LUI™

Language Use Inventory™

■ **An Assessment of Young Children's Pragmatic Language Development**

Manual

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Development of the LUI and Psychometrics

Overview

This chapter will present a brief history of the development and psychometrics of the LUI. The version of the LUI that has undergone norming and that accompanies this manual is, in fact, the third version of the questionnaire following three tryout studies that will be briefly described in this chapter. For more detailed information the user is directed to O'Neill (2007) and O'Neill (in press). Evidence of reliability and validity is an ongoing process as the LUI becomes more widely used in different research and clinical capacities. Prior to a new version of the manual that includes such new findings, updates will be posted online at www.childstudies.uwaterloo.ca/lui and www.knowledgeindevelopment.ca.

Item Development

The development of items for the LUI began with an extensive review of the literature related to typically-developing and non-typically developing children's language development, with a particular focus on those aspects of pragmatic communicative competence influenced by children's developing theory of mind abilities (e.g., joint attention, mental state language, curiosity about other people and their behavior, teasing, adaptations of communication to take into account knowledge shared or not shared with other people), as discussed in Chapter 2 (e.g., Bates, Camaioni & Volterra, 1975; Bloom, Merkin, & Wootten, 1982; Bruner, 1983; Clark, 1993; Dunn, 1988; Ervin-Tripp, 1977; Ervin-Tripp & Gordon, 1986; Garvey,1984; Nelson, 1989; Ninio & Snow,1996; O'Neill, 1996; O'Neill, 2005; Shatz, 1994; Snow & Dickinson, 1991. This firm grounding of the LUI's items in research findings meets current calls for assessment tools with greater "empirical validity" (cf. Hirsh-Pasek, Kochanoff, Newcombe, & DeVilliers, 2005).

The original version was much longer, by design, in order to be as broad as possible, with the intention to reduce the number of items through internal reliability testing to a number that could be completed within about 25-30 minutes by a parent. This original version consisted of 338 items divided into 19 subscales and the intended age range was broader, from 13 to 48 months.

Tryout Studies Prior to Norming

The version of the LUI used in the norming study represents the fourth version of the inventory. In three separate tryout studies prior to norming, the inventory was rewritten, reworked, and refined based on the results of reliability analyses and other findings. This work will be briefly reviewed.

Tryout Study 1.

The goal of this study was to shorten the initial 338-item questionnaire (ideally to allow it to be completed within 30 minutes) based on an evaluation of the corrected item-total correlations (i.e., correlation between that item and the rest of the subscale items), item means and variances, and the internal consistency of each subscale (i.e., the extent to which different items within the same scale measure the same skills) evaluated by computing Cronbach's (1984) coefficient alpha. At this time, the two-option (yes/no) response format had already been decided upon as a result of piloting suggesting that the provision of more intermediary options (e.g., sometimes) led to their overuse and a lack of clarity. Appended to this original version, was a short questionnaire collecting information pertaining to birth order, the presence of major health or speech problems and exposure to other languages similar to the Basic Information Form used in the development of the *MacArthur Communicative Development Inventories* as provided in Fenson et al. (1993).

Participants and Procedure

The questionnaire was mailed to 195 parents of children between the ages of 13 and 48 months of age (in six 6 month age-groups) recruited from the University of Waterloo's Centre for Child Studies database. Parents who were in the database had been initially recruited from the general population via advertisements in newspapers, grocery stores, malls, and community centers inviting them to volunteer to take part in studies of children's cognitive and language development. A cover letter described the nature of the study and asked parents to complete the questionnaire in one sitting. The aim was for the questionnaire to be self-explanatory, so no further instructions were provided to parents. Parents were provided with a postage-paid envelope with which to return the questionnaire. If the questionnaire was not received within 2 to 3 weeks, one reminder call was made. When the questionnaire was received, parents were sent a follow-up thank-you letter and a small gift for their child.

The return rate was 97% (N=190). Seven questionnaires were excluded, two for prematurity (2 or more weeks premature) and five for large amounts of missing data. The final sample included 183 questionnaires (48% girls, 52% boys) with 30-32 questionnaires in each of the six age groups. The sample was largely middle-class. All the children had acquired English as their first language, although 18% were also being exposed to a second language (including French, Croatian, Spanish, German, Portuguese, Polish, Italian, Danish, Punjabi and Mandarin).

Results

The mean and variance for each subscale total and all items for each of six 6-month age-groups were examined. Cronbach's (1984) coefficient alpha, α, was computed for each subscale along with the corrected item-total correlation (CITC) for each item. A minimum coefficient level of .3 was generally used in interpreting the CITC scores, following a convention suggested by Anastasi (1998). For Cronbach's coefficient alpha values there appears to be fair consensus that, for tests to be used in applied settings or for clinical and diagnostic use, reliability coefficients of .90 or above are the most desirable, although given practical realities, coefficients over .80 are generally also viewed as acceptable minimums (Aiken, 1985; Anastasi, 1988; Guilford, 1956; Hammill, Brown & Bryant, 1989; Helmstadter, 1964; Salvia & Ysseldyke, 2001; Sattler, 1988). Items were considered for deletion if they had a low CITC score, demonstrated no variance across age, or if their deletion from the subscale increased the alpha value for the subscale as a whole. Items were considered for reassignment if their addition to another subscale increased the item's CITC value and/or increased the alpha value of the other subscale suggesting a better fit with that subscale.

As a result of this process, 132 items were deleted, 80 items were reworded and/or reassigned to different subscales, and two pairs of subscales were collapsed. It was also decided that two subscales assessing children's interests when talking or playing would not be *scored* subscales because parents would often indicate as atypical interests that were more aptly described as a typical, strong interest (e.g., an intense, but age-typical interest in vehicles). The subscales were retained, nevertheless, because the descriptions of children's interests provided by the parent could prove useful for a researcher or clinician.

Using the remaining 206 items, the alpha values of the 15 scored subscales were computed as a best approximation of the improvement the changes would bring. Ten subscales demonstrated high internal consistency (α's of .80 to .98). Two subscales (A and D) demonstrated moderate internal consistency (α's = .62 and .76) and three subscales (B, F, and M) demonstrated low internal consistency (α's < .60).

Further Changes following Tryout Study 1

1. **New items:** To address the lower reliabilities of 5 of the subscales, 26 new items were added (following further review of the literature).
2. **Scoring simplified***:* Forty-four items requiring reverse scoring were reworded to avoid this.
3. **Rearrangement of subscales:** The arrangement of subscales was altered to better cohere and reflect developmental increases in means with age.
4. **Lowest age range increased to 18 months:** The lowest age group was changed from 13 to 18 months as most items were responded to as "no" before this age.
5. **Administration by phone:** To better allow for oral administration with parents possessing only limited literacy skills, the questionnaire was administered by phone to 10 parents of low income recruited in a parent-and-child drop-in centre. This resulted in the simplification of the wording of items and reorganization of some of

the subscales to increase continuity in a conversation. Oral administration times varied from 20-40 minutes.

6. **New questionnaire to assess exposure to other languages:** A new questionnaire was developed to assess exposure to other languages in a more detailed manner. It asked parents to indicate all adult persons with whom the child regularly interacts, the language(s) spoken by the person, the percentage of time the person speaks one or more languages, and the number of hours a week the child typically spends with the person. The purpose of this information was to be able to classify children into groups depending on the percentage of time they were reported to be exposed to another language (e.g., less than 20%, more than 50% of the time, etc.).

7. **Threshold for second language exposure and instructions to parents of children exposed to languages other than English:** Given the substantial percentage of children in Canada exposed to languages other than English at home, the inclusion of solely monolingual English speaking children was not merited. A decision was made not to exclude children unless their exposure to the second language was substantial. To determine a lowest threshold for "substantial" exposure, the research literature was consulted. Good agreement appeared to exist among researchers studying bilingualism that exposure to a second language for less than 20% of the child's waking hours (as estimated from parent reports) does not lead to substantial language growth in that second language and that such children should not be considered as bilingual children in studies of bilingualism (e.g., Pearson, Fernandez, Lewedeg, & Oller, 1997). Thus, it was decided that in the next reliability study that exposure to a second language exceeding 20% of waking hours would be established as the threshold for exclusion.

It should also be noted that given that the focus of the LUI is a child's ability to *use language*, the assumption is that, for a researcher or a clinician wishing to assess a child's pragmatic language competence, the primary issue would be to ascertain whether the child is indeed able to use language in the ways asked about, regardless of the particular language used. Moreover, asking parents to report on the questionnaire as "yes" only the particular items performed in English as opposed to a second language would impose an artificial distinction that would place an unnecessary demand on parents, especially given that it has been documented that bilingual speakers are not always aware of the language they are speaking (Goodz, 1989) and bilingual families often do not adopt a "one-parent one-language" strategy even if possible (Pearson et al., 1997). For these reasons, in the information letter accompanying the questionnaire, if a child was exposed to a language(s) other than English, parents were instructed to check an item as "yes" if the child produced the words or utterances asked about *either in English or in the other language(s) he/she was exposed to*.

Tryout Study 2

Once the changes described immediately above were implemented, a second study was conducted in order to determine the internal reliability of the revised questionnaire.

Participants and Procedure

Parents were recruited by the same means as in the first study. The questionnaire was mailed to 229 parents of children between the ages of 18 to 47 months (in five 6-month age groups) with a return rate of 86.5% (N = 198). Thirty-seven (18.7%) questionnaires were excluded, 29 for missing data (defined as more than 2 items not answered overall, or more than 1 item in any subscale) and 1 each for medical reasons, prematurity (2 or more weeks premature), diagnosed language delay, and exposure to English only at 19 months of age. Four children exposed to a language other than English for more than 20% of their waking hours were excluded. Thus 161 questionnaires constituted the final sample (52% girls, 48% boys) with a range of 30-36 questionnaires per age group. The sample was largely middle-class. All the children had acquired English as their first language, although 20% were reported to be exposed to a second language in the home for less than 20% of waking hours (including French, Spanish, German, Italian, Danish, Greek, Turkish, Polish, Croatian, Arabic, Afrikaans, Punjabi, Japanese, and Chinese). The distribution of questionnaires followed the same procedure as in the first study.

Results

Identical statistical analyses were conducted as in the first study (e.g., CITC scores, Cronbach's alpha) in order to determine the need to further delete, reassign, or reword old items or create new items. A factor analysis with varimax rotation was also carried out to examine the coherence of the subscales with respect to the other subscales on the questionnaire. As a result, a further 55 items (comprising 3 subscales) were deleted leaving 177 items remaining and a total of 14 subscales (12 of which are scored) that continue to comprise the subscales of the LUI today.

Using the remaining 177 items, the alpha values of each of the 12 scored subscales were recomputed as a best approximation of the improvement the changes would bring. The results indicated that the internal consistency of the questionnaire's subscales had improved considerably from the first reliability study: of the 12 scored subscales, 8 had alpha values in the range of .90 to .98, two had values of .89 and .80 and one had a value of .74 (B: Use of declarative gestures). When an exploratory factor analysis with varimax rotation was carried out including the 12 scored subscales, a two factor solution was supported: the first factor comprised the 10 subscales in Parts 2 and 3 assessing aspects of a child's use of words and the second factor comprised the two gesture subscales in Part 1. All subscales had loadings above .5 except C (Types of words used), which had a loading of .33. None of the loadings were overlapping. The eigenvalues for the two factors were 6.138 and 1.126 respectively and the two factors accounted, respectively, for 51.2% and 9.4% of the variance explained (for a total of 60.5%). The alpha values of the subscales comprising these two factors were calculated and were .97 and .89 respectively.

Further changes following Tryout Study 2

1. **New Items:** Three new items were added resulting in a total of 180 items (for all 14 subscales, including E and L, and excluding items requiring written answers).

2. **Rearrangement of Subscales:** The subscales were rearranged further to better reflect the progression of abilities with increasing age and the two factors that emerged. The omission of the two gesture subscales, A (Imperative gestures) and B (Declarative gestures), was considered at this point, given their emergence as a second separate factor and the fact that both subscales demonstrated a linear *decrease* in their scores with age (as would be expected). Nevertheless, it was felt that, for children with very low levels of language use, it was valuable to retain these scales so that a parent was able to indicate some positive answers as opposed to having to indicate negative responses from the start. However, given the complexity of the reverse-scoring that would be required for these two gesture subscales in Part A, the decision was made that hitherto only the scores from the subscales in Parts 2 and 3 (excluding the non-scored subscales E and L) would be included in a child's *LUI Total Score*. This decision was also more congruent with the main focus of the LUI on expressive language use.

3. **Readability analyses:** Readability analyses (e.g. Flesch-Kinkaid Grade Level - (Kinkaid, Fishburne, Rogers, & Chissom, 1975; Fog Readability Score - Gunning, 1952) were conducted for each subscale and, to the extent possible, instructions or questions were reworded to require less than an 8th grade reading ability often advocated for public health information (e.g., National Work Group on Literacy and Health, 1998).

4. **Family information questionnaire:** In anticipation of the demographic information we would require for the norming study, a new demographic questionnaire was developed (in consultation with Dr. John Goyder, Dept. of Sociology, University of Waterloo) to determine the household income, ethnic and cultural background of child and parents, occupation and level of schooling of the parents, and family structure (lone vs. two parent).

Tryout Study 3 (Final Version of LUI)

Given that few, if any, further changes were anticipated to the questionnaire following Tryout Study 2, the goal of this third study was to assess the internal reliability and validity of the final version and to conduct a test-retest reliability study. This study is described in detail in O'Neill (2007). As no further changes were made to the inventory following this study, the results represent evidence of the reliability and validity of the current version of the LUI. Where relevant in the discussion to follow, however, these results have been updated following analyses conducted on the data from the norming study (described in Chapter 6).

Participants and Procedure

Time 1. Parents were recruited from the UW Centre for Child Studies database as for the two previous studies. The questionnaire was mailed to 207 parents of children between the ages of 18 to 47 months. This age range was divided into 5 six-month intervals (18-23, 24-29, 30-35, 36-41, and 42-47 months). At the time of the initial call, parents were also asked if they would be willing to complete the questionnaire twice. 192 (93%) of the questionnaires were returned. Fifteen (8%) were dropped for the following reasons: missing data (8), medical reasons (2), second language exposure over 20% of waking hours (2), prematurity exceeding 2 weeks (1), and age older than 47

months (1). This resulted in a final sample size of 177. All the children had acquired English as their first language, although 13.4% were reported to be exposed to a second language in the home for less than 20% of their waking hours (including French, Spanish, German, Italian, Portuguese, Turkish, Slovenian, Hungarian, Romanian, Slovakian, Croatian, Vietnamese, and Cantonese).

Time 2. Of the final 177 participants, 175 had indicated a willingness to complete the questionnaire twice and so, when the questionnaire was returned to the lab, a second was mailed with instructions to complete it within 4 weeks of initial completion of the Time 1 questionnaire. 158 (90%) of these questionnaires were returned. Of these, 17 (11%) were dropped for the following reasons: missing data (5), subsequently being dropped at Time 1 (11), and responding beyond the 4 week time window (1). Thus, a final total of 141 questionnaires was used in the test-retest sample.

Evidence of Reliability

Internal consistency

Results of both Tryout Study 3 (N=177) and the norming study (N=3563) strongly support the internal reliability of the LUI and its subscales. The final alpha values for each part and subscale are listed in Table 5.1 for each of these two studies.

Table 5.1. Cronbach's alpha values for all parts and subscales of the LUI from Tryout Study 3 (N= 177) and the norming study (N=3563).

LUI Part/Subscale		Alpha Values (SEM)		# of items
		Norming Sample	Tryout Study 3	
Part 1	**How your child communicates with gestures**	.88 (1.00)	.91 (1.26)	**13**
A	How your child uses gestures to ask for something	.89 (1.06)	.92 (1.14)	11
B	How your child uses gestures to get you to notice something	.53 (0.28)	.55 (0.32)	2
Part 2	**Your child's communication with words**	.95 (0.93)	.95 (1.08)	**28**
C	Types of words your child uses	.93 (0.77)	.93 (0.90)	21
D	Your child's requests for help	.88 (0.60)	.87 (0.56)	7
Part 3	**Your child's communication with longer sentences**	.99 (3.44)	.99 (3.81)	**133**
F	How your child uses words to get you to notice something	.81 (0.62)	.83 (0.65)	6
G	Your child's questions and comments about things	.90 (0.85)	.91 (0.79)	9
H	Your child's questions and comments about self/other	.98 (1.88)	.98 (1.76)	36
	Self only	.96 (1.22)	N/A	(14)
	Others only	.96 (1.50)	N/A	(18)
I	Your child's use of words in activities with others	.93 (1.14)	.94 (0.94)	14
J	Teasing and your child's sense of humour	.79 (0.79)	.80 (0.81)	5
K	Your child's interests in words and language	.86 (0.91)	.86 (1.19)	12
M	How your child adapts conversation to other people	.93 (1.24)	.93 (1.26)	15
N	How your child is building longer sentences and stories	.98 (2.11)	.98 (1.88)	36

Test-retest Reliability

As part of Tryout Study 3 discussed above, an assessment of the LUI's test-retest reliability (i.e., the extent to which scores remain stable across two or more administrations) was carried out. Given the rapidity with which language skills can change over short periods of time, and the fact that the rate of language change can be uneven among children, one would not expect high stability. However, within a period of a few weeks, one might expect to see considerable stability. In keeping with time periods used in other test-retest reliability studies pertaining to assessments of language development, it was decided that parents would be asked to complete a second questionnaire within 4 weeks of completion of the initial inventory.

Significant growth was observed in children's scores even within the short 4 week time period. That is, a significant difference in mean score between Time 1 and Time 2 ($p <$ .05) was found for all but three subscales (Subscale A: Imperative gestures; B: Declarative gestures; G: Questions/comments about things). Nevertheless, test-retest stability and reliability was excellent with all subscales demonstrating significant Pearson correlations of .85 to .96 ($p <$ .001) between the test and retest scores, except for Subscale B ($r =$.34). When the correlations were recomputed, controlling for age, the significance results did not change, except that the range of partial correlations for all subscales except B ($r =$ .32) was between .75 and .89 (all p's < .001).

Evidence of Validity

Face and Content Validity

The firm grounding of the content of the items in established research findings was intended to ensure that the questionnaire covered a representative sample of behaviors from the domain of pragmatics as a way of establishing its content validity (Anastasi, 1988). The breadth of communicative abilities covered was also intended to ensure that parents regarded the questionnaire as presenting an opportunity to portray their child's communicative abilities accurately and completely (i.e., ensure the face validity of the questionnaire).

Construct Validity

Intercorrelations

Intercorrelations among the subscales of the LUI from Tryout Study 3 are reported in O'Neill (2007). As it has been possible to examine these intercorrelations more recently using data from the norming study, the results below are presented with respect to this data. The results are very consistent with those reported in O'Neill (2007).

Table 5.2 shows the intercorrelations among all 12 scored subscales, controlling for age (in months). Children's scores on both gesture subscales (A: Imperative gestures and B: Declarative gestures) were significantly, but fairly weakly, positively correlated ($r =$ .206). Scores on Subscale A were weakly and negatively correlated (r's < .3) with scores on all

other subscales. Scores on Subscale B were all nonsignificantly correlated with children's scores on all other subscales, probably because children scored uniformly high across age groups on this subscale. This decrease in the use of gestures in relation to an increase in the use of verbal forms is in keeping with the findings of other researchers examining the relation between gestures and early speech (Iverson & Goldin-Meadow, 2005) as gestures are replaced with words.

Table 5.2.   Partial intercorrelations for the scored LUI subscales controlling for children's age in months (Norming Study)

	A	B	C	D	F	G	H	I	J	K	M	N
A	-											
B	.206*	-										
C	-.129*	.011	-									
D	-.100*	.030	.800*	-								
F	-.124*	.030	.733*	.678*	-							
G	-.152*	.006	.771*	.706*	.740*	-						
H	-.200*	.013	.716*	.654*	.741*	.833*	-					
I	-.132*	.030	.699*	.653*	.714*	.765*	.841*	-				
J	-.092*	.007	.240*	.237*	.330*	.362*	.464*	.422*	-			
K	-.145*	.021	.514*	.488*	.532*	.597*	.687*	.650*	.507*	-		
M	-.186*	.014	.564*	.525*	.639*	.682*	.796*	.748*	.481*	.695*	-	
N	-.215*	-.018	.350*	.303*	.481*	.508*	.677*	.577*	.497*	.628*	.735*	-

*p < .001

For the remaining 10 subscales that form Parts 2 and 3 of the LUI, 30 of the possible 45 intercorrelations (67%) between these 10 subscales demonstrated moderate *r* levels in the range of .237 to .70. These results suggest that these subscales are measuring aspects of pragmatic language competence that differ to a certain degree.

The higher intercorrelations of some of the subscales could have led to their amalgamation. This was not done for two reasons. First, phone interviews with parents suggested that shorter subscales with a greater focus were easier to complete. Second, high intercorrelations found with a typically-developing group of children do not preclude the possibility that different results might be found with subpopulations of children with language impairment, as further research will need to investigate.

Factor analysis

The results of a factor analysis conducted as part of Tryout Study 3 are reported in O'Neill (2007). As it has been possible to conduct this analysis more recently using data from the norming study, the results below are presented with respect to this data (see Table 5.3). It should be noted that the results are almost identical to those reported in O'Neill (2007).

An exploratory factor analysis with varimax rotation supported a two-factor solution, with the first factor corresponding to the 10 subscales of Parts 2 and 3 assessing verbal communication (eigenvalue = 8.28) and a second factor corresponding to the 2 gesture

subscales in Part 1 (eigenvalue =1.13). No subscales overlapped in their loadings and all loadings for the first factor were greater than .75. The two factors accounted, respectively, for 68.99% and 9.43% of the variance explained, for a total of 78.4%. The finding that all the subscales in Parts 2 and 3 loaded onto one factor was not contrary to expectation. As will also be evident from the results of the age analyses and test-retest study to follow, the very rapid growth of these abilities in tandem with each other suggests a fair amount of overlap in the development of these abilities in time. The fact that these subscales load onto one factor with a typically-developing group of children also does not preclude the possibility that different results might be found with subpopulations of children with language impairment.

Table 5.3. Summary of exploratory factor analysis results for the LUI using principal components analysis with a varimax rotation (Norming Study)

LUI Subscale		Factor Loadings	
		Factor 1	Factor 2
A	How your child uses gestures to ask for something	-.41	**.62**
B	How your child uses gestures to get you to notice something	.08	**.86**
C	Types of words your child uses	**.87**	-.01
D	Your child's requests for help	**.83**	.05
F	How your child uses words to get you to notice something	**.91**	-.08
G	Your child's questions and comments about things	**.93**	-.11
H	Your child's questions and comments about themselves or other people	**.95**	-.19
I	Your child's use of words in activities with others	**.94**	-.12
J	Teasing and your child's sense of humour	**.75**	-.25
K	Your child's interest in words and language	**.88**	-.20
M	Your child's interest when talking	**.91**	-.22
N	How your child adapts conversation to other people	**.85**	-.30
	Eigenvalues	8.28	1.13
	% of variance	68.99	9.43

Note: Factor loadings over .50 appear in bold

Convergent/Divergent Validity

Studies are underway to examine the convergent and divergent validity of the LUI. For example, in one study we are investigating the relation between children's scores on the LUI (versus other (non-pragmatic) measures of language) and social competence as rated by parents and teachers.

Criterion-Related Validity

Concurrent Validity

Assessing the concurrent validity of the LUI is made difficult by the lack of standardized tests assessing pragmatic language in young children. Nevertheless, one available test that does assess aspects of early pragmatic development is the *Communication and Symbolic Behavior Scales* (CSBS, Wetherby and Prizant, 1993). The CSBS has norms

reported for 8 to 24 months. (Note that at the time of this study, the shorter CSBS-DP (Wetherby & Prizant, 2002) version did not exist.)

Thirty 22-month-old children (15 girls and 15 boys) were administered the long form of the CSBS. The measure involves videotaping the child and the experimenter as they engage in a series of structured and unstructured activities that included joint book reading, examination of toys (balloons, bubbles), pretend play with feeding and grooming, simple games (peekaboo), and mild frustrations (toys in a sealed container).

Scaled scores were computed for the subscales of the CSBS as instructed in the manual. The CSBS does not provide a subscale measure for pragmatics per se, but (a priori) 7 subscales were considered to potentially overlap in content with the areas of pragmatic functioning addressed by the LUI. These CSBS subscales included: Behavior Regulation, Joint Attention, and Sociability which together are grouped in a cluster entitled *Communicative Function*; Inventory of Different Words Expressed and Different Word Combinations which together are grouped into the cluster entitled *Communicative Means-Verbal*, and two further independent subscales *Respondent Acts* and *Repairs*. It should be noted that the two Communicative clusters are not viewed by the CSBS authors as measures of vocabulary or syntactic growth, but rather as reflecting the pragmatic ability to "express communicative intentions" (p. 9).

Tables 5.4 and 5.5 show the correlations found between children's total score on the LUI and their CSBS raw and scaled scores for each of the two communicative clusters and a total score comprised of all 7 relevant subscales. All Pearson correlations were significant and most values were moderate to high. These results support the concurrent validity of the LUI with the pragmatics-relevant CSBS subscales. It should be remembered in interpreting these results that, despite the a-priori choice of seven relevant CSBS subscales considered, the areas of pragmatics assessed by the LUI and the CSBS still differ considerably, making very high correlations between the two measures unlikely. The strength of the correlations found is also notable given that administration of the LUI requires only 30 minutes of a parent's time versus approximately 1 hour of testing with a trained examiner to administer the CSBS and 2-3 hours to score it.

Table 5.4. Correlations between children's raw scores on the LUI and their raw scores on the Communication and Symbolic Behavior Scales.

CSBS scores	*r*	*p*-value
Sum of the two Communicative Clusters	.656	<.001
Communicative Function	.356	.05
Communicative Means - Verbal	.784	< .001
Sum of the seven CSBS scores used	.570	.001

Table 5.5.   Correlations between children's raw scores on the LUI and their scaled scores on the Communication and Symbolic Behavior Scales.

CSBS scores	*r*	*p*-value
Sum of the two Communicative Clusters	.735	<.001
Communicative Function	.503	.05
Communicative Means - Verbal	.856	< .001
Sum of the seven CSBS scores used	.570	.001

Discriminant Validity

Evidence of the discriminant validity of the LUI is reported in O'Neill (2007) and will only be briefly reviewed here. A study was conducted to determine whether children's scores on the LUI would distinguish between children with and without language delay. The scores of children whose parents were seeking an initial assessment at a child development centre regarding possible language delay were compared with those of a matched group of typically-developing children drawn from our laboratory database for whom no concern about language development had been expressed. The clinic group included 49 children (age range 21 to 47 months; mean age 28.8 months; 40 boys and 9 girls). By design, the typically-developing group was matched for sex and age in months.

When the total LUI scores of the clinic group (all of whom received a later diagnosis of language impairment and none of whom were discharged) were compared with those of the typically-developing group, the mean total score of the clinic group on the LUI was 27.4 compared to 106.5 for the typically-developing group. The average difference in scores was 79.1 points, a difference that was highly significant, $t(96) = 15.47$, $p <$ .001. This difference remained relatively stable across the entire age range from 21 to 47 months. A discriminant function analysis conducted using total scores corrected for age revealed sensitivity and specificity to be 95.9%. The results strongly support the discriminant validity of the LUI and exceed even the most stringent criteria of 90% accuracy suggested by psychometricians (e.g., Plante & Vance, 1994).

Predictive Validity

A study is currently underway by the author and Dr. Diane Pesco of Concordia University (Montreal, Canada) to examine the longer-term language outcomes of over 300 children at age 5 years who participated in the norming study.

Ongoing Research and Development

Evidence of the LUI's reliability and validity will continue to accrue as research currently underway by the author and other researchers worldwide is completed. There has been considerable research interest in the use of the LUI for assessing children with a variety of developmental difficulties or delays. For example, a number of researchers in Canada and the USA are examining the use of the LUI with respect to young children with autism or at greater risk for developing autism (e.g., siblings of children with autism). All

efforts will be made to present updates about these new findings promptly on-line at www.childstudies.uwaterloo.ca/lui and www.knowledgeindevelopment.ca.

6

Standardization and Norms Development

Overview

The LUI has undergone standardization (norming) on a Canadian sample of over 3500 children. This chapter will describe the procedure for this norming study and present the demographic characteristics of the norming sample with respect to five main variables (lone parent status, low income, visible minority, level of schooling of mother, and exposure to language(s) other than English). Information with respect to the analyses conducted to obtain the norms is also presented in this chapter.

The Norming Study

Sampling Procedure

The goal of this study was to collect 100 completed questionnaires (50/50 girls/boys) at each month between the ages of 18 to 47 months inclusive, for a total of 30 age groups and 3000 completed questionnaires. The figure of 100 was arrived at through a power analysis performed on data from the third tryout study. A sample size of 100 for a given subgroup is also conventionally taken as the lower limit for adequate precision (McCauley & Swisher, 1984; Salvia & Ysseldyke, 1981; Sattler, 1988; Weiner & Hoock, 1973) and found in other language assessment measures (e.g., *MacArthur-Bates Communicative Development Inventories*, Fenson et al., 1993, 2007; *Children's Communication Checklist – 2*, Bishop, 2003; *Clinical Evaluation of Language Fundamentals – Preschool*, Semel, Wiig, & Secord, 2004).

A probability sampling strategy with quotas was developed for the norming study. Community locations across Canada, including most specifically daycares/preschools and informal parent-child drop-in centres, were identified and then contacted in random order. Letters describing the project were brought or mailed to each location to be distributed to all parents with children in the specified age range of the LUI. The letter indicated to parents an email address and toll-free phone number to call if they were interested in participating in the study. If interested, they were mailed the LUI (with the *Family Information for Child* Section appended, see Appendix) and a cover letter (see Chapter 2). Parents were provided with a self-stamped envelope in which to return the questionnaire. Upon receipt of the questionnaire, all parents were sent a thank-you

letter and t-shirt for their child. In addition to recruiting by mail at the above locations, research assistants also travelled extensively to recruit parents in person at community locations (e.g., informal drop-in Early Years Centres) and events (e.g., children's festivals, seasonal festivals) within driving distance. Recruitment also included flyers placed in community locations (e.g., doctor's offices, supermarkets, libraries, malls).

This probability sampling strategy with quotas was used to ensure that representative proportions of children from each demographic group would be included in the norming study sample. Analyses of data gathered by Statistics Canada during the 2001 Census provided the basis for stratification along the following variables: *low income, lone parent, visible minority, level of schooling of mother and exposure to languages other than English.* These five demographic variables were chosen as they have been identified in research pertaining to child language acquisition as potentially affecting the rate of language acquisition (e.g., Fenson et al., 1993; Morisset, Barnard, Greenberg, & Booth, 1990) or have been typically controlled for in previous norming studies involving the development of Canadian norms with children (e.g., *Wechsler Intelligence Scale for Children - III*, Wechsler, 1996). The use of the PUMF (Public Use Microdata Files) Individuals and Families data set provided by Statistics Canada for the 2001 Canada Census survey isolates the data for children under 6 years of age within the Census reports and provides total counts and percentages for Canada, the provinces, and the territories for children in this age group with respect to these five variables. French-speaking children in Québec were eliminated from the Canadian population of children under 6 years for the purposes of this study. A more detailed description and definition of these five variables and their distribution in the norming sample follows in the section *Demographic Distribution of the Sample*.

Data collection began in December 2003 and concluded in December 2006.

General Exclusion and Medical Exclusion/Inclusion Criteria

Questionnaires were completed for 4483 children. Of these 4483 questionnaires, 920 (20.5%) were excluded, resulting in a final sample of 3563 questionnaires. Our exclusion rate was higher than for some norming studies (e.g., MacArthur CDIs) but one main reason for this is that *no* recruitment took place through university laboratory subject pools, which largely represent a sample of parents already prescreened for many possible exclusionary criteria (either self-screened or otherwise). In contrast, all parents and children in the norming study for the LUI were recruited from community (as opposed to academic) locations resulting in a greater number of exclusions for a greater variety of reasons.

General Exclusion Criteria

Questionnaires were excluded from the final norming sample for one or more of the following reasons:
- completion errors including missing information in required parts of *Family Information for Child Section* or completion times over several days or weeks (n = 20);
- birth weight and/or prematurity status unknown (n = 26);

- exposure to English as second language for under 12 months (n = 3);
- exposure to language other than English at greater than 20% of time (n = 378; 8 % of sample);
- exclusion for medical reasons (see details below) (n = 288; 6% of sample);
- exclusion for missing data (n = 205; 4.6% of sample).

Medical Exclusion and Inclusion Criteria

In the norming study, 288 children were excluded for medical reasons. Children were excluded for one the following medical reasons (n's represent exclusions in the descending order shown below, but more than one medical reason may have applied):

- the combined occurrence of prematurity and birth weight under 5lbs 5oz (n = 144);
- major birth complications (n = 16);
- diagnosed condition generally accepted as resulting in impairment or delay in cognitive and/or language functioning (e.g., fetal alcohol syndrome) (n = 32);
- diagnosed developmental delay (e.g., pervasive developmental disorder) (n =10);
- diagnosed hearing impairment (n = 25);
- diagnosed speech or language delay (unless purely articulation delay) (n = 61).

Despite these exclusions, children in the norming sample represented a group with diverse medical backgrounds. For example, children were included in the final sample:

- if a developmental or language delay/impairment was indicated to be *suspected* but the child had not received a diagnosis;
- who may have had complications at birth, but whose parents indicated on the questionnaire that no further complications or negative effects on development with respect to language and/or cognition were to be expected (e.g., jaundice, febrile seizures);
- whose medical condition(s) is not generally indicated to result in language or cognitive delay or impairment (e.g., hyperthyroidism, anthrogryposis, asthma);
- with ear infections, even if numerous, given research to date confirming the difficulty of determining a clear relation between ear infections and the presence of language delay (e.g., Campbell et al., 2003; Dale, Price, Bishop, & Plomin, 2003; Feldman et al., 2003; Roberts, Rosenfeld, & Zeisel, 2004). In the norming sample, 1600 of the 3563 children (45%) were reported to have had ear infection(s).

Demographic Distribution of the Sample

Age and Sex

Table 6.1 shows the number of girls and boys (by age) included in the final norming sample for the LUI (N=3563).

Table 6.1.   Number of children by age and sex in the norming sample.

Age in Months	Girls (*n*)	Boys (*n*)	Age in Months	Girls (*n*)	Boys (*n*)
18	61	71	33	56	63
19	63	59	34	56	58
20	57	55	35	61	57
21	57	60	36	58	57
22	57	57	37	68	63
23	64	59	38	56	59
24	57	55	39	58	57
25	59	60	40	59	65
26	55	60	41	61	65
27	57	57	42	60	60
28	56	60	43	56	60
29	58	63	44	63	55
30	58	69	45	58	57
31	57	62	46	55	59
32	57	64	47	63	56
			Total	**1761**	**1802**

Geographical Composition

Our norming sample was comprised of children from 577 communities in Canada and from all 10 provinces and three territories and included urban and rural communities (community size was not, however, a controlled variable). Table 6.2 shows the number of children recruited from each province and territory.

Table 6.2.   Number of girls and boys (and total) by Canadian province or territory in the norming sample and compared to the percentage by province or territory from 2001 Canada Census survey (children aged 1 – 3 years, excluding Québec).

Province or Territory	Girls (*n*)	Boys (*n*)	Total (*n*)	% Norming Sample	% Canada Population (1-3 years)[a]
Alberta	81	77	158	4.4	14.0
British Columbia	91	76	167	4.7	15.3
Manitoba	50	55	105	3.0	5.3
Newfoundland and Labrador	30	30	60	1.7	1.9
New Brunswick	30	22	52	1.5	2.8
Northwest Territories	0	3	3	0.1	0.2
Nova Scotia	55	74	129	3.6	3.6
Nunavut (Territory)	3	1	4	0.1	0.3
Ontario	1390	1343	2733	77.4	51.4
Prince Edward Island	13	14	27	0.8	0.6
Québec	2	3	5	0.1	N/A
Saskatchewan	55	60	115	3.2	4.6
Yukon (Territory)	2	3	5	0.1	0.1
Total	**1802**	**1761**	**3563**		

[a]Information was derived from the 2001 Canada Census survey retrieved in 2004 from Statistics Canada.

Although more than two-thirds of the sample were recruited from the province of Ontario, it should be noted that this was partially by design, given that at the time of the study, three of the five most ethnically diverse cities in Canada in terms of the percentage of foreign-born residents in Canada were located here (i.e., Kitchener, Hamilton, and Toronto) according to the 2001 Canada Census (see also Carter, Polevychok, & Sargent, 2005). It is also the case that the greatest proportion of Canada's children (excluding Québec) aged 1 to 3 years reside in the province of Ontario (51.4%, 2001 Canada Census). Nevertheless, when recruitment took place, all attempts were made to recruit as many children as possible from provinces other than Ontario in accordance with the percentage of children aged 1 – 3 years residing in each province and territory (excluding Québec) according to the 2001 Canada Census survey. The resulting numbers and percentage among the norming study sample as compared to the percentage for Canada (excluding Québec) are shown in Table 6.2.

Demographic Composition

Demographic Variables

Our demographic variables were defined as closely as possible to the definitions in the 2001 Census Dictionary provided by Statistics Canada. The information requested of parents on the LUI's *Family Information for Child Section* (see Appendix) was also worded as closely as possible to these definitions and the wording of the questions on the 2001 Canada Census survey. In this section, these definitions with respect to *low income status*, *lone parent status*, *visible minority* and *level of schooling of parents* will be discussed. *Exposure to languages other than English* will be discussed in a separate section to follow.

Low income: Income status, according to the 2001 Census Dictionary (Statistics Canada), refers to the position of an economic family in relation to Statistics Canada's low income cut-offs (LICOs). The low income cut-off is defined as the income level at which families spend 20% more than average on food, shelter, and clothing (2001, Census Dictionary, p. 163-164). These cut-offs take into account total household income, family size and population size of area of residence (i.e., degree of urbanization) and are revised annually. It may be of note that, since its initial publication, Statistics Canada has emphasized that the LICOs are not measures of poverty, but reflect a consistent and well-defined methodology that identifies those who are substantially worse off than average (2001, Census Dictionary, p. 165). In the *Family Information for Child* section appended to the LUI in the norming study, a parent was asked to indicate family size, place of residence, and income level (in $1000 increments up to the largest possible cut-off amount for a family of 7 members as determined by Statistics Canada for the year 2003). This information was used to identify children from families meeting the low income cutoff. It should be noted that, according to the 2001 Canada Census survey, the percentage of children under 6 years of age from families meeting the LICO is considerably higher (29.7%) than the percentage when determined with respect to the population as a whole (e.g., 19.4% among census families and non-family persons in total). Among our norming sample, 4.9% of respondents declined to answer this question.

Lone Parent: According to the 2001 Census Dictionary (Statistics Canada) lone parent is defined as a mother or a father, with no spouse or common-law partner present, living in a dwelling with one or more children (p. 150). Guardians are included as parents under the Statistics Canada definition of parent. For the norming study, parent(s) were asked to indicate whether the child's mother, father or any other guardian(s) live in the child's household. If only one adult was listed as being in the child's household, the household was classified as lone parent. Thus, for example, if a grandparent was reported to be living full-time in the home in addition to a parent, the parent was not classified as a lone parent. If, in the case of divorce, children were reported to live in two separate households, and each of these households met the definition for lone parent, then the child's parent status was considered to be lone.

Visible Minority: Under Canada's Employment Equity Act, members of visible minorities are "persons, other than Aboriginal persons, who are non-Caucasian in race or non-white in colour" (2001 Census Dictionary, Statistics Canada, p. 143). On the 2001 Canada Census survey, visible minority mark-in response categories included: Chinese, South Asian, Black, Filipino, Latin American, Southeast Asian, Arab, West Asian, Japanese, and Korean and were based on the visible minority groups identified by the Employment Equity Technical Reference Papers, published by Employment and Immigration Canada in 1987 and used for federal employment equity programs (2001 Census Dictionary, Statistics Canada, p. 143). In the *Family Information for Child* section of the LUI for the norming study, a parent was asked about the ethnic and cultural background of the family via an open-ended question in which the parent could note the population group(s) (e.g., Irish, Armenian, Chinese, Inuit, etc.) for each member of the household. Using the information provided by the parent in conjunction with the visible minority population groups as defined by the 2001 Census Dictionary, each child was classified as visible minority or not. It should be noted that, on the 2001 Census Survey, the most frequent response to the question asking respondents to identify the ethnic and cultural origin of their ancestors was "Canadian" (39% of responses to this question). In our norming sample, this response was also observed and scored as non-visible minority. Among our norming sample, 7.1% of respondents declined to answer this question.

Level of Schooling of Parent(s): In accordance with the levels of schooling as used for the 2001 Canada Census survey, parent(s) in the norming study were asked to indicate the highest level of schooling achieved for mother, father, and any guardian(s) from the following six mark-in response categories: (1) less than grade 9, (2) grade 9 to 12/13 but did not graduate high school, (3) High(Secondary) school graduate, (4) Trades/Non-University certificate or diploma (e.g., community college, technical institute), (5) University certificate below Bachelor level, and (6) University: Bachelor's degree or above. For our analyses, which examined only mother's level of schooling, levels 1 and 2 were grouped together, as were levels 4 and 5.

Table 6.3 describes the composition of our norming sample and compares it with the Canadian population. Note that for all five demographic variables we used the Statistics Canada's PUMF Families data set for the 2001 Canada Census to determine the population values specifically with respect to *families with children younger than 6 years of age.*

Table 6.3. Demographic profile of families in the norming sample compared with the Canadian population (excluding Québec) with respect to children under 6 years of age.

Demographic Characteristic	Canada (%)[a]	Norming Sample
Income Status		
Below low income cut-off	29.7	10.0
Above low income cut-off	69.6	85.1
Not reported	-	4.9
Family Structure		
Lone parent home	17.4	6.6
Dual parent home	82.7	93.4
Visible Minority Status		
Visible minority	15.4[b]	12.1
Not a visible minority	84.6[b]	80.8
Not reported	-	7.1
Level of Schooling of Mother		
Some high school or less	29.1	3.5
High school diploma	23.5	13.5
Trades or non-university certificate or diploma	29.4	33.4
University bachelor's degree or higher	17.9	49.6
Home Language Exposure		
Language most often spoken to child at home:		
English only	84.8	80.2
Language(s) other than English	15.2	19.8

[a] Information was derived from the 2001 Canada Census survey (retrieved from Statistics Canada from http://nesstar.tdr.uoguelph.ca) and is restricted to families with children younger than six years of age who live in a province or territory other than Québec.

[b] As reported for the female spouse on the 2001 Canada Census survey.

Exposure to Languages Other than English

Canada Census Survey Definition and Population Values

On the 2001 Canada Census survey (Long Form; Statistics Canada), respondents were asked (in Part A of a section pertaining to Home Language) to report for each child in the home, "the language spoken most often to this child at home. If two languages are spoken, report the language spoken most often. If both languages are used equally often, report both languages". Excluding the province of Québec, 84.8% of children under 6 years of age were to be exposed to only to a *single* language and that single language was reported to be English. The remaining 15.2% of children under 6 years of age were reported to be exposed to a language(s) other than English. For this remaining 15.2%, the level of exposure to language(s) other than English could be presumed, given the wording of the question, to be a minimum of 50% of the time. It was not possible, given the wording of the Canada Census questions and the statistical analyses possible with the Census data file to determine the percentage of children exposed to a language other than English for less than 50% of the time, which would have been a closer fit to our norming sample data where exposure did not exceed 20%.

Nevertheless, as shown in Table 6.3, the percentage of the norming sample reporting exposure to a language(s) other than English exceeded 15.2%.

Exposure to a Language Other than English in the Norming Sample

The LUI norming sample included only those children for whom exposure to a language other than English was calculated to be 20% or less.

Of the total norming sample, 704 (19.8%) of children were reported to be exposed to at least one other language in addition to English. Included in this group were 193 children reported to be exposed to 2 other languages and 44 reported to be exposed to 3 or more languages.

The sample also included 9 children learning English as a second language who had been exposed to English for a minimum of 12 months. In addition, twenty-four children were reported as being exposed to sign language (which in most cases appeared to be "baby sign" exposure).

Among parents who indicated that their child was exposed to a language(s) other than English, more than 50 different languages were noted. Table 6.4 shows the 10 most frequent languages listed and the number of respondents for whom each language was listed.

Table 6.4. Number of children in the norming sample exposed to a language other than English listed in order of the top 10 most frequent languages reported.

Rank	Language	*n*
1	French	330
2	Spanish	137
3	German	92
4	Italian	58
5	Portuguese	46
6	Dutch	29
7	Greek	19
8	Polish	14
9	Cantonese	12
10	Chinese	11

The languages children were reported to be exposed to were also grouped by language family (see Statistics Canada, 2001 Census Dictionary, p. 90). The twelve most frequently reported language families are shown in Table 6.5.

Further analyses are underway to examine the results of children at higher levels of language exposure and determine the applicability of the norms.

Table 6.5. Number of children in the norming sample exposed to a language other than English listed in order of the top 12 most frequent languages families reported. (Examples given are from languages reported.)

Rank	Language Family	*n*
1	**Italic** (Romance) (*French, Italian, Portuguese, Romanian, Spanish*)	574
2	**Germanic** (e.g., *German, Danish, Dutch, Norwegian*)	137
3	**Slavic** (*Polish, Croatian, Czech, Ukrainian, Macedonian, Russian*)	58
4	**Sino-Tibetan** (e.g., Chinese, Cantonese, Mandarin)	29
5	**Aboriginal Languages**: 1. Algonquian, 2. Athapaskan, 3. Iroquoian, 4. Inuit (*e.g., 1. Cree, Ojibway, Saulteaux MicMac; 2. Northern Tutchone; 3. Mohawk; 4. Inuktitut*)	24
6	**Afro Asiatic** (*Arabic, Hebrew, Lebanese, Sudanese*)	20
6	**Indo Iranian** (*Bengali, Gujarati, Hindi, Konkani, Marathi, Persian, Punjabi, Telegu, Urdu*)	20
7	**Greek**	19
8	**Austronesian** (*Filipino, Samoan*)	16
9	**Finno-Ugric** (*Estonian, Finnish, Hungarian*)	9
10	**Japonic** (*Japanese*)	8
11	**Austro-Asiatic** (*Vietnamese*)	5
12	**Armenian**	3
12	**Korean**	3
Other	(e.g., *Turkic, Hmong-Mien, Niger-Congo*)	6

Norms Development

Curve Fitting

Growth-curve modelling is often used to show overall patterns of development and to predict scores (Burchinal & Applebaum, 1991; Fenson et al., 1993). Growth curve modelling was used to estimate how LUI scores are distributed in the broader population from which the normative sample was drawn. The resulting model was then used to generate the percentile tables found in Chapters 8 through 11, which indicate, for a given child's LUI score, the percentage of children in the population of the same age and sex that would be expected to score lower on the LUI.

In several ways, the growth curve modelling process "smoothed" over variability in the raw LUI scores that is attributable to sampling error. First, it produces a logistic function relating LUI scores to age, which smoothes over some variability in the raw scores (i.e., the collection of mean LUI scores for each age month). In other words, compared to the somewhat bumpy plot (due, for example, to sampling or measurement error) that would result if one simply plotted the raw means for each age group, the regression analysis produces a smooth curve through the raw scores which represents, based on the entire norming data set, the best estimate (i.e., the fitted or predicted value) of the population

mean at each age month. While a number of functional forms were considered, ultimately the logistic function was used because it is characterized by an early gradual increment, leading to a rapid surge, and followed by a leveling off. This pattern is typically observed in the acquisition of language and in other developmental domains (Burchinal & Applebaum, 1991; Fenson et al., 2007).

In the second manner in which the data were smoothed in this analysis, the modelling process adjusted for variability in demographic variables across the age month subsamples. That is, for those demographic variables that qualify the relation between LUI scores and age, the modelling process generated predicted LUI scores at each age month that correct for the fact that, in the raw data, a subsample for one particular age month was not always exactly matched with respect to all the demographic variables to subsamples for all other age months.

Further details of how the model was constructed for the LUI are now provided. Using total scores on the LUI as the dependent variable, a logistic regression analysis was conducted predicting scores based on the child's age in months, sex, and four additional demographic variables, all of which were dichotomous: low income (yes or no), lone parent (yes or no), visible minority (yes or no) and mother's education level (university or less than university). A full model, consisting of all the predictors and all possible two-way interactions, was first fit to the raw data, and then insignificant predictors were dropped one at a time in an iterative fashion until a reduced model with only significant (p < .05) predictors was found.

Age, as expected, was a statistically significant predictor of LUI scores. In addition, sex and the age by sex interaction term were significant predictors. At each age month, the mean LUI Total Score was lower for boys than for girls (see Figure 1). In light of this result, separate growth models and percentile tables were constructed for boys and for girls.

The resulting models were used to generate fitted (estimated) LUI scores for a given age in months, setting the values of the significant demographic variables equal to their grand means for the normative sample as a whole. As noted above, this process adjusts for sampling variability in the demographic variables from one age month to the next in the normative sample. Put simply, the regression analysis estimated what the percentiles would be in any given age month if the sample of children in that age month were exactly matched to the overall norming sample in terms of demographic characteristics.
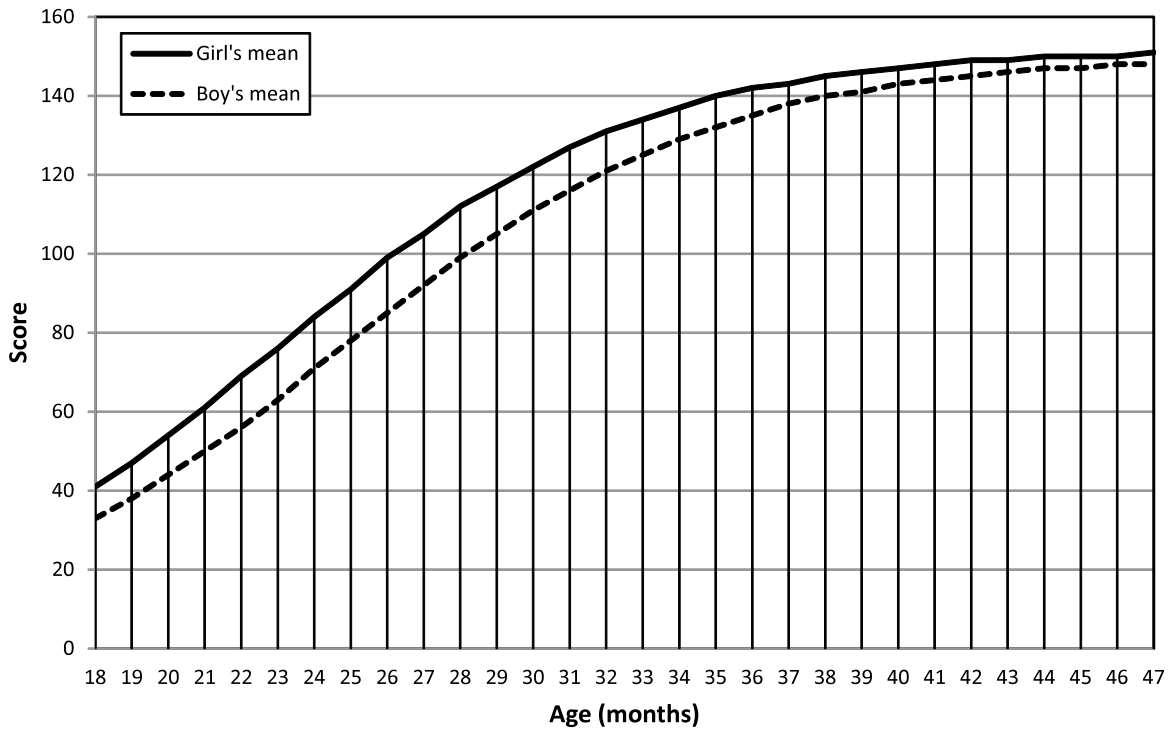
Percentile Scores

Using the regression models described above, the mean LUI score for boys or girls of a particular age in months can be estimated. The models can also be used to produce an estimate of the variance associated with the mean. In turn, by assuming that LUI scores are normally distributed at each age month, percentile equivalents for any particular score can also be estimated. (Tests of the normality assumption did not reveal any evidence that the hypothesized normal distribution should be rejected.) It is these percentile values that are presented in the tables provided in Chapters 8 through 11.

The same process was used to generate tables of percentile equivalents for scores on each of the main parts of the LUI separately, as well as for each of the 10 individual scored subscales. These supplementary tables can be used, for example, in identifying particular areas of difficulty for those children whose overall LUI scores place them in a low percentile category.

Line graphs showing the 90th, 75th, 50th, 25th and 10th percentiles by age for LUI Total Scores, Parts 1 to 3 and all 10 scored subscales were also generated and are presented in Chapters 12 and 13.

Figure 6.1. Fitted mean LUI Total Score for girls and boys (Norming Study).

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