Validation of an Early Language Milestone Scale in a High-Risk Population

James Coplan, MD, John R. Gleason, PhD, Rita Ryan, BA,
Michael G. Burke, BS, and Margaret L. Williams, MD

From the Department of Pediatrics, Upstate Medical Center, Syracuse, and
Departments of Psychology and Education, Syracuse University, Syracuse, New York

ABSTRACT. Detailed language evaluations were obtained by interviewing the parents of 191 healthy children aged 0 to 3 years, and by testing the children themselves. From these data, normative values were derived for 41 language milestones in the first 36 months of life. These values were used to construct the Early Language Milestone Scale (ELM Scale), a brief language assessment tool suitable for use by general pediatricians. Physician use of the ELM Scale in a population of 119 children considered at high risk for the presence of developmental disability yielded 97% sensitivity and 93% specificity for the ELM Scale as a detector of developmentally delayed children, when compared with more formal developmental measures as applied by a clinical psychologist or speech pathologist. Early language milestones are a sensitive indicator of developmental integrity; delayed achievement of early language milestones strongly suggests the presence of a significant underlying developmental disability. The ELM Scale may be adopted as a valid measure of developmental status among children considered at high risk for the presence of developmental disabilities. *Pediatrics* 70:677–683, 1982; *speech, language, mental retardation, hearing loss, cerebral palsy.*

Pediatricians are often called upon to evaluate young children for the presence of possible developmental disability. Delayed early language milestones have been postulated as an extremely sensitive indicator of developmental disability,[1,2] but an early language milestone assessment scale suitable for use by general pediatricians is not presently in wide use.[3] This report describes the construction of such an instrument and its validation in a population of children at high risk for the presence of developmental disability.

"Speech" and "language" are not synonymous terms: speech refers broadly to all vocalization with communicative intent, including prespeech phenomena such as cooing and babbling, as well as single words, phrases, and sentences. Normal speech development has been amply described.[4-8] Language refers to any symbol system for the storage or exchange of information. Language encompasses not only speech, but listening comprehension, and communication by visual means. (Smiling, visual recognition of familiar persons or objects, and the imitation or initiation of gestures may all be regarded as visually mediated language phenomena.) The most common causes for speech or language delay during infancy are mental retardation, hearing loss, dysarthria accompanying cerebral palsy, and communicative disorders.[5] (A communicative disorder may be defined as a significant delay in speech or language due to selective impairment of cerebral function, in the absence of mental retardation, peripheral hearing loss, motor impairment, or anatomic abnormality of the vocal tract.) Different developmental disabilities give rise to different patterns of speech and/or language delay: The child with isolated oral motor dysfunction (eg, due to dysarthria) has delayed speech, but normal auditory comprehension and normal visual communication skills.[9] The hearing impaired child has both delayed speech and impaired auditory comprehension, but retains normal visual communication skills.[10] Finally, the mentally retarded child has delayed *language*, with delayed visual communication skills, as well as delayed speech and auditory comprehension.[11] Our goal was to devise a language screening instrument sensitive to each of these various aspects of language delay.

Despite the availability of descriptive data on early speech-language development, and despite the presumption that speech/language delay during the first three years of life often signifies a major un-

derlying developmental disorder, few tests of early language development are available. A review of several compendia of tests in print[12-15] reveals at least 55 tests of language function in childhood. Most of these tests, however, are unsuitable as language assessment tools during infancy: 11 tests are for articulation only, 37 tests of general language function are for older children only, and four tests are offered with little or no normative or validating data. Only three tests of general language function in the 0- to 3-year age range were found.[16-18] Each of these tests lacked either criteria for passing and failing, or validation with other standardized instruments, rendering them of uncertain value as measures of language development, or as indicators of overall developmental delay.

STANDARDIZATION OF EARLY LANGUAGE MILESTONE SCALE

Item Selection

Fifty-seven language milestones spanning the first three years of life were culled from the literature,[4-7] or from the first author's own experience. Items were selected based upon their presumed significance as markers of linguistic development, as well as for their ease of administration. Although similar items may have appeared on previous language scales, most of these scales have either been offered without adequate normative data,[6,8,16] or were not designed as instruments to be used by primary pediatricians.[11-13,19-21] The milestones were grouped into four quadrants: Auditory expressive (AE), auditory receptive (AR), visual expressive (VE), and visual receptive (VR), according to the rationale offered in the preceding section. Within each quadrant, items were arranged in sequence according to their presumed or previously described ages of emergence.

METHODS

In order to obtain normative data for each individual item, a cross-sectional study of healthy children was undertaken. Subjects were obtained from the private practices of several pediatricians in Syracuse, NY, as well as from the pediatric outpatient department at the State University of New York-Upstate Medical Center. Former premature infants, acutely or chronically ill children, or any child with a known developmental disorder were excluded. Children with recurrent acute or chronic serous otitis media were also excluded, inasmuch as these children have been shown to have delayed speech.[22] Informed consent was obtained from the parents in all cases. An instruction manual was written, and

two medical students were trained in the use of the scale. Initial training time was approximately eight hours, with approximately one week of practice required before complete proficiency was obtained.

Each subject was first tested on those items that were approximately at his or her chronologic age. Next, the examiner worked backward from the child's chronologic age until three items in a row in each quadrant (AE, AR, VE, VR) were passed; this was considered the child's basal level. Finally, the examiner worked forward until three items in a row in each quadrant were failed; the highest item passed was considered the child's ceiling level. In the exceptional case of a child with extremely delayed development, both the ceiling and the basal levels were to be established by working backward from the child's current chronologic age. Parents were only required to state whether or not the child had reached a given milestone; the actual age of achievement of that milestone was not obtained. This minimized the potential inaccuracy of parental recall.

In determining whether a given item had been passed or not, consideration was given to parental history (H), direct testing (T) and incidental observation (O) of the behavior in question; space was provided on the score sheet for recording each of these response categories separately. Although many items could be passed by any of these three means, it was recognized at the outset that certain items would have to be obtained only by parental history or incidental observation. This was particularly true of the auditory expressive items in the first year of life. These prelingual utterances (cooing, giving the "raspberry," monosyllabic babbling, and polysyllabic babbling) proceed according to a well-defined sequence.[4-6,8] It is not possible to force a performance from the child, however, and the screening situation generally precludes the luxury of waiting for the child to produce these utterances spontaneously. Conversely, some items were obtained only by direct testing. These tended to be items with high stimulus value, capable of eliciting a consistent response from age-appropriate subjects (eg, orienting to a bell, pointing to named objects, following prepositional commands).

Analysis of each item was performed by grouping responses for all subjects tested on a given item according to the chronologic age of the subjects (0 to 14 days = newborn, 15 to 45 days = 1 month old, 46 to 75 days = 2 months old, etc). For each item, this yielded a series of histograms showing percent of subjects passing the item at successively older one-month age intervals. The results obtained by history, incidental observation, and direct testing were considered separately. Smoothed curves were derived using a logistic model for fit of passing vs

age at testing. From these curves, the 25th, 50th, 75th, and 90th percentile values for the emergence age of each item in the normal population were obtained.

RESULTS

Standardization Results

A group of 191 children were studied; this comprised the normative sample upon which standardization of the ELM Scale is based. The normative sample is an approximate cross section of the Syracuse community with respect to race, sex, and socioeconomic composition: 80% white/20% black, 50% male/50% female, 80% private patients/20% clinic patients. Administration of the ELM Scale was well tolerated. No parent refused, and there were only seven children for whom complete test data were lacking: one infant fell asleep, four infants were crying, and two 2-year-old subjects were noncompliant during testing.

Of the original 57 items, 16 were eliminated from the final instrument. Reasons for exclusion included: failure of an item to show sufficiently rapid increase in percent of subjects passing with increasing chronologic age (five), ambiguity of parental responses making clear interpretation of item failure by parental history difficult (four), redundancy (three), and 90th percentile exceeding 36 months of age (four). Two items were retained despite the fact that their upper limits exceeded 36 months: Use of the personal pronoun "I," and execution of prepositional commands. These two items were retained because of their presumed linguistic significance. Because of the relative paucity of visual items, the visual expressive and visual receptive quadrants were collapsed into one, leaving three major divisions to the ELM Scale: auditory expressive, auditory receptive, and visual (Table 1).

Item analysis revealed that for those items that could be elicited both by history and by testing, the emergence age by testing always followed the emergence age by history by several months. Emergence ages based upon incidental observation were always later still (Fig 1). This progression of apparent emergence ages was assumed to represent difficulty in always obtaining each infant's best performance in a test situation, rather than parental overestimation of the child's abilities. This assumption is justified by previous studies that have documented the accuracy of parental reporting of current developmental behavior.[23] Because of this progression of emergence ages depending on the technique of elicitation, the final version of the ELM Scale stipulates which technique must be followed with each item; in most cases, parental history has been stipulated as the method of choice.

Validation of ELM Scale

Validation of the ELM Scale was obtained in two ways: First, the emergence ages for each item as obtained during the standardization phase of the present study were compared with the emergence ages of similar items from previously published reports. Second, passing and failing criteria for the ELM Scale as a whole were developed, based upon the performance of the children in the normative sample. These criteria were then applied to all children referred to us for evaluation of possible developmental delay. Children in this high-risk group also underwent formal developmental testing performed by a clinical psychologist, special education teacher, and speech pathologist, all of whom were unaware of the child's performance on the ELM Scale. Psychometric evaluation was performed using the Bayley Scales of Infant Development,[11] the Stanford-Binet Intelligence Scale,[24] or the Leiter International Performance Scale.[20] Language was assessed using some combination of the Receptive-Expressive Emergent Language Scale (REEL Scale),[16] the Preschool Language Scale,[21] the Peabody Picture Vocabulary Test,[25] and the speech pathologist's own clinical judgment. Passing or failing this formal assessment was based upon the presence of significantly delayed language or global cognitive deficits. Isolated physical disability (eg, cerebral palsy) was not counted as failing, except when dysarthria leading to speech delay was also present.

Administration of the ELM Scale was performed as follows: All 41 of the retained ELM items are displayed graphically on a single sheet of paper which is ruled into 36 monthly divisions, with the location of each item corresponding to its 25th, 50th, 75th, and 90th percentile emergence values (Fig 2). To test a child, the examiner draws a vertical line down the page at the child's chronologic age, and administers all items intersected by the line, working backward from the line to determine the child's basal level in each division, AE, AR, V. Basal and ceiling levels are determined in the same fashion as in the standardization phase: three successive items passed or failed. If the subject achieves a basal level in each division without failing any item beyond the 90th percentile, then testing is terminated and the ELM Scale is considered passed. In effect, therefore, the 90th percentile values from the normative population are adopted as the cutoff scores for passing the ELM Scale. Failure of one or more item beyond the 90th percentile in the process of arriving at a basal level requires the determination of a subject's ceiling level for that division. If the 75th percentile value of the ceiling item in the affected division exceeds

TABLE 1. Early Language Milestone Scale Items*

Item*	Set by	Normative Data†			
		25%	50%	75%	90%
I. Auditory expressive (AE)					
AE1 Coos	H	NB	0.1	1.7	3.2
AE2 Reciprocal vocalization	H	NB	0.4	1.5	2.6
AE3 Laughs	H	1.1	2.1	3.0	4.0
AE4 Blows bubbles (gives "raspberry")	H	1.7	3.5	5.4	7.3
AE5 Monosyllabic babbling	H	4.2	6.1	8.1	10.0
AE6 Polysyllabic babbling	H	5.4	7.2	9.0	10.8
AE7 Mama/dada: nonspecific usage	H	4.8	6.6	8.4	10.1
AE8 Mama/dada: correct usage	H	7.0	9.3	11.7	14.0
AE9 First word beyond mama/dada	H	8.4	11.3	14.2	17.0
AE10 4–6 single words	H	10.9	15.1	19.3	23.5
AE11 Tells 2 or more wants	H	15.2	17.2	19.0	20.8
AE12 2-word sentences	H	17.3	19.3	21.2	23.2
AE13 50 or more single words	H	17.6	20.3	22.9	25.6
AE14 Any use of "me" or "you"	H	18.2	21.8	25.3	28.8
AE15 Uses prepositions	H	23.0	26.8	30.5	34.2
AE16 Holds brief conversations	H	24.7	27.9	31.1	34.3
AE17 Gives name and use of two objects	T	27.3	29.7	32.0	34.4
AE18 Correct use of pronoun "I"	H	22.3	31.2	>36	>36
II. Auditory receptive (AR)					
AR1 Alerts to voice	H	NB	NB	NB	1.0
AR2 Turns laterally to voice	H	0.4	1.2	2.1	2.9
AR3 Recognizes certain sounds	H	0.5	1.3	2.2	3.1
AR4 Turns laterally to bell	T	2.0	3.0	4.0	5.0
AR5 Turns laterally then downward to bell	T	3.8	5.3	6.7	8.2
AR6 Inhibits to command "no"	H	5.3	6.9	8.5	10.1
AR7 Turns diagonally downward to bell	T	6.4	8.3	10.2	12.1
AR8 Follows 1-step commands	H	8.3	10.1	11.8	13.5
AR9 Points to 1 or more body parts	H	12.8	15.4	18.1	20.8
AR10 Follows 2-step commands	H	14.1	17.8	21.4	25.1
AR11 Points to named object	T	16.5	20.0	23.5	27.0
AR12 Points to objects described by use	T	23.5	26.5	29.6	32.6
AR13 Follows prepositional commands	T	25.8	29.6	33.3	>36
III. Visual (V)					
V1 Smiles	H	NB	0.5	1.0	1.5
V2 Recognizes parents	H	1.1	1.7	2.3	2.9
V3 Recognizes objects	H	0.7	1.6	2.5	3.4
V4 Responds to facial expressions	H	0.7	2.0	3.4	4.7
V5 Visual tracking	T	1.3	2.4	3.6	4.7
V6 Blink to threat	T	1.7	2.8	3.9	4.9
V7 Imitates gesture games	H	5.9	7.0	8.0	9.1
V8 Follows gestural commands	H	5.9	7.6	9.3	11.0
V9 Initiates gesture games	H	7.3	8.9	10.4	12.0
V10 Points to desired objects	H	10.0	12.5	15.1	17.7

* Abbreviations used are: H, history; T, testing; NB, newborn.
† Complete description of each item and specific manner of elicitation are contained in separate directions. Ages are given in months.

the subject's chronologic age, then the child's failures while establishing a basal level are overlooked, and the ELM Scale is also considered to be passed. This feature is included in order to compensate for the fact that not all normal children manifest all of the early language milestones (Fig 2). Due to the wide gap in visual items between 5 and 8 months of age, it is difficult for infants less than 5 months of age to achieve ceiling values in this division (Table 1). It was decided, therefore, that subjects would be permitted to fail one visual item in the series V3 through V6 without penalty. Time required to ad-

minister the ELM Scale varies between one and three minutes, depending upon the child's age and level of ability.

Validation Results

For individual ELM Scale items that resemble previously described language milestones, emergence ages obtained with the ELM Scale normative sample compare closely with previously published descriptions of language development.[4-8,11,16,19,24] This suggests that the composition of the normative

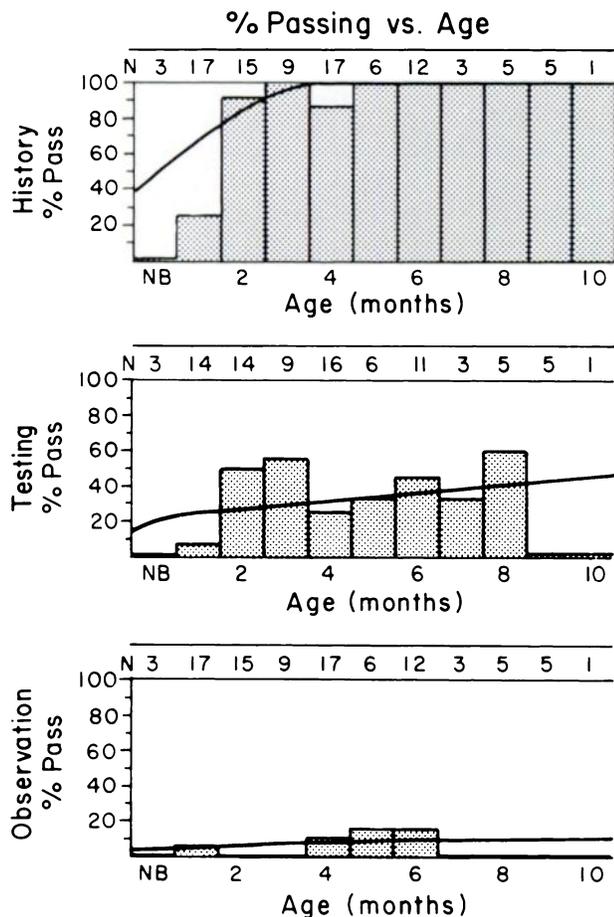**680   EARLY LANGUAGE MILESTONE SCALE**

% Passing vs. Age

Fig 1. Compiled data for one item (AE2, reciprocal vocalization): N, number of subjects tested in each one month age block; shaded bar graphs, percent passing at each age; smooth curve, logistic model for fit of pass vs age at testing. Note that apparent emergence age is earliest by history, somewhat later by testing, and essentially indeterminate based on incidental observation.

sample, the wording of the items, and the administration of the ELM Scale were all reasonably appropriate. Ages for many of the prespeech items (cooing, reciprocal vocalization, raspberry, babbling) have not been quantified prior to the present report, although their approximate emergence ages are well known.[4-6] The same is true for some visual items, such as index finger pointing.[11]

One hundred nineteen children less than 3 years of age were referred to us for evaluation of possible developmental problems during the three years preceding this report; this constitutes the high-risk group. Results of formal language and psychometric testing were abnormal in 65 of these children; 63 were correctly identified as abnormal by the ELM Scale (sensitivity = 97%; Table 2). The most common developmental abnormality found was mental retardation (Table 3). Fifty-four children had normal language and intellectual ability on formal testing; 50 were correctly identified as normal by the ELM Scale (specificity = 93%). Fifteen of these 54

children had cerebral palsy; this did not alter the ELM Scale's specificity for the presence of language and/or intellectual impairment. All 63 children correctly identified as abnormal by the ELM Scale have been enrolled in developmentally based therapy programs (infant stimulation, speech therapy, or preschool programs). Follow-up data reveal that each of these children continues to manifest signif-
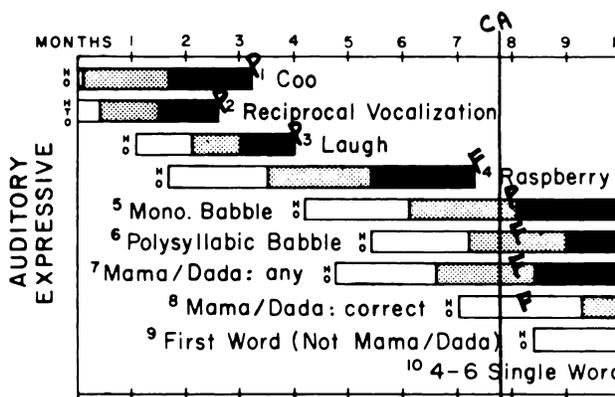

Fig 2. Portion of score sheet for hypothetical 32-week-old child. Child fails one item (AE4, raspberry) beyond 90th percentile in process of establishing basal level. Child passes screen, however, since 75th percentile value of ceiling item (AE5, monosyllabic babbling) exceeds subject's chronologic age. Open portion of each bar, 25th to 50th percentile; shaded portion, 50th to 75th percentile; solid portion, 75th to 90th percentile; H, T, and O refer to allowable means of elicitation for each item: H, history; T, testing; O, incidental observation; CA, chronologic age; P, pass; F, fail. (Reprinted with permission of James Coplan, © 1981.)

TABLE 2. Sensitivity and Specificity of Early Language Milestone (ELM) Scale in High-Risk Population*

	Formal Psychological and Speech/Language Testing	
	Failed	Passed
Failed ELM	63 (a)	4 (b)
Passed ELM	2 (c)	50 (d)

* Sensitivity = a/(a + c) × 100 = 97%; specificity = d/(b + d) × 100 = 93%.

TABLE 3. Characteristics of High-Risk Group

N = 119 (62 male/57 female)
Mean age 18 mo (range 5–36 mo)
Intellectual function
  Normal intelligence: 60 (50%)*
  Mental retardation: 43 (36%)†
    Mild 16 (13%)
    Moderate 15 (13%)
    Severe-profound 12 (10%)
  Communicative disorders: 16 (13%)

* Includes 19 children with associated diagnoses: cerebral palsy, 15 (three with dysarthria); orthopedic defects, two; conductive hearing loss, one; behavior problems, one.
† Includes ten children with associated diagnoses: cerebral palsy, ten; seizures, five; sensorineural hearing loss, two.

icant developmental delays (mean duration of follow-up ten months, range 2 to 28 months).

DISCUSSION

Despite the assumption that early language milestones are an extremely sensitive indicator of developmental status,[1,2] a language screening tool for the first three years of life with well established norms and adequate validation has not previously been available. Among general pediatricians, the assessment tool most often used during this age interval is the Denver Developmental Screening Test.[3,26] The language portion of the Denver Developmental Screening Test used during the first three years of life contains only 19 items; no distinction is drawn between expressive and receptive abilities, nor are visual communication skills mentioned, although a few visual items are found on other subscales of the test. Despite its popularity among pediatricians, the Denver Developmental Screening Test has been shown to have only weak agreement with reference tests such as the Bayley Scales of Infant Development[11] or the Cattell Infant Intelligence Scale[27] during the first two years of life. Using either the Bayley or the Cattell Scale as the criteria for measurement of developmental abnormality, the Denver Developmental Screening Test correctly identified only 29% of developmentally delayed children less than 1 year of age, and only 57% of developmentally delayed children between 1 and 2 years of age.[28] Because of this low sensitivity, reliance upon the Denver Developmental Screening Test in the first two years of life may lead to the underdetection of developmentally delayed children, and its use with this age group has been criticized on this basis.[29] A recent revision of the Denver test shortens the time required for its administration, but does not improve its sensitivity relative to more formal measures such as the Bayley or Cattell Scales.[30]

The present study provides normative data on 41 language items, based upon a balanced cross-sectional sample of 191 children. Percentile values for many items are presented here for the first time, although the approximate emergence ages for most of them have been known previously. Access to these data makes possible further research into the relationship between early language development and other developmental and medical phenomena of infancy and early childhood. This is particularly important in view of recent data confirming the fact that children with delayed speech at 36 months of age are very likely to manifest developmental disabilities during later childhood and adulthood.[31]

The present report also establishes the validity of the ELM Scale as a rapid language assessment tool suitable for use by pediatricians in the evaluation of children at high risk for the presence of developmental disabilities. Although delayed speech is not synonymous with mental retardation, mental retardation is the most common cause of speech delay in the general pediatric population[5]; the same was found in the high-risk group reported here. Conversely, all mentally retarded children manifest some degree of delayed speech. A careful evaluation of early language milestones is therefore one reasonable method of identifying children with possible mental retardation. The ELM Scale is extremely specific for the presence of language or intellectual delay, and it is not affected by the presence of physical handicap (except dysarthria); this makes the ELM Scale particularly useful in assessing the intellectual function of physically handicapped children.

IMPLICATIONS

The significance of delayed language milestones in the first three years of life as an indicator of possible underlying developmental disability has been confirmed, and a rapid and reliable means for assessing these milestones in children suspected of possible developmental disability is now available. Children less than 3 years of age who manifest delayed language milestones should undergo formal developmental assessment rather than waiting to see whether they will "grow out of it."

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CANDID COMMENT

Growing up is when you discover that, of your six senses, common sense dominates the other five.

From A. H. Berzen, *Wall Street Journal*, Dec 21, 1981.