Leonard, H.C. & Hill, E.L. (2016, in press). The role of older siblings in infant motor development. *Journal of Experimental Child Psychology*. (Elsevier)

The role of older siblings in infant motor development

Hayley C. Leonard [a] & Elisabeth L. Hill [b]

[a]Department of Psychology, University of Surrey, Guildford, UK
[b]Department of Psychology, Goldsmiths, University of London, London, UK

Keywords: motor development; infant; siblings; imitation; longitudinal

Abstract

Previous research has suggested that infant motor skills may be affected by older siblings, but has not considered whether this is due to specific characteristics of the older sibling, or of the quality of the sibling relationship. The current study used a longitudinal diary method to record infant motor milestones from 23 infants with older siblings, along with parent reports and standardised assessments of motor skills. Parent reports of the older siblings' motor skills and the sibling relationship were also collected until the infants were 18 months old. The motor skills, age, and sex of the older siblings were not significantly related to any measure of infant motor development. A significant correlation was revealed between perceived agonism between siblings and infant fine motor skills at 18 months, suggesting the importance of considering reciprocal effects of motor development on sibling relationships. Overall, the suggestion that older siblings may provide a good model of motor skills for infants is not supported by the current data. In the future it will be important to assess the dynamic interactions between different factors in predicting infant motor development, allowing early identification of motor difficulties, which could impact other areas of cognitive development and health.

Introduction

Motor skills are central to our interactions with objects and other people, and represent key milestones in an infant's development (Leonard & Hill, 2014). As such, it is important to understand different factors that influence the development of motor skills in infancy. One such factor is the presence of older siblings, as sibling relationships provide a basis for learning opportunities and socialisation in a number of contexts (Brody, 2004). In terms of motor development, older siblings may provide good role models for infants to imitate (Abramovitch, Pepler, & Corter, 1982; Barr & Hayne, 2003; Erbaugh & Clifton, 1984) or may affect the amount of time that a parent has to encourage motor milestones, such as learning to sit up independently or walk (e.g., Brody, 2004). The current study aimed to investigate the role that older siblings play in infant motor development, using a longitudinal approach and focusing on a range of different motor skills and milestones.

The relatively few studies that have investigated sibling effects on motor skills have reported that imitated behaviour was often copied from an older sibling (e.g., Barr & Hayne, 2003), and that young children were more likely to explore objects and the environment if an older sibling was present (Samuels, 1980). This exploration is important, as it provides opportunities for social and cognitive development (Campos et al., 2000), and the presence of older siblings could therefore affect a range of infant skills. Other more recent studies have reported mixed results. Specifically, Cruise and Reilly (2014) collected questionnaire data from a sample of over 10,000 caregivers of 9-month-old infants, and reported significantly poorer performance on motor measures for infants with older siblings compared to those without siblings. Koutra et al. (2012) also reported poorer gross motor performance by infants with older siblings compared to only children on standardised motor measures. Berger and Nuzzo (2008) reported that while some of their sample began to crawl and walk earlier than their older siblings, others took longer to achieve these milestones than their siblings.

These mixed results could be due to different measures and ages of participants across studies. However, it is important to note that most of this research focuses on the presence or absence of a sibling, but does not take into account different characteristics of the older child, or of the sibling relationship, on the younger child's motor development. If an older sibling has particularly poor motor skills themselves, then they may not provide an appropriate model for the younger child to copy. On the other hand, reduced age-appropriate motor development may more closely match the skills of a younger sibling, thus providing a model of skills that infants are close to learning, rather than those that are much more advanced. While previous research has not directly addressed this question, the studies of imitation mentioned previously have not reported any age effects in their sibling dyads in either direction (Abramovitch et al., 1982; Barr & Hayne, 2003). Infants who were closer in age to their older sibling (and therefore more similar in motor skills) did not produce more imitation than those with a wider age gap.

In the study by Berger and Nuzzo (2008), although the age at which the older sibling achieved two motor milestones was compared to the younger sibling, motor skill in a broader sense (i.e., gross and fine motor interactions with other objects; early postural milestones such as sitting unsupported) was not considered. These interactions provide a fuller picture of infants' motor skills and their exploration of the environment, which is important in understanding their development within a social context. The current study aimed to address this issue, collecting measures for both younger and older siblings of a range of motor milestones, gross and fine motor skills, as well as a measure of the sibling relationship. The sibling relationship was considered important as infants who have close relationships with their older siblings may be more likely to play with them than those who are in constant conflict, providing more opportunities for imitation. As the older siblings ranged in age, both the age of the older sibling and the difference in ages between the younger and older sibling were taken into account in the analyses. Furthermore, the sex of both siblings was taken into account.

The current study therefore aimed to assess to what extent a) the older sibling's motor skill, b) the older sibling's age and sex, and c) the perceived relationship between siblings affected infant motor development. To our knowledge, this is the first study to assess the role of these variables on motor development in a broader sense, rather than on imitative behaviour (Abramovitch et al., 1982) or on crawling and walking only (Berger & Nuzzo, 2008). Based on this related research, however, it was expected that there would be no effect of age and sex of the older sibling or the sibling pair on the infant's motor development. Given that younger siblings imitate the actions and behaviour of older siblings, it was also hypothesised that an older sibling with better motor skills and a closer relationship with a younger sibling would provide a better model for imitation, and these measures would therefore be positively related to infant motor development.

Method

Participants

Parents were contacted through a University database of volunteers, local baby and toddler groups, and word of mouth, and were recruited if they had an infant of 6 months or younger and only one older child, aged under 7 years. Thirty-seven eligible families consented to take part in the study. Parents completed a demographics questionnaire (see Materials) in order to identify and exclude any infants who had been born before 37 weeks, had any diagnosed medical problems, or had an older sibling with any confirmed neurodevelopmental disorder. No infants were excluded on these bases. Seven parents completed the demographics questionnaire before withdrawing from the study, without providing a reason. A further seven parents failed to complete the study (2 withdrew due to health problems; 5 could not be contacted after the 12-month follow-up). The remaining 23 infants (12 male and 11 female; mean age at recruitment: 4.15 months, SD: 1.23 months) were mainly Caucasian (*N*=15; African/Caribbean *N*=1, Mixed Race *N*=2, and 'Other' *N*=1). There were 15 male and 8 female older siblings (mean age of siblings at recruitment: 2.66 years, SD: 1.37 years).

Nineteen of the twenty families who provided occupation information were classified as high SES (Office for National Statistics, 2010), and 67% of parents had degree qualifications or higher.

Materials and Procedure

After parents had consented, they completed a demographics questionnaire to ensure they met inclusion criteria (see Participants). This questionnaire gathered data regarding parental education, employment, ethnicity, any medical issues or diagnoses in the immediate family, and reports of the older siblings' achievement of motor milestones (see Table 1). Parents were sent a diary in which to record the infant's achievement of motor milestones, along with a booklet of photos demonstrating each milestone, and information about infant behaviour in the first 12 months. The diary questions and information sheets were adapted, with permission, from Ellis-Davies, Sakkalou, Fowler, Hilbrink and Gattis (2012). Parents were asked to record the dates of the first three occurrences of 15 specific motor milestones (see Table 1), and could provide additional information regarding where the behaviour occurred, whether it was spontaneous, encouraged, assisted or imitated, and from whom imitated behaviour had been copied.

--Table 1 about here---

When the infant was 12 months old, parents were sent two copies of the Vineland Adaptive Behavior Scales (VABS-II; Sparrow, Cicchetti, & Balla, 2005). They were asked to complete one each for the infant and older sibling as close to the infant's birthday as possible. The VABS-II provides measures of communication, daily living, socialisation and motor skills, and is suitable for age 0-90 years. For the current study, only the Gross and Fine Motor scales are of interest. Parents / caregivers reported whether they had seen a particular behaviour on a scale of 'Never', 'Sometimes' or 'Usually'. They could also respond 'Don't Know' or 'No Opportunity' to any of the items. Raw scores were transformed into *v*-scale (standard) scores (M=15, SD=3) for the analyses.

When the infant was 18 months old, parents were asked to complete the VABS-II for the infant and older sibling. An additional questionnaire, the Parental Expectations and Perceptions of Children's Sibling Relationships Questionnaire (PEPC-SRQ; Kramer, 1995) was also sent. This asks parents/caregivers to rate the frequency of a number of sibling behaviours on a scale of 1-5 ("Never – Always"). These behaviours are split across three subscales: Perceived Warmth (e.g., protectiveness, help, playing together; max.=65), Perceived Agonism (e.g., fighting over objects, arguing, aggression; max.=40) and Perceived Rivalry/Competition (e.g., rivalry, competition, jealousy; max.=15). These subscales were used separately within the analyses to assess any correlations between these aspects of sibling relationships and infant motor development.

At 18 months, the infant's motor skills were assessed using a standardised measure of infant development, the Mullen Scales of Early Learning (MSEL; Mullen, 1995). This measure is suitable between 0 and 68 months, and measures language, cognitive development and motor skills. Here, only the Gross and Fine Motor scales are of interest. Items on each scale are scored as 'Present' or 'Absent', and testing continues until three consecutive tasks are scored as absent. Raw scores were converted into standard *T*-scores (M=50, SD=10). The MSEL was usually conducted in a child-friendly laboratory environment, with breaks provided as necessary. In some cases, a home visit was necessary and the assessment was performed in a room with a large table and enough space for gross motor items, and with as few distractions as possible. To ensure that testing conditions were the same across these environments, only the parent and experimenter were present in the room during the assessment, and the child sat on the parent's lap during table-top tasks. The whole assessment took 20-40 minutes, depending on the number and length of breaks required, and the number of items that the child could complete. The 18-month questionnaires and the diaries were collected during this visit, and all children received a certificate for their participation. Diaries were copied and the original copies returned to parents as a keepsake.

Results

Non-parametric tests were used throughout the analyses due to the small sample size, and were Bonferroni-corrected for multiple comparisons. For ease of interpretation, the alpha value presented for each set of analyses is the adjusted value.[1]

The mean motor scores from the VABS-II and MSEL are presented in Table 2, along with the mean ages of motor milestone achievement, for both infants and older siblings. The age of motor milestone achievement for infants was taken from the first date at which parents reported the behaviour (the proportion of recorded responses was greater for the first occasion for all milestones than for subsequent occasions). Initial analyses revealed that there was no difference in infant motor development due to infant sex (VABS-II Gross and Fine Motor scores at 12 and 18 months: *U*s<51.5, *p*s>.025; MSEL Gross and Fine Motor scores at 18 months: *U*s<58.5, *p*s>.025; Motor milestones: *U*s<35.0, *p*s>.003), and data were therefore collapsed across infant sex.

---Table 2 about here---

In order to assess whether older siblings affected infant motor skill and achievement of motor milestones, a number of bivariate correlations and non-parametric comparisons were conducted. These analyses are presented separately in relation to the key research questions.

Does the older sibling's motor skill affect infant motor development?

Spearman correlations were conducted between older sibling motor skill (VABS-II scores, ages of motor milestone achievement) and infant motor skill (VABS-II and MSEL scores, ages of motor milestone achievement).

There were no significant correlations between infants' VABS-II Gross and Fine Motor scores and those of their older siblings at 12 months (all r_s<-.54, *p*>.01) or at 18 months (r_s<.22, *p*s>.01). No significant correlations were found between the infants' MSEL scores at 18 months and older siblings' VABS-II scores (all r_s<.26, *p*>.006), nor between the ages at which infants achieved motor milestones and their older siblings' VABS-II scores (all r_s<.73, *p*>.002). The ages at which older siblings achieved motor milestones were not significantly correlated with infant motor skill: VABS-II motor scores at 12/18 months (all r_s<.51, *p*>.006); MSEL motor scores (all r_s<-.53, *p*>.006); infant motor milestones (all r_s<.73, *p*s>.003).

Mann-Whitney comparisons were conducted on the ages of achievement of the four milestones for which there were reports for both infants and older siblings. The reported age of rolling over was significantly earlier for infants than older siblings, *U*=45.00, *p*=.005, *r*=-.50, while crawling was reported significantly later for infants than older siblings, *U*=17.00, *p*<.001, *r*=-.75. No significant differences were evident in the reported age of standing, *U*=121.00, *p*=.21, or walking, *U*=141.00, *p*=.37.

Does the older sibling's age or sex affect infant motor development?

The age difference between infants and older siblings was calculated in months (*M*=33.12, *SD*=12.11). Spearman correlations were conducted between this variable and measures of infant motor skill. There were no significant correlations: VABS-II motor scores at 12/18 months (r_s<.19, *p*>.01); MSEL motor scores (r_s<-.27, *p*>.025); infant motor milestones (r_s<-.62, *p*>.003).

[1] This was calculated as *p*=.05 divided by the number of comparisons or correlations at each age, and so the significance value for each analysis differs. For example, for analyses involving the motor milestones at each age, alpha should be greater than .003 (.05/15) to be regarded as significant. For analyses involving the VABS-II at each age, there were only two variables (Gross and Fine Motor skills), and so alpha should be greater than .025 to be regarded as significant.

The effect of the older sibling's sex on infant motor development was assessed in two ways. First, infant motor skills were compared between those with a male older sibling and those with a female older sibling. No significant differences were revealed between these groups, using Mann Whitney comparisons: VABS-II motor scores at 12/18 months (U<.55.00, p>.025); MSEL motor scores (U<49.50, p>.025); infant motor milestones (U<35.00, p>.003). Second, the sex of each sibling pair was coded (boy-boy, boy-girl, girl-boy, girl-girl). Given that this resulted in some very small cell values (e.g., only 3 girl-girl dyads), the pairs of siblings were grouped into 'same-sex' (N=10) and 'opposite-sex' (N=13) dyads, and infant motor skill compared between these groups. No significant differences were evident in the motor skill of infants who had an older sibling of the same sex compared to the opposite sex: VABS-II motor scores at 12/18 months (Us<.54.50, ps>.025); MSEL motor scores (Us<54.50, ps>.025); infant motor milestones (Us<36.00, ps>.003).

Does the perceived relationship between siblings affect infant motor development?

Spearman correlations were conducted between infant motor scores and the scores from the PEPC-SRQ in the three relationship domains (parents' perceptions of warmth [M=41.81, SD=6.35], agonism [M=21.14, SD=2.42], rivalry/competition [M=7.05, SD=2.26] between siblings). No significant correlations were revealed between *perceived warmth* in sibling pairs and infant motor skill, [VABS-II motor scores at 12/18 months (all r_s<.31, p>.025); MSEL motor scores (all r_s<.08, p>.025); infant motor milestones (all r_s<-.52, p>.003)], nor between *perceived rivalry/competition* in sibling pairs and infant motor skill [VABS-II motor scores at 12/18 months (all r_s<.46, p>.025); MSEL motor scores (all r_s<.30, p>.025); infant motor milestones (all r_s<-.42, p>.003)]. One significant correlation was revealed between *perceived agonism* and infant VABS-II Fine Motor scores at 18-months, r_s=.61, p=.003, but there were no other significant correlations with infant motor skill [other VABS-II motor scores at 12/18 months (all r_s<.34, p>.025); MSEL motor scores (all r_s<.37, p>.025); infant motor milestones (all r_s<-.40, p>.003)].

Discussion

The current study used a longitudinal approach to assess the role of older siblings on infant motor development, investigating whether characteristics of the older sibling or of the sibling relationship influenced infant motor skills in the first 18 months of life. As expected from previous research, no significant relationships were found between infant motor development and the ages and sexes of the siblings in each dyad. Contrary to predictions, the parent-reported motor skill of older siblings was not significantly correlated with infant motor development. Comparisons of the ages at which older siblings and infants achieved particular milestones were also inconclusive; while infants, as a group, rolled over earlier than their older siblings, they began to crawl later. Finally, of the different dimensions of sibling relationships assessed, only parent-perceived agonism between siblings was significantly correlated with any aspect of infant motor development, specifically with Fine Motor scores from the VABS-II at 18 months.

The fact that the older siblings' motor abilities were not significantly related to infants' motor development was somewhat unexpected, given the reports from previous research that new actions are often copied from older siblings (e.g., Abramovitch et al., 1982; Barr & Hayne, 2003). However, Abramovitch et al. did suggest that imitated actions were more often related to play, rather than skill development, and this could explain why infants' functional motor abilities were not improved in line with those of older siblings in the present study. Indeed, parents reported that most behaviours were 'spontaneous' or 'encouraged', with very few examples of imitation recorded. The comparison of the ages at which infants and their older siblings achieved particular motor milestones also reflected the mixed findings of Berger and Nuzzo (2008). It may be that parents are inaccurate when retrospectively recalling milestone achievement for their older child. Although recall was relatively high amongst the parents in the study (74-83%), we cannot be certain as to the accuracy of this recall. In order to ensure accuracy of recall for the older siblings' motor milestones, data would need to be collected prospectively in a similar way for older and younger

siblings during the appropriate time frame for each child. This would only be possible in a large cohort study in which the older sibling was already being studied, and any who had younger siblings were then followed up. This was not within the scope of the current study. We did, however, prospectively collect questionnaire data concerning the older siblings' broader motor skills during the time period of interest (using the VABS-II), and there were no significant correlations between these skills and the younger siblings' motor development. Thus the suggestion that older siblings may provide a good model of motor skills for infants is not supported by the current data.

Given that the imitation of older siblings' actions seems to be a less important factor than expected, it is perhaps unsurprising that perceived warmth in the sibling relationship was unrelated to infant motor development; increased warmth would be expected to provide more opportunities for siblings to interact playfully, and therefore, for infants to imitate siblings. On the other hand, the significant correlation between parent-reported Fine Motor skills at 18 months and agonism in the sibling relationship could reflect an effect of infant motor development on the quality of the sibling relationship, although it is not possible to assess the direction of these relationships within the current data. The Fine Motor scale of the VABS-II focuses on the abilities to reach, grasp, and manipulate objects, and it may be that developing this type of fine motor control means that toys or objects that were previously only used by older siblings are of increased interest to the younger child. This may lead to more instances of fighting over toys, aggression, anger, and unresolved conflicts between siblings, as specified in the 'agonism' subscale of the PEPC-SRQ. Alternatively, the link between fine motor skills and conflict could be mediated by a separate factor, such as the infant's increasing independence as motor skills develop. For example, the onset of crawling in infants is often associated with increased demonstrations of anger in both parents and infants (Campos, Kermoian, & Zumbahlen, 1992) as infants begin to independently explore their environment. The maturation of fine motor skills provides additional opportunities for exerting independence (e.g., self-feeding), and may lead to increased conflict when this independence is curtailed. It is important to note that the Fine Motor score on the MSEL at the same age did not correlate with agonism in the sibling relationship, and should therefore be interpreted with caution. Furthermore, the sibling relationship may change over time. Future studies should therefore use a range of measures of these relationships and their effect on motor development to aid our understanding of the dynamic reciprocal interactions between infant development and its social context.

The current results suggest that the wide variation in the ages at which motor milestones are achieved (World Health Organization, 2006) may be as evident within families as between families. This could rely on a number of factors, including parenting practices and expectations (Venetsanou & Kambas, 2010). For example, siblings may differ in the age at which they first attended pre-school, which can have positive effects on both gross motor (Koutra et al., 2012) and fine motor (Van Waelvelde, Peersman, Lenoir, Engelsman, & Henderson, 2008) skills. Opportunities to sit, walk, or explore independently could differ between siblings, based on the actions of the caregiver and the other calls on their time with two or more children, compared to only one. An investigation of these additional factors was outside of the scope of the current study. However, future research will benefit from using in-depth observations of parenting practices and sibling interactions as well as questionnaires.

In conclusion, the current study has added to the sparse literature into the impact of having an older sibling on infant motor development by considering different characteristics of the older sibling and of the sibling relationship, rather than the presence or absence of a sibling in the family. Detailed longitudinal information collected from both parental reports and standardised assessment suggested that infants with typically-developing older siblings did not often imitate behaviour directly related to motor milestones, and were just as likely to achieve a milestone later than their older sibling as they were to achieve it at an earlier age. The study also highlighted the potential impact of infant motor development on conflict between siblings, suggesting that infant development and the sibling relationship may have reciprocal effects, which are likely to change over developmental time. Future studies should consider these reciprocal relationships, as well as

extending the sample to include families of lower SES and different ethnicities, in order to improve our understanding of different factors that may influence motor development and assess causal relationships between these factors. This could have important implications for identification of risk factors for poor motor skills and, therefore, for poor cognitive, socio-emotional and health outcomes.

Acknowledgements
This work was supported by a British Academy / Leverhulme Trust grant, grant number SG121791, to HL. We would like to thank Sophie Jackson for data collection, Rhiannon Thomas and Hannah Adeyinka for help with recruitment and Andrew Bremner for providing testing space. We are grateful to all the families who participated in the studies.

The authors confirm that they have no Conflicts of Interests.

References

Abramovitch, R., Pepler, D, & Corter, C. (1982). Patterns of sibling interaction among preschool-age children. In M.E. Lamb & B. Sutton-Smith (Eds.). *Sibling Relationships: Their Nature and Significance Across the Lifespan*. London: Lawrence Erlbaum Associates.

Barr, R., & Hayne, H. (2003). It's not what you know, it's who you know: Older siblings facilitate imitation during infancy. *International Journal of Early Years Education, 11*, 7–18.

Berger, S.E., & Nuzzo, K. Older siblings influence younger siblings' motor development. *Infant and Child Development, 17*, 607-615.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*, 371-399.

Brody, G. H. (2004). Siblings' direct and indirect contributions to child development. *Current Directions in Psychological Science, 13*, 124-126.

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*, 149-219.

Campos, J. J., Kermoian, R.,& Zumbahlen, M. R. (1992). Socioemotional transformations in the family system following infant crawling onset. In N. Eisenberg & R. A. Fabes (Eds.), *Emotion and its Regulation in Early Development* (pp. 25–40). San Francisco: Jossey-Bass.

Cruise, S., & O'Reilly, D. (2014). The influence of parents, older siblings, and non-parental care on infant development at nine months of age. *Infant Behavior and Development, 37*, 546-555.

Ellis-Davies, K., Sakkalou, E., Fowler, N. C., Hilbrink, E. E., & Gattis, M. (2012). CUE: The continuous unified electronic diary method. *Behavior Research Methods, 44*, 1063-1078.

Erbaugh, S., & Clifton, M. A. (1984). Sibling relationships of preschool-aged children in gross motor environments. *Research Quarterly for Exercise and Sport, 55*, 323-331.

Koutra, K., Chatzi, L., Roumeliotaki, T., Vassilaki, M., Giannakopoulou, E., Batsos, C., Koutis, A., & Kogevinas, M. (2012). Socio-demographic determinants of infant neurodevelopment at 18 months of age: Mother–Child Cohort (Rhea Study) in Crete, Greece. *Infant Behavior and Development, 35*, 48-59.

Kramer, L. (1995). Parental Expectations and Perceptions of Children's Sibling Relationship Questionnaire (PEPC-SRQ). Illinois: University of Illinois.

Leonard, H. C., & Hill, E. L. (2014). Review: the impact of motor development on typical and atypical social cognition and language: a systematic review. *Child and Adolescent Mental Health, 19*, 163-170.

Mullen, E. M. (1995). Mullen Scales of Early Learning. Oxford: NCS Pearson.

Office for National Statistics (2010). Standard Occupational Classification 2010. Hampshire: Palgrave Macmillan.

Samuels, H.R., (1980). The effect of an older sibling on infant locomotor exploration of a new environment. *Child Development, 51,* 607-609.
Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). Vineland Adaptive Behavior Scales (2nd ed). Oxford: NCS Pearson.
Van Waelvelde, H., Peersman, W., Lenoir, M., Engelsman, B. C. S., & Henderson, S. E. (2008). The Movement Assessment Battery for Children: Similarities and differences between 4-and 5-year-old children from Flanders and the United States. *Pediatric Physical Therapy*, *20,* 30-38.
Venetsanou, F., & Kambas, A. (2010). Environmental factors affecting preschoolers' motor development. *Early Childhood Education Journal*, *37*, 319-327.
World Health Organization (2006). WHO Multicentre Growth Reference Study Group. WHO Motor Development Study: Windows of achievement for six gross motor development milestones. *Acta Paediatrica, Supplement, 450,* 86–95.

Table 1. Measures of motor development collected at each stage of the project for infants and older siblings.

Stage of project	Infant Motor Skill	Older Sibling Motor Skill
Recruitment	--	Achievement of motor milestones: rolling over, crawling, standing unsupported, walking
12 months	VABS-II Gross Motor VABS-II Fine Motor	VABS-II Gross Motor VABS-II Fine Motor
18 months	VABS-II Gross Motor VABS-II Fine Motor MSEL Gross Motor MSEL Fine Motor Diary reports of achievement of motor milestones: 1) turned from side to back; 2) palmar grasp; 3) pincer grip; 4) reached for objects when laying on front; 5) reached for objects when sitting; 6) reached for objects on floor when standing; 7) sitting unsupported; 8) crawling; 9) pulled from sitting to standing; 10) stood unsupported; 11) cruised (walked holding on to furniture); 12) walked with support; 13) walked without support; 14) ran; 15) climbed stairs	VABS-II Gross Motor VABS-II Fine Motor

Note. Measures of motor skill for older siblings were measured when the *infant* was 12 months and 18 months old, respectively. Diaries were adapted from Ellis-Davies et al. (2012), with permission.

Table 2. Means, standard deviations (in parenthesis) and *ranges* of standard scores on the motor scales of the Vineland Adaptive Behavior Scales-II (VABS-II) and the Mullen Scales of Early Learning (MSEL), and ages of motor milestone achievement.

Motor Measure	**Infants**	**Older siblings**
Questionnaires		
VABS-II GM (12m)	14.00 (2.85)	13.76 (1.88)
	8.00-18.00	*9.00-16.00*
VABS-II FM (12m)	16.35 (2.67)	15.62 (2.53)
	11.00-21.00	*12.00-19.00*
VABS-II GM (18m)	14.06 (1.67)	14.31 (2.14)
	10.00-17.00	*10.00-18.00*
VABS-II GM (18m)	16.82 (1.84)	15.77 (1.59)
	14.00-20.00	*12.00-18.00*
Standardised Test		
MSEL GM	49.29 (11.05)	--
	20.00-67.00	
MSEL FM	52.52 (7.02)	--
	38.00-63.00	
Reported Milestones		
Roll side to back	2.73 (0.69)	4.57 (1.97)
	2.13-3.48	*2.00-10.00*
Palmar grasp	2.89 (0.75)	--
	2.03-3.39	
Reach on front	4.41 (0.23)	--
	4.23-4.67	
Reach while sitting	5.26 (0.73)	--
	4.42-5.70	
Pincer grip	6.95 (1.02)	--
	6.00-8.03	
Sit unsupported	6.17 (0.75)	--
	5.68-7.03	
Crawl	8.99 (0.43)	5.87 (0.99)
	8.65-9.48	*4.00-7.50*
Pull up	9.61 (0.80)	--
	8.77-10.36	
Stand unsupported	11.02 (1.13)	10.43 (2.14)
	10.29-12.33	*7.00-15.50*
Reach while standing	11.13 (1.75)	--
	9.54-13.00	
Cruises	10.90 (0.74)	--
	10.04-11.33	
Walks supported	10.64 (0.85)	--
	10.04-11.61	
Walks unsupported	13.29 (0.60)	12.07 (1.76)
	12.67-13.87	*9.00-16.00*
Runs	14.88 (0.27)	--
	14.58-15.07	
Climbs	13.49 (1.59)	--
	12.29-15.29	

Note. VABS-II scores for older siblings were measured when the *infant* was 12 months and 18 months old, respectively.