The Infant Monitor of vocal Production (IMP) normative study: Important foundations

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Abstract

The purpose of this study was to establish a set of normative data (growth curve and centiles) for the Infant Monitor of vocal Production (IMP) using a representative population of infants with typically developing hearing. A linear mixed effect model and regression was used to derive 'stage-for-age' trajectory and growth centiles from the standard sequence of IMP assessment scores of 85 infants with normal hearing (age range 3 to 13 months). A significant linear relationship was demonstrated between IMP scores and infant age (p<.001). No significant relationship was found between IMP scores and gender, mono/bilingual language environment, singleton/sibling status, maternal education, or maternal work status. Inter-rater reliability and correlation for agreement was strong (0.94). These findings show that IMP assessment depicts the vocal development of infants with normal hearing as an hierarchical relationship between the complexity of infant vocal productions and infant age. Normative gains in vocal competency (-1SD/+1SD) approximated one IMP question per month of age from an infant's baseline level of IMP achievement.

KEYWORDS infant vocal development, assessment, normal hearing, deafness

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Introduction

When an infant diagnosed with hearing loss receives appropriate very early amplification and quality early intervention (JCIH, 2013), the prospect exists for that infant to progress to speech and language in step with typical hearing peers (Fulcher, Baker, Purcell, & Munro, 2013). However, the infant's capacity to reliably process the speech signal and (re)produce speech may remain in question until standardized assessments of linguistic development are able to determine progress at a later point in time (e.g., Fenson et al., 2007; Zimmerman et al., 2011). This conundrum can postpone further decision-making with respect to the hearing technologies and strategies needed to effectively support the young child's future habilitation of language.

For almost a decade, the Infant Monitor of vocal Production (IMP) (Cantle Moore, 2004) has been used in early intervention programs to help parents understand the nature and pace of their baby's vocal development, following neonatal diagnosis and amplification for hearing loss (S. Lane, personal communication, May 16, 2014; C. Yoshinaga-Itano, personal communication, July 13, 2009; RIDBC Early Childhood Services, 2005). The IMP is a criterion referenced tool that guides a professional and parent conversation about an infant's current everyday vocal ability. The instrument progressively evaluates an infant's vocal productions throughout the first 12 months of natural hearing, or very early device-assisted hearing, by documenting the parent's comments in response to a set of hierarchical questions that probe how and when (or whether) their baby's innate vocal behaviours transition to audition-led imitations of speech and salient words (see Cantle Moore, 2014).

While there are various scales and instruments available to assess the auditory and oral communication behaviour of very young children (e.g., Rossetti, 1990; Wilkes, 2001) the

IMP was designed to serve a different instructive purpose. The process of IMP assessment enables a professional and parent to jointly investigate, measure and review the evolving relationship between an infant's auditory perception and processing of speech, and his oro-motor capacity to produce speech sounds and patterns. As a result, the IMP evaluates the formation and linkage of skills that underlie the implicit target of speech, before the first year of natural hearing or very early assisted-hearing experience has elapsed.

Rationale

The potential for the IMP to red flag any departure from the typical birth-12 month continuum of prelinguistic vocal behaviour—and thus, inform timely decision-making about the effectiveness of an infant's hearing device fitting and/or habilitative plan—has been demonstrated in a longitudinal series of pilot studies examining infant vocal development as a function of hearing experience. That program of research has included infants with normal hearing, aided bilateral hearing loss (Cantle Moore & Leigh, 2010), earlier cochlear implantation (<10 months of age) (Cantle Moore, 2012), diagnosed features of auditory neuropathy spectrum disorder (ANSD) (Cantle Moore, 2011), unilateral hearing loss (Cantle Moore et al., 2014) and infants commencing bilingual/bi-modal habilitation pathways (Cantle Moore, 2013). The accumulated findings of those investigations determined that a principal IMP study was essential, to establish a normative evidence base for diagnostic surveillance in very early intervention for hearing impairment and other neonatal conditions where infants are identified to be at risk for speech delay (Ward, 2017).

At risk surveillance

"When an initial screening is for hearing, other problems may be overlooked until an astute clinician, therapist, or family member notes a lack of appropriate skill progression"

(Wiley & Moeller, 2007, p. 8). The early identification of motor-speech impairment is a case in point, and one of particular importance where infants diagnosed with neonatal hearing loss are also at risk for developing cerebral palsy (CP) (e.g., Lipscombe et al., 2016; Ward, 2017). This population includes infants born prematurely (Trønnes et al., 2014) and those who require neonatal medical intervention and intensive care following birth (Kulak et al., 2010). Anecdotal reports also exist of idiopathic childhood apraxia of speech (CAS)/developmental verbal dyspraxia (DVD) co-occurring with hearing loss (Royal College of Speech and Language Therapists (RCSLT), 2011, p.13). CAS reflects difficulty in the planning of speech movements, and early indicators have been observed to include very limited (or absent) consonant-vowel babbling and the ongoing dominance of vowel sounds in expressive vocalizations (Davis & Velleman, 2000; Overby & Caspari, 2015). Although "typical features may be difficult to recognise in very young children" (RCSLT, 2011, p.12), in cases where CAS has been suspected, the child's immature vocal productions continued to be incongruous with their (aided) auditory development and comprehension of speech. The IMP has demonstrated potential to identify irregularities in early vocal production at the root of such an incongruence of skill, and thereby flag 'at risk' progress warranting further investigation.

Objectives

The primary purpose of this study was to establish normative IMP data (growth curve and centiles) for a representative population of infants with normal hearing. The following research questions guided the investigation of that objective.

1. Does the IMP define a typical trajectory of vocal competence for infants with normal hearing and no diagnosed disability, birth to 12 months of age, independent of the language(s) spoken at home and by caregivers?

It was hypothesised that the vocal productions of all typically developing, hearing infants would steadily progress toward speech and first words in the first year of life, irrespective of variation in language(s) heard spoken at home or used by caregivers speaking to the infant.

2. Do parents report the vocal productions of typical infants to vary in content and/or change in complexity, month on month?

It was speculated that increasing oro-motor experience and oro-motor control would enable typically developing infants to progressively produce greater variety and complexity of vocal productions across the first year of life, and that parents would be aware of (observe) those ongoing changes. Specifically, that parents would report: (a) typical 11-12 month old infants demonstrated vocal productions of *greater variety and complexity* than typical 8-9 month old infants; and (b) typical 8-9 month old infants demonstrated vocal productions of *greater variety and control* than typical 5-6 month old infants—particularly in regard to oro-motor control of canonical babble, the rhythmic production of repetitive consonant-vowel (CV) sequences (e.g., bʌbʌbʌ).

3. Do parents report typical infants to produce similar consonant and vowel sounds (CV pairs) in babble, independent of whether the home language environment features the speech sound repertoire of a single language (monolingual) or more than one language (bilingual)?

It was reasoned that in the first year of hearing, infants growing up in bilingual language environments would receptively distinguish differences in consonant and vowel production in more than one language (Kuhl et al., 2014), however, the typical continuum of infant oro-motor development would impede production of consonant and vowel sounds that the infant was not yet physically mature enough to orally shape and control. Hence, the CV pairs produced in infant babble (<12 mths of age) would be similar in sound and manner of production, regardless of receptive language experience (monolingual or bilingual).

4. Is the frequency of occurrence of rhythmically fluent CV babble associated with prospective linguistic development indicated at completion of the IMP?

It was hypothesized that: (a) infants exhibiting frequent CV rhythmic motor fluency in babble at 8-9 months of age would produce a greater number of distinct proto-words/first words at 11-12 months of age than infants exhibiting limited CV rhythmic motor fluency in babble at 8-9 months of age.

Participants

Approval to conduct the study was granted by the University of Newcastle, Human Research Ethics Committee. A representative population of parents was informed of the study in brochures made available through local Council family services (child health and vaccination centres, day-care facilities, libraries) across the Greater Sydney region, NSW, Australia. The participants included all parents who self-selected to enrol in the study via the publicised website. Criteria for proceeding to actual enrolment in the study confirmed that: (a) the parent-participant spoke English, as a first or additional language, (b) the consenting participant was the parent of an infant who had passed newborn hearing screening, (c) the infant had not been diagnosed with any form of disability, (d) the infant was currently less than 6 months of age, and (e) the parent was able to attend a series of three appointments at one of the five listed study sites. The parent's formal consent to become a study participant acknowledged that the parent was also giving consent for their infant child to become a study subject.

All parents enrolled in the study (n=91) were mothers of eligible infants and all were Australian citizens or permanent residents. Six parent-participants withdrew from the study during the term of research owing to infant illness (3), parent illness (1), or the parent's decision to return to work (2). The remaining parent-participants (n=85) completed all three

stages of IMP assessment regarding their infant's vocal development, birth to 12 months of age. The demographics of those 85 participants (parent and infant) are presented in Table 1.

Insert TABLE 1 about here

At the initial study appointment (IMP baseline assessment) each parent received a small welcoming gift of infant clothing. Following each of the three study appointments each parent received a $20 chain store gift card as reimbursement of travel expenses.

Method

The study followed a normative, iterative process. The parent's report of their infant's current vocal ability was documented by IMP assessment at three separate time-points over an eight month period. IMP baseline documentation commenced when the infant was 4-6 months of age, and continued in sequence at 7-9 months and 10-13 months of age (see Figure 1). These age-points coincided with milestones of vocal competency probed by the question sequence of the IMP (see Cantle Moore, 2014).

Insert FIGURE 1 about here

Five early intervention Teachers of the Deaf were employed to collect the study data. Each teacher held a post-graduate qualification in special education/early intervention and all

were trained and experienced users of the IMP in their professional practice. The initial study appointment for each parent-participant was randomly assigned to one of these early intervention professionals. The following two study appointments were arranged mutually by the professional and parent, so the relationship continued in subsequent IMP conversations and to streamline the scheduling of appointments.

Procedure

The collection of data continued for 20 months. Participant demographic data was entered directly by the parent, at the time of their enrolment via the study website. All IMP assessment data was documented in paper format by the professional during their conversation with the parent and later entered into the database for analysis. The hardcopy assessment files were stored in numerical (enrolment) order for reference.

Both participant and teacher permission was sought and obtained for a random sample of 27 parent-professional IMP conversations to be video-recorded, to ensure that IMP presentation protocols were adhered to by all professionals, and to enable a 10% sample of parent responses to be independently scored by a second professional for inter-rater agreement and reliability. All files and data were stored in a secured manner and place for the required 5 year post-completion period.

Statistical methods

The relationship between IMP assessment question ceiling (Q ceiling) and chronological age as a continuous variable was examined using a linear mixed effect model (LMM) to evaluate the relative contribution of different sources of variability, and to determine if any demographic characteristic had a relationship with IMP score and rate of vocal progress. Random intercept and slope terms were estimated using Restricted Maximum

Likelihood (REML) and tested for significance using likelihood ratio tests and the Akaike Information Criterion (AIC). Only significant terms were retained for the base LMM. Analysis was carried out using the R statistical package with the mixed models fitted using the lme program from the nlme library. Statistical significance was set at $p < .05$ for all inquiries.

The effects of five demographic characteristics were tested by adding each one in turn to the base LMM model with two fixed effect terms—the main effect for the characteristic, and its interaction with age—to test for differences between the groups and different progress rates respectively. The reference centile limits for Q ceiling at age were determined using a linear regression method described in Altman (1993) which included a regression test for non-constant variability of residuals by fitting the absolute residuals from the regression model against age. Possible curvature in the age relationship was tested by adding quadratic terms to the regression model using centred age variables. The reliability of Q ceiling scores was tested by way of two person inter-rater agreement on a random 10% sample of the data (9/85 infant subjects).

Results

Statistical modelling

An overlay plot of the lines of best fit for each subject (3 time points each) is shown in Figure 2. A linear mixed effects model (LMM) was applied to understand the importance of apparent differences between subjects and whether there was evidence of infants progressing at different rates. A statistically significant linear relationship was found between Q ceiling and age ($p < .001$) and a significant random intercept term ($p = .002$, SD=0.60) with residual (SD= 1.17). The random slope term was not significant ($p = .92$). Four outliers to the group were identified. Three of these infants had pronounced slow increase in Q ceiling

score—one of the three was diagnosed with chronic middle ear pathology and received bilateral grommets at 12 months of age. The fourth infant started assessment from a high baseline score. The between subject variability characterised by the random intercept term was found to be only a minor contribution to the total variability (21% of the total variance), hence a simple regression model with age was considered satisfactory for determination of the reference centile limits.

Insert FIGURE 2 about here

The base LMM in Figure 2 was extended to examine the effect of five binary demographic variables: home language environment, maternal education, maternal work status, infant gender, and infant position in the family. None were found to have any relationship, either for differences in the levels of the characteristic or rate of progress—e.g., male and female progress rates were not different. Table 2 shows the stability of the Q ceiling measure against these characteristics.

Insert TABLE 2 about here

A linear regression was fit for Q ceiling against age (p <.001, B=0.916, SE=.032) and the absolute values of the residuals were calculated. (Addition of a quadratic term did not support curvature in the age relationship.) A significant negative slope (p=.02) was found for

the age relationship, with the absolute residuals indicating the spread about the regression line was decreasing with increasing age. As per Altman (1993) the regression equation was converted to the SD of residuals by multiplying the coefficients by $\sqrt{(\pi/2)}$ giving SD=1.41 - 0.0477Age. The equation was used to calculate the centiles using normal distribution Z scores for the 3rd, 15th, 50th, 85th and 97th centiles as multipliers for the SD at each age (see Table 3). Figure 3 presents the resultant growth curve with centile bands.

Insert TABLE 3 about here

Insert FIGURE 3 about here

Consonant-vowel productions (CV)

The consonant-vowel productions of infants—as reported by their parents in IMP questions 13-16—were examined for similarity and difference in content (see Figure 4). All infant subjects (100%) were reported to produce the CV sound pair perceived as [dæ] or [tæ]. The CV sound pairs perceived as [bʌ] and [mʌ] were produced by the majority of infants from both monolingual (85%) and bilingual (100%) home environments. The CV sound pair perceived as [ga] or [ka] was reported to be produced by more infants from bilingual home environments (81%) than infants from monolingual home environments (55%).

Insert FIGURE 4 about here

Psychometric properties

The face validity of IMP assessment, with reference to the criteria of interest to professional users (Cantle Moore & Leigh, 2010) and parent participants (Cantle Moore, 2013), was established in accordance with Nevo (1985) and Secolsky (1987) in an earlier stage of the IMP project.

In the present study, test-retest of the serially documented IMP was not performed due to the dynamic nature of typical infant vocal development and associated limitations in timing, which posed the possibility of a Hawthorne effect moderating a parent's re-evaluation of their infant's current vocal ability. As an alternative, the reliability of scores was examined by way of inter-rater scoring of video-recorded case examples of IMP assessment in progress. Accordingly, a 10% random sample of IMP assessments (9|85 infant subjects, 27|255 professional-parent IMP conversations) was video-recorded and independently scored by a second professional. The inter-rater scoring of infant vocal progress (Q ceiling score) was found to have high reliability in both percentage agreement (97%) and correlation for agreement (0.94).

A validation of norms was carried out by comparing Q ceiling-at-age scores generated from the present study (group 1, n=85) with Q ceiling-at-age scores generated in an earlier IMP study investigating results for infants with normal hearing (group 2, n=9) and infants with bilateral aided hearing (group 3, n=18) (Cantle Moore & Leigh, 2010). Linear mixed effect models were used to perform these group comparisons.

No significant differences were found between the scores attained by the two separate groups of normal hearing infants (groups1 and 2). Specifically, the infants in the present

study and the normal hearing infants in the earlier study demonstrated no significant difference in fixed effects intercept (p= 0.78) and slope (p=0.20) respectively. In contrast, differences were found between the present study group and the group of infants with bilateral aided hearing (groups 1 and 3). The infants with aided hearing displayed significantly lower intercept ($p < 0.001$) but not slope (p=0.17), thus demonstrating that infants with aided hearing traced the same continuum of vocal development as typical hearing infants, albeit at a slower rate of progress.

Insert FIGURE 5 about here

Discussion

The objective of this study was to establish a set of normative data (growth curve and centiles) for the Infant Monitor of vocal Production (IMP) using a representative population of infants (n=85) with normal hearing. To this end, the vocal competency of each infant was systematically documented in sequential IMP presentations, baseline to 12 months of age.

The first of four research questions investigated whether IMP assessment defined a typical trajectory of infant vocal competence (<12 months of age), and whether the same continuum and rate of vocal progress existed regardless of the language(s) the infant heard spoken at home and by caregivers. The study results confirmed that an hierarchical relationship exists between the complexity of infant vocal productions and infant age, and that IMP assessment can reliably depict a typical stage-for-age trajectory (norms) of vocal competence for infants with normal hearing who are less than 12 months of age, and have no diagnosed disability. This finding was shown to be independent of the infants' home

language environment and experience, be that monolingual or bilingual. While some difference in innate vocal proficiency was revealed at IMP baseline level of assessment (<6 months of age), the subsequent rate of infant vocal progress toward speech was notably similar and defined a common trajectory. In effect, normal gains in infant vocal competency were found to approximate one IMP question per month of age from an infant's individual baseline score (0.93, SD=0.08). In addition, the norm centiles were found to substantiate the ±1SD (15^{th}—85^{th} centile) range in typical progress as depicted by the angle between vectors for age and Q ceiling on the IMP scoring graphic (see Cantle Moore, 2014.)

A second research question sought to qualify features of the typical trajectory of infant vocal development. Generally speaking, parent participants described their infants as developing an increasing ability to control their vocalizations and/or produce more varied 'speech-like sounds' across relative weeks and months. This steady progress was evidenced in the above-mentioned scoring gains of approximately one IMP question per month of age. Some 96% of parents observed that, in the three month period between IMP baseline assessment (5-6 months of age), and mid-point assessment (8-9 months of age), their infant had progressed from innate, reflexive vocal behaviour to what was described as 'trying to talk'—i.e., the purposeful production of rhythmic, canonical (CV) babble. Likewise, 78% of parents reported that, between the mid-point assessment (8-9 months of age) and final IMP assessment (11-12 months of age), their infant started to produce a variety of more complex vocal utterances which included examples of proto-word/first word use (e.g., "Doh ta", replicating "Don't touch"). These three features—steady gains in vocal proficiency, canonical babble appearing by 9 months of age, and proto-word use in evidence around 12 months of age—are widely accepted as markers of typical vocal development which, for the greater part, are independent of the language being acquired (Oller, 2000).

Research question three examined the nature of consonant and vowel sounds produced in typical infant babble. Fourteen of the mothers participating in the study spoke a language other than English at home (viz: Cantonese [5], Arabic [2], Russian [2], Hindi [1], Polish, French, Afrikaans and Auslan) and hence, their young infants were exposed to a different speech-sound repertoire to that of their monolingual English peers. In spite of this variation in receptive speech experience, all infants were reported to produce notably similar CV sound pairs in canonical babble and proto-word use. Parent perceptions and description of some consonant sounds varied slightly, but the manner and place of consonant production was the same. In particular, the alveolar consonant sound [d, t] was described as being followed by the same open-front vowel sound to form [dæ] or [tæ]; the bilabial consonants [b, m] were described as occurring with the mid-central/neutral vowel sound in [bʌ] or [mʌ]; and the velar consonant sound [g, k] was reported as being produced with an open-back vowel to form [ga] or [ka]. It is reasoned that these similarities in CV production are framed (Gildersleeve-Neumann, Davis, & Macneilage, 2013; Kern, Davis, & Zink, 2009) by age-related physiological development and oro-motor control that enables an infant to vocalize while engaging the lips and tongue (active speech articulators) using rhythmical jaw movements. Hence, the premise that typical infants (<12 months of age) would produce similar consonant and vowel (CV) productions irrespective of their receptive language experience, be that monolingual or bilingual, was substantiated for the subjects in this study. This outcome indicates IMP assessment has the potential for use without language bias.

The final research question explored whether the volubility of an infant's CV babble at mid-point assessment was associated with their capacity for proto-word and imitative word use at 12 months of age. No trend was found in the study data to suggest a significant relationship existed between an infant's frequent oro-motor practice of CV babble and their subsequent ability to produce phonetically consistent proto-words or word imitations. Rather,

it was documented that some infants who were producing canonical babble frequently and fluently at the mid-point assessment (8-9 months of age) had continued to babble in varied, non-reduplicative jargon at 12 months in addition to producing one or two first words. On the other hand, a number of infants who were documented to only occasionally practice canonical babble at the mid-point IMP assessment were reported to produce several protowords or frozen phrases (e.g., "Uh-oh") at 12 months of age (Lieven, Pine, & Barnes, 1992).

Conclusion

The normative nature of this study is based on a moderate size, representative sample of parents and their infants with typical hearing. The results demonstrate that the Infant Monitor of vocal Production is a reliable and authentic assessment of the early stage-for-age vocal progress of typically hearing infants (<12 months of age). In particular, IMP-measured gains in vocal competency define a trajectory of normative development and growth which is independent of the variables of home language environment, infant gender, infant position in the family, maternal education and maternal work status. The IMP is therefore deemed to have a useful role as a diagnostic surveillance and assessment tool in very early intervention for hearing loss and related neonatal conditions where infants are at risk for speech and language delay. As a normed instrument the IMP has explicit value where informed and timely decision-making is of primary importance to an infant's future development and language outcomes.

Limitations of the study

The conclusions reported above are moderated by a number of research limitations. First, although the participating parents and infants were representative of the population at

large, the numbers were moderate for a norming study. Further iterations of this normative study are needed to corroborate the reported findings. Second, concurrent validity was not tested against an established and normed instrument of infant vocal development (e.g., Receptive-Expressive Emergent Language Test (REEL-3), Bzoch et al., 2003; Stark Assessment of Early Vocal Development (SAEVD-R), Nathani et al., 2006). Rather, criterion validity was tested like-for-like against the results of an earlier study in this project series (Cantle Moore & Leigh, 2010) in which IMP assessment demonstrated sensitivity to difference in vocal development, normal hearing to aided-hearing infants. Lastly, the results indicate that IMP norms have the potential for application in other languages; what is not known is whether cultural bias exists in the design and conversational wording of the IMP probe questions. Further studies are now underway to explore these matters.

Future directions

Questions remain regarding the potential and veracity of IMP norms in broader application. Studies are currently in progress to investigate whether IMP assessment in cultural translation to other languages generates similar norm results. In addition, the mid-2018 launch of eIMP Online—a project funded under grant through the Commonwealth Research Centre (Hearing CRC) https://www.hearingcrc.org/research/ —will provide the means to address data limitations resulting from the moderate population numbers examined in IMP research studies to date. The eIMP Online will deliver the IMP instrument and automated generation of assessment reports (Parent, and Professional) to the wider field of education, allied health/medical professionals working with parents and infants in early intervention and mainstream practice. The anticipated expansion in subsequent IMP research data will permit large scale iteration of existing studies and enable future investigations into the role of the IMP in clinical and educational early intervention for infants diagnosed with

hearing loss and/or other anomalies which impact early vocal development and progress towards speech.

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TABLE 1

PARENT AND INFANT DEMOGRAPHICS

Characteristic	Subject *n*/85	% of participants
Home language environment		
Monolingual	71	84
Bilingual	14	16
Maternal education		
High school/Dip	12	14
University degree	73	86
Maternal work status @ 12mths		
Home / Part-time	78	92
Full time	7	8
Infant gender		
Male	37	44
Female	48	56
Infant birth history		
Premature > 4wks	3	3.5
Full-term, healthy	82	96.5
Infant position in family		
Singleton	61	72
Sibling	24	28

TABLE 2

SIGNIFICANCE OF DEMOGRAPHIC VARIABLES

Characteristic	Difference between levels	Progress rate
	p	*p*
Gender	0.74	0.78
Home language environment	0.22	0.08
Maternal education	0.59	0.93
Maternal work status	0.46	0.74
Infant position in family	0.78	0.99

TABLE 3

CENTILES FOR QUESTION CEILING AS A FUNCTION OF AGE

	Question Ceiling (1-16)				
	Centile				
Age in months	3rd	15th	50th	85th	97th
4	5.5	6.8	8.4	10	11.3
5	6.6	7.8	9.3	10.8	12.1
6	7.6	8.8	10.2	11.7	12.9
7	8.6	9.7	11.1	12.5	13.7
8	9.6	10.7	12.1	13.4	14.5
9	10.7	11.7	13	14.2	15.3
10	11.7	12.7	13.9	15.1	16.1
11	12.7	13.7	14.8	16	
12	13.8	14.6	15.7		
13	14.8	15.6			

FIGURE 1. Distribution of infant age at each of the three points of IMP assessment

FIGURE 2. Line of best fit for each subject (*n*=85)

FIGURE 3. Question ceiling growth curve as a function of age, with growth centiles (3rd, 15th, 50th, 85th and 97th).

FIGURE 4. Production of consonant-vowel pairs (IMP questions 13-16).

FIGURE 5. Norms relative to normal hearing (group 2) and aided hearing (group 3) infants.