

Effect of dual-language exposure in infancy on language and cognition: Evidence from a South-Indian birth cohort

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Abstract

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- bilingualism,
- Children,
- Cognition,
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Background: Language and cognitive development in infancy is a complex process with multifactorial influences. The effort made by the infant to attain language development can improve cognition. From the longitudinal follow-up of a birth cohort, we explore the relationship of dual language exposure on cognition and language development at two years of age.

Methods: For this study, 251 children from a low-middle-income urban population in Vellore were recruited at birth as part of a multi-national multidisciplinary study and followed up at serial intervals as per the original study protocol. Languages spoken include Tamil, Urdu and Telugu and data about language exposure were collected. BayleyScales of Infant Development was used to assess cognition and language development at two years of age.

Results: Out of 228 children who were recruited at two years of age, 169 (74.1%) children were monolinguals and 59 (25.9%) bilinguals. The average composite scores (SD) for cognition and language components were 93.3 (7.5) and 99.1 (9.4) respectively. At two years of age, both language and cognitive development was comparable for both monolinguals and bilinguals, adjusting for sex, socioeconomic status and maternal education.

Conclusion: There was no significant effect of early dual language exposure on language and cognition at two years of age in an urban low-middle-income community setting in South India.

Introduction:

Speaking two or more languages has become common in this increasingly globalized world. Two-third of the population worldwide is now bilingual^[1] and majority multilingual speakers. In the Indian scenario, by virtue of its cultural and linguistic diversity, children can be exposed to more than one language before the initiation of formal schooling. According to the Census of India (2011), India is characterized by extensive linguistic diversity, with over 19,500 mother tongues and 122 major languages, and the routine use of two or more languages by a majority of individuals, rendering bilingual exposure normative in Indian children^[2-3].

Bilingualism can be dual language exposure since birth or actively using more than one language in daily activities or a range of use and expertise in more than one language^[4]. Bilingualism can manifest in different forms depending on the timing, context, and manner of language acquisition. Researchers commonly distinguish between simultaneous and sequential bilingualism. Simultaneous bilingualism refers to the acquisition of two languages from birth or within the first few years of life, during which both languages develop concurrently without a clearly established first language^[5]. Sequential bilingualism occurs when a child first acquires one language as a dominant or first language and is subsequently exposed to a second language after the initial language system has been established. In this case, the phonological, syntactic, and lexical structures of the first language may influence the acquisition of the second language^[6-7]. Bilingualism can affect speech acquisition in young children, in all three phases of; 1) speech perception where children understand sound systems; 2) speech storage of sounds semantically and phonologically and 3) speech retrieval and production using oropharyngeal musculature. Simultaneous bilingualism exposure in early childhood differs from that of a second language exposure in a child (Sequential) with already existing dominant language in that, for the latter the phonology (sound systems) and syntax (grammar) of the dominant language can be extrapolated to the newly learning

language^[7]. The primary difference lies in timing and language influence: simultaneous bilinguals develop two linguistic systems in parallel, whereas sequential bilinguals acquire a second language through the framework of an already established first language. Simultaneous bilingual exposure in early childhood differs from second language exposure in a child (sequential bilingualism) with an already established dominant language. In the latter, the phonology (sound systems) and syntax (grammar) of the dominant language may be extrapolated to the newly learned language^[7]. Indian studies have reported similar cross-linguistic transfer effects, particularly in phonology and morphosyntax, among children exposed to structurally distinct languages such as Dravidian and Indo-Aryan languages^[8-9].

Recent reviews have reached conflicting conclusions about the effects of early childhood dual language exposure on cognition and speech development^[10-15]. During the first half of the 20th century it was believed that bilingualism in early childhood was detrimental to linguistic and intellectual development. Early onset simultaneous bilingualism may promote two separate phonological systems that interact, increasing the demand on language learning capacities in bilingual children delaying language acquisition and speech production of one or both languages^[16-17]. In contrast, other researchers highlight the importance of neuroplasticity that allows the young brain to learn two or more languages in early childhood^[12-16]. While Hambly et al., (2013) argue that the literature has not convincingly shown that bilingual children's language acquisition is slow, there is a consensus that both positive and negative transfers occur between languages^[16-17].

Even though the additional demands made by bilingualism on the cognitive resources of the developing brain were historically considered disadvantageous, subsequent, more methodically robust, studies revealed 'enhanced cognitive ability' in bilingual children^[10,18-20]. Bilinguals are hypothesised to use additional cognitive resources in selective attention, discrimination, inhibition and switching during language use,

thus promoting cognitive flexibility reflecting in better executive functioning^[10,21-22]. However, there have been contradictory reports of no added benefit in bilingual children and adults including professionals language interpreters^[23-25]. Recent reviews have highlighted publication bias against negative findings in bilingual research and reported cognitive advantages disappeared after appropriate corrections for publication bias^[11,13,14].

India being a multicultural society with multiple languages, most individuals are exposed to more than one language in their lifetime. There is a dearth of literature evaluating early onset bilingualism and its effect on language and cognitive development of toddlers in India. With this background, the current study conducted in a longitudinal birth cohort follow-up aims to evaluate if early bilingual exposure has better developmental and cognitive skills at two years of age in a low-middle income country community setting in South India.

Materials and methods:

Study population and methodology-

The current study population was a birth cohort followed up for the The Etiology, Risk Factors and Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health and Development (MAL-ED) Network, a longitudinal, multinational prospective cohort study conducted in eight different countries across the world^[26]. The study site in India comprised of Old Town, Salavanpet and neighbouring areas in Vellore, South India; which are predominantly urban slum dwelling areas with a population density of 42,000/km², where houses share common walls^[27]. A population of 12,000 was covered for this study and a door-to-door survey identified pregnant women, who were invited to include their children in the study immediately after birth. After informed consent, children were recruited at birth. All details including socio-economic status and languages spoken were collected at recruitment. Majority of families in this area use Tamil as their mother tongue, but there is a proportion that has either Telugu or Urdu as their mother tongue, but

are also proficient in Tamil. Children recruited had regular home visits (twice per week) by trained fieldworkers for active disease surveillance and to monitor feeding and immunization practices for the first two years of life. Monthly anthropometric measurements were done for the first 2 years with developmental assessments at 7, 15 24 and 36 months of age and further cognitive assessments later. The initial birth cohort recruitment was conducted between March 2010 and February 2012 and recruited 251 children. The original birth cohort recruitment, follow-ups and subsequent analyses were approved by the Institutional review board. Informed consent was obtained from the caregiver for each study stage. For the purpose of this current analysis, developmental assessment at 24 months of age was considered as outcome variable.

Study Measures:

Bayley Scales of Infant and Toddler Development-III (BSID-III)-

The Bayley Scales of Infant and Toddler Development-III (BSID-III), which assesses development in the domains of gross motor, fine motor, language (expressive and receptive) and cognition, were done at 24 months of age to assess child development^[28]. The measure was culturally adapted, translated to Tamil and piloted prior to administration. A single trained psychologist conducted the testing in a standardized child friendly setting in the community clinic. Around 5-6% of the tests were videoed and centrally reviewed for quality control purposes^[29]. Receptive and expressive language as well as cognitive domain raw scores were derived for each child from this measure and further composite scores calculated based on Bayley manual recommendations.

Maternal cognition was assessed at 6-8 months of child age by Raven's progressive matrices^[30]. To assess the socio-economic status, a socioeconomic index was created using Water, Assets, Maternal education and household Income (WAMI)^[31].

Data entry and analysis:

The Data Coordinating Center (DCC) of the MAL-ED study developed a double data entry database

application. After checking forms for completeness and accuracy, data was entered into the application. The discrepancies between first and second entry were cleared by data supervisors after confirming from the forms. The data was analyzed using STATA 13. (StataCorp, College station,TX,USA).

Results:

In the original cohort, 251 children were enrolled

at birth after visiting 301 mothers. On subsequent follow-up, 228 children participated at two years of age and the loss to follow-up was mainly due to family migration out of the study area (Fig. 1). The group at two years of age was similar to the birth cohort in the distribution of sex and socio-economic status (Table 1).

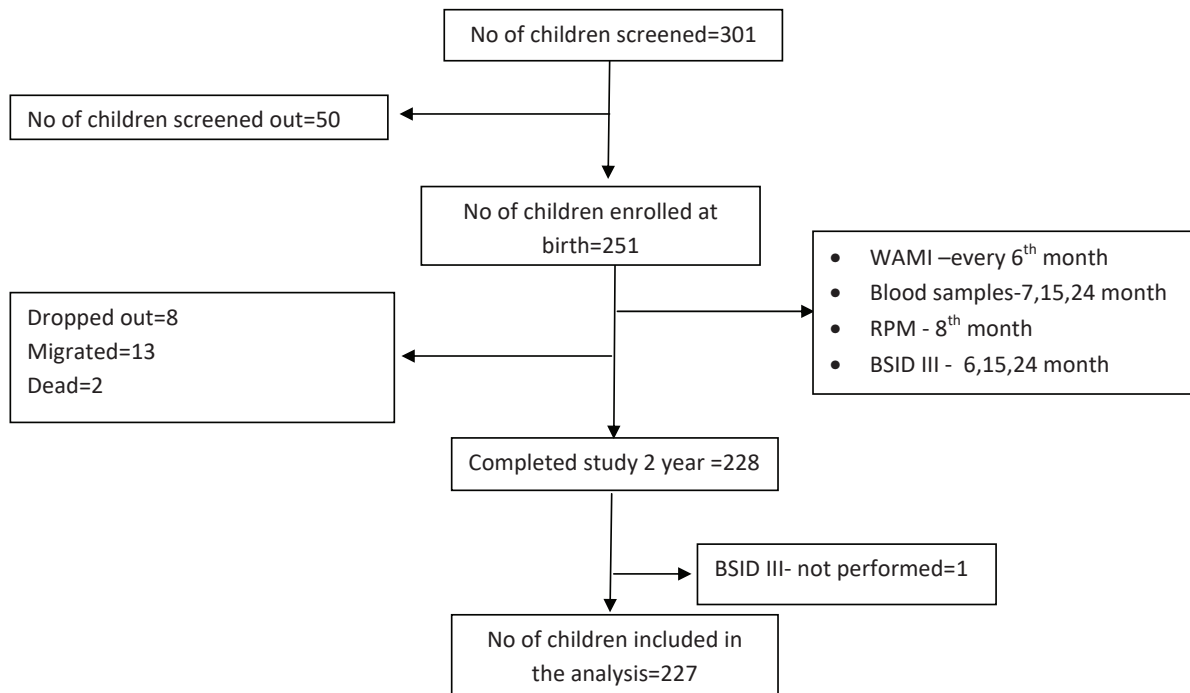


Fig 1: Flowchart depicting the follow-up of the birth cohort

WAMI – Water and sanitation, Assets, Maternal education and Income score for socio-economic status; RPM – Raven’s progressive matrices; BSID III – Bayley Scales of Infant and Toddler Development III

Table. 1: Characteristics of study children at enrolment and two years of age

Characteristics	Enrolment (N=251)	At 2 years (N=228)
1. Gender		
Male (%)	113(45.0)	105 (46.0)
Female (%)	138(55.0)	123 (54.0)
2. SES (WAMI)		
Low (<33 percentile)	71 (30.6)	69 (30.3)
Middle(33-66 percentile)	86 (37.1)	78 (34.2)
High (> 66 percentile)	75 (32.3)	81 (35.5)
3. Exposure to language		
Tamil alone	-	169 (74.1)
Dual language	-	59 (25.9)
4. Maternal cognition raw score (mean (sd))	-	43.9 (10.5)

SES – Socio-economic status; WAMI - Water and sanitation, Assets, Maternal education and Income score

The cohort recruited at Vellore had an average family size (range) of 5.70 (3-13) and the mean educational years (range) of the head of the family was 6.81 (0-18) (for detailed demographic description, refer to John et al, 2014) (John et al., 2014). The houses, which were in the urban slum area of Vellore had on average 2 rooms per house (range 1-6) with a family size of 5.70 (range 3-13) and 22% of families cooked on open fires outside their homes. The recruited birth cohort had a girl predominance (56%) with a mean birth weight (SD) of 2.82 (0.44) kg.

Tamil is the predominant and official language of the region. Around 25% of families had other languages such as Telugu or Urdu as the dominant language spoken at home, but children had exposure to Tamil in the immediate vicinity including Tamil-speaking neighbours, playmates and electronic media. Children get enrolled into a government sponsored Tamil preschool programme known as Balawadi between the ages of one and half and two years of age; and in the current cohort 175 (82.2%) children attended Balawadi with the average (range) duration of 15.34 (0-42) months. Baseline demographics did not significantly differ between monolinguals and bilinguals (Table. 2)

Table. 2: Basic characteristics of monolingual and bilingual children

Characteristics	Monolinguals (N=169)	Bilinguals (N=59)	P value
1. Gender			
Male (%)	79 (46.8)	26 (44.1)	0.720
Female (%)	90 (53.2)	33 (55.9)	
2. SES (WAMI)			
Low (<33 percentile)	59 (34.9)	22 (37.3)	0.370
Middle(33-66 percentile)	62 (36.7)	16 (27.1)	
High (> 66 percentile)	48 (28.4)	21 (35.6)	
3. Maternal cognition raw scores (mean (sd))	44.5 (10.6)	41.9 (10.0)	0.101

SES – Socio-economic status; WAMI - Water and sanitation, Assets, Maternal education and Income score

Developmental tests were administered in Tamil, which was the non-dominant language for dual language speakers. However, dual language speakers were able to answer in Tamil satisfactorily at two years of age. Bayley testing was attempted for all children enrolled at two years of age and completed for 227 (99.6%) children. The average composite scores (SD) for cognition and language components were 93.3 (7.5) and 99.1 (9.4) at 24 months of age respectively.

Exposure to dual languages did not render any added advantage or disadvantage to both cognition and language scales at two years of age (Table 3). Higher socio-economic status had a significant positive effect on cognition at this age. Girls had a significant better language at two years of age; while lower socio-economic status rendered a significant disadvantage.

Table 3: Factors associated with cognition and language components of BSID III composite scores assessed at 2 years (N=227)

	Unadjusted Beta coefficient (95% CI)	P value	Adjusted Beta coefficient (95% CI)	P value
Cognition				
Dual language	-1.37 (-3.6 – 0.9)	0.226	-1.25 (-3.5 – 1.0)	0.266
Female sex	-0.14 (-2.1–1.8)	0.886	-0.14 (-2.1– 1.8)	0.887
Low maternal cognition	-1.82 (-3.8 – 0.1)	0.066	-0.85 (-2.9 – 1.2)	0.407
Middle SES	-2.70 (-5.0 – -0.4)	0.022	-2.62 (-5.0 – -0.3)	0.027
Low SES	-4.20 (-6.6 – -1.8)	0.001	-3.87 (-6.3 – -1.4)	0.002
Language				
Dual language	-1.14 (-3.9 – 1.7)	0.422	-0.80 (-3.6 – 2.0)	0.570
Female sex	2.62 (0.2 – 5.1)	0.035	-2.49 (0.08 – 4.9)	0.043
Low maternal cognition	-3.13 (-5.6 – -0.7)	0.012	-2.13 (-4.6 – 0.4)	0.096
Middle SES	-1.13 (-4.0 – 1.8)	0.442	-0.94 (-3.9 – 2.0)	0.524
Low SES	-4.30 (-7.3 – -1.3)	0.005	-3.54 (-6.6 – -0.5)	0.025

BSID III – Bayley Scales of Infant and Toddler Development III; SES -socio economic status

Discussion:

This prospective birth cohort follow-up study from urban Vellore explores the effect of early onset dual language exposure, on cognition and language at two years of age using a developmental assessment tool. The follow-up group did not significantly differ from the original cohort (Table 1).

Review of literature on cognitive linguistic abilities in children with bilingual language acquisition has indicated mixed effects. The result of the current study showed that there was no significant impact of early dual language exposure on language and cognition at two years of age and suggests that simultaneous bilingualism does not put children at a disadvantage. Early onset bilingualism by virtue of its additional demand on neural network for selective attention, discrimination, selection, inhibition and switching of languages, along with the neuroplasticity of young brain is expected to improve executive functioning while lowering lexical retrieval, when compared to monolinguals^[10,18,19,21,32]. These gains in executive

control can be seen as early as two years of age^[21]. There can be additional benefits of bilingualism on theory of mind and performance on false belief tasks^[33]. The current study did not exclusively look at any of these specific domains. Studies evaluating language acquisition have demonstrated similar finding as of this study that both monolinguals and bilinguals acquire language at the same rate^[12,16].

Literature reviews have shown that there is limited evidence to suggest a slower speech acquisition in bilinguals, but for qualitative differences and unexplored or incompletely explored factors such as socio-economic status, schooling and language status could have affected outcomes in published literature^[10,12]. In lower socio-economic settings, bilingualism can act as a protective factor for executive control^[34]. In higher SES settings, total vocabulary was found to be equal for both monolinguals and bilinguals^[17]. In the current study, language and cognitive development was found to be similar in both monolinguals and bilinguals, correcting for SES, maternal education and sex differences.

Complexity of both languages and language dominance can impact the acquisition of phoneme repertoire in the non-dominant language^[12]. Simultaneous bilingualism in dual language users can cause atypical developmental errors in language acquisition of both languages and delayed disappearance of typical developmental errors. Vocabulary and grammar was better for monolinguals on single language comparisons, while the total vocabulary was comparable when both languages were considered^[17]. There was no difference between monolinguals and bilinguals on language recall, emotional responsiveness, working memory or total vocabulary but memory generalization was better for bilinguals^[35]. In speech production, simultaneous bilinguals can have inconsistent errors in one or both languages including delayed phonological skills, increased phonological errors and atypical articulation^[34].

There have been different hypotheses explaining neuro-anatomical and physiological representations of bilingualism. Some had proposed macrostructural changes such as increase in gray matter density and white matter integrity in bilingual individuals^[36], with increase in neural network involving larger frontal and basal ganglia networks^[20]. Others have proposed a co-existing model where two languages are represented as different micro-anatomical substructures within the same cerebral language area^[37]. The language mode, that is the state of activation of bilingual/multilingual languages and language processes affecting bilingual/multilingual understanding and expression, also has been proposed^[22]. However, studies on language mode have been limited and it is difficult to evaluate language modes and processes in children especially toddlers.

In the current study, language acquisition and cognitive development appear to be similar for both

monolinguals and bilinguals as have been published by other authors^[12,16,17,35]. It was proposed that processes of language acquisition appear similar in both mono and bilinguals, but outcomes might vary depending on the larger socio-cultural context. There are limitations for the current study. This is a sub-analysis of a larger multi-national study and was not designed to analyse the effect of bilingualism exclusively. Nevertheless, stringent quality assurance and quality control processes followed in the original study can aid the validity of the current finding^[29]. The present study in a low SES urban slum linguistically diverse cohort in a low middle income country can be a worthwhile addition to the bilingualism literature that there is no difference in language and cognitive acquisition in toddlers between monolinguals and bilinguals. Future research can evaluate language modes and processes in culturally and linguistically diverse settings such as India and their influence on bi and multilingualism development.

Conclusion:

In this South Indian birth cohort, children exposed to two languages in infancy had language and cognitive scores at 24 months that did not differ significantly from those of monolingual children after adjustment for measured factors. The findings do not suggest a developmental disadvantage associated with dual-language exposure in this setting. Because this was a secondary analysis with assessment at one age, longer follow-up using measures in both languages would help clarify later outcomes.

Conflict of Interest: None

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