwicklungsstörungen (PDSS)* [Patholinguistic Diagnostics for Language Impairments] (2nd ed.). München: Urban & Fischer.

**Kretch, K. S., Franchak, J. M., & Adolph, K. E.** (2014). Crawling and walking infants see the world differently. *Child Development*, *85*, 1503–18.

**Krippendorff, K.** (2013). *Content analysis: an introduction to its methodology* (3rd ed.). Los Angeles, CA: Sage.

**Kuhn, L. J., Willoughby, M. T., Wilbourn, M. P., Vernon-Feagans, L., & Blair, C. B.** (2014). Early communicative gestures prospectively predict language development and executive function in early childhood. *Child Development*, *85*, 1898–914.

**Lausberg, H., & Sloetjes, H.** (2009). Coding gestural behavior with the NEUROGES-ELAN system. *Behavior Research Methods*, *41*, 841–9.

**Law, J., Rush, R., Schoon, I., & Parsons, S.** (2009). Modeling developmental language difficulties from school entry into adulthood: literacy, mental health, and employment outcomes. *Journal of Speech, Language, and Hearing Research*, *52*, 1401–16.

**Levine, D., Pace, A., Luo, R., Hirsh-Pasek, K., Michnick Golinkoff, R., Villiers, J. de, … Sweig Wilson, M.** (in press). Evaluating socioeconomic gaps in preschoolers' vocabulary, syntax and language process skills with the Quick Interactive Language Screener (QUILS). *Early Childhood Research Quarterly*. doi.org/10.1016/j.ecresq.2018.11.006

**Libertus, K., & Violi, D. A.** (2016). Sit to talk: relation between motor skills and language development in infancy. *Frontiers in Psychology*, *7*(475). doi:10.3389/fpsyg.2016.00475

**Liszkowski, U.** (2011). Three lines in the emergence of prelinguistic communication and social cognition. *Journal of Cognitive Education and Psychology*, *10*, 32–43.

**Liszkowski, U., & Tomasello, M.** (2011). Individual differences in social, cognitive, and morphological aspects of infant pointing. *Cognitive Development*, *26*, 16–29.

**Lock, A., Young, A., Service, V., & Chandler, P.** (1990). Some observations on the origins of the pointing gesture. In V. Volterra & C. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 42–55). Berlin: Springer.

**Longobardi, E., Spataro, P., & Rossi-Arnaud, C.** (2014). The relationship between motor development, gestures and language production in the second year of life: a mediational analysis. *Infant Behavior and Development*, *37*(1), 1–4.

**Lüke, C., Grimminger, A., Rohlfing, K. J., Liszkowski, U., & Ritterfeld, U.** (2017). In infants' hands: identification of preverbal infants at risk for primary language delay. *Child Development*, *88*, 484–92.

**Lüke, C., Ritterfeld, U., Grimminger, A., Liszkowski, U., & Rohlfing, K. J.** (2017). Development of pointing gestures in children with typical and delayed language acquisition. *Journal of Speech, Language, and Hearing Research*, *60*, 3185–97.

**Mullen, E. M.** (1995). *Mullen Scales of Early Learning – Manual*. Circle Pines, MN: American Guidance Service.

**Oudgenoeg-Paz, O., Volman, M. C., & Leseman, P. P.** (2012). Attainment of sitting and walking predicts development of productive vocabulary between ages 16 and 28 months. *Infant Behavior and Development*, *35*(4), 733–6.

**Petermann, F., Stein, I. A., & Macha, T.** (2008). *ET 6-6. Entwicklungstest für Kinder von 6 Monaten bis 6 Jahren*. [Developmental test for children aged 6 months to 6 years]. Frankfurt am Main: Pearson.

**Statistisches Bundesamt Deutschland** (2013). *Statistisches Jahrbuch Deutschland und Internationales*. Retrieved from: <https://www.destatis.de/GPStatistik/servlets/MCRFileNodeServlet/DEAusgabe_derivate_00000156/1010110137004.pdf%3Bjsessionid%3D3E40F45FF790A81E6948D609C3DB9A7C> .

**Stoel-Gammon, C.** (2011). Relationships between lexical and phonological development in young children. *Journal of Child Language*, *38*, 1–34.

**Szagun, G., Stumper, B., & Schramm, S. A.** (2009). *FRAKIS. Fragebogen zur frühkindlichen Sprachentwicklung* [Questionnaire for Early Language Acquisition]. Frankfurt am Main: Pearson.

**Tomblin, J. B., Smith, E., & Zhang, X.** (1997). Epidemiology of specific language impairment: prenatal and perinatal risk factors. *Journal of Communication Disorders*, *30*, 325–43.

**Walle, E. A., & Campos, J. J.** (2014). Infant language development is related to the acquisition of walking. *Developmental Psychology*, *50*(2), 336–48.

**West, K. L., Leezenbaum, N. B., Northrup, J. B., & Iverson, J. M.** (2019). The relation between walking and language in infant siblings of children with Autism Spectrum Disorder. *Child Development*, *90*(3), e356–e372. doi.org/10.1111/cdev.12980

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