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Toward a Technology of Dynamic Indicators of Communicative Expression for

Infants and Toddlers

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Abstract

Proficiency in expressive communication is an important outcome in early childhood necessary for cognitive and social development. In two studies, this manuscript reports the development of an experimental measure for assessing growth in expressive communication in children birth to three years. The measure was developed using general outcome measurement (GOM) procedures (Deno, 1997; Fuchs & Deno, 1991). GOMs are uniquely appropriate for use in the identification of children having difficulty acquiring a socially valid outcome, like expressive communication, and evaluating the effectiveness of interventions for these children. Results from a sample of 25 infants and toddlers in Study I demonstrated the development and feasibility of these measures. Results from a sample of 50 infants and toddlers repeatedly assessed for nine months in Study II indicated that the measure displayed adequate psychometric properties of reliability and validity and was sensitive to growth over time. Implications for use are discussed.

Toward a Technology of Dynamic Indicators of Communicative Expression for Infants and Toddlers

One of the most important skills a child needs to develop during early childhood is expressive communication (Bates, O'Connell, & Shore, 1987; Kaiser, 1993). Children need communication skills to gather information, to grow cognitively, and to interact appropriately with others in their environment (Crais & Roberts, 1996; Walker, Greenwood, Hart, & Carta, 1994). Expressive communication in the form of gaze, gesture, and babbling emerge in the behavior of young children long before use of spoken language (McCathren, Warren, & Yoder, 1996; Tomasello & Farrar, 1986). Delayed development of communication skills can lead to additional developmental problems.

Implications of Delays in Expressive Communication

Children with delays in expressive communication often experience problems in early literacy, school achievement, behavioral development, and establishing relationships with friends and family (McCathren, et al., 1996; Schuele, 1999). Nonetheless, delays in expressive communication are often not identified until the preschool years (Wetherby & Prizant, 1992). Communication problems are one of the most prevalent reasons for referring children for special education services (Marcovitch, Chiasson, Ushycky, Goldberg, & MacGregor, 1996). At least 70% of preschool children with disabilities have communication impairments (Wetherby & Prizant, 1993b) and 12% of all services provided to infants and toddlers in 1995 were for speech and language (U.S. Department of Education, 1998). Consequently, it is vital that identification of communication and language delays be made as early as possible in order to provide appropriate intervention services. Research indicates that children who receive intervention services for communication develop improved language (Yoder & Warren, 1999). In addition,

children who receive effective interventions during early childhood may be at reduced risk for early failures in school (e.g., reading), thus preventing future problems (Cole, Dale, & Mills, 1991).

Monitoring Intervention Progress

Dynamic indicators are needed to ensure that intervention services for improving children's early communication skills are appropriate and effective. IDEA (reauthorized with P.L. 105-17 in 1997) regulations for Part C require that an evaluation be conducted to determine a child's initial and continuing eligibility, a child's level of functioning across developmental domains, and information gathered to monitor progress toward IEP/IFSP goals. While a variety of assessments are available, most currently used assessments tell interventionists if a child has a delay (standardized norm-referenced tools), the child's level of skill mastery (criterion-referenced tools), or if an intervention program has made a difference in terms of change in developmental age scores or the number of IEP objectives mastered (Carta, 1999; McLean, 1996). However, these tools do not tell practitioners if the child is on track in making progress toward a meaningful general outcome (Deno, 1997).

Uniquely suited to progress monitoring are General Outcome Measures (GOMs; Deno, 1997; McConnell, 2000). GOMs are designed to reflect progress toward an identified general outcome. This stands in contrast to mastery monitoring approaches typically used to measure young children's acquisition of subskills assumed to be components of the general outcome (Deno, 1997; Fuchs & Fuchs, 1998). In mastery monitoring, a separate monitoring method must be developed for each subskill, requiring frequent changes in monitoring systems and additional work for teachers. GOMs used in pediatric medicine, such as height and weight charts, provide information about how well a child is growing, and whether a need exists for additional

evaluation or a change in care. Curriculum Based Measurement (CBM) is the best-known educational GOM. It is most often used to measure progress learning basic academic skills in reading, math, and writing (Fuchs & Fuchs, 1986; Fuchs, Fuchs, Hamlett, & Bentz, 1994; Marston, 1989). CBM provides quick, reliable, and accurate measurement of growth toward long-term IEP goals (e.g., Fuchs & Deno, 1991). A defining characteristic of CBM is that it is comprised of dynamic indicators, designed to monitor a child's progress by detecting when an individual child is falling below growth expectation, when intervention is needed, whether or not the intervention is effectively moving the child toward the desired outcome, and if not, that a change is needed to accelerate growth (Deno, 1997). Currently, dynamic indicators for tracking the developmental progress of children acquiring communication do not exist.

Efforts to develop GOMs for both older and younger children are in evidence. For example, CBM problem solving tasks and scoring systems have been developed to monitor progress developing "critical thinking" at the secondary level (Tindal & Nolet, 1995). Dynamic Indicators of Basic Early Literacy Skills (DIBELS: Good & Kaminski, 1996; Kaminski & Good, 1996) have been developed to assess the progress of kindergarten and first grade students in acquiring early literacy skills, including phonological awareness, letter naming, and vocabulary. In addition to sensitivity to growth over time, the key skill elements that comprise the DIBELS have been shown to predict early literacy (Good, 1996). However, GOMs have yet to be developed for younger children, especially infants and toddlers.

This manuscript reports results of a recent effort to develop an expressive communication GOM for infants and toddlers aged birth to three years. This effort is part of a larger effort developing GOMs for children birth through age eight through the Early Childhood Research Institute on Measuring Growth and Development (ECRI-MGD; McConnell, et al., 1996).

Guiding this research was the work of Deno, Mirkin, & Chaing (1982) who described the criteria for general outcome measure design for use in CBM progress monitoring. Like CBM, research was designed that addressed the extent that a prospective GOM (a) relies on "authentic" child behaviors in natural settings, (b) can be used efficiently and economically, (c) is standardized and replicable, (d) assesses key skill elements of an important child outcome, (e) is technically adequate, and (f) is sensitive to growth and change over time and to the effects of interventions (ECRI-MGD, 1998). In the two related studies described here, initial GOM instruments were developed (Study I) and their technical adequacy examined (Study II).

Study I - Initial Instrument Development and Feasibility

Overview

All GOM development conducted by the ECRI-MGD has been based on 15 general outcomes for early education programs validated by a national sample of parents ($n = 351$) and professionals ($n = 672$) (Priest et al., 1998). Development of GOMs in expressive communication was guided by the following general outcome: "The child uses gestures, sounds, words, or sentences to convey wants and needs or to express meaning to others." In the national survey, parents and professionals ranked this outcome as first in importance out of 15 outcomes (Priest et al., 1998). While this manuscript reports findings of the effort to develop an expressive communication GOM for infants and toddlers, work of colleagues has focused on development of similar measures for children 3 to 5 years (Minnesota) and 5 to 8 years (Oregon) (ECRI-MGD, 1998; Kaminski, 1999).

Purpose

The purpose of Study I was to develop and test the feasibility of alternate experimental expressive meaning GOMs for infants and toddlers. The goal was selecting the best measure based on the design criteria listed above.

Method

Participants

Participants in the pilot study included 25 children, ages 5 to 34 months. Fifty-six percent of the children were female and 44% were male. Two children had identified disabilities. Disability status was determined from information provided by childcare center staff about children who received special education services. One child was assessed at home, the remaining children were assessed at three child care centers in two Midwestern cities. One center was associated with a local university that included children with and without disabilities while the other two centers were located in the inner city and served children of teen parents attending special high school programs.

Design

The general design combined assessment development activities with a pilot study to probe the technical feasibility of the system. The development process included: (a) determining the key skill elements of expressive communication for infants and toddlers, and (b) developing appropriate, standardized assessment formats and coding/scoring systems that, because of their efficiency and economy, could be used repeatedly to measure progress. When this work was completed, a pilot study of technical features was conducted. Initial work focused on the identification of key skill elements from the literature and measurement tasks/items that would overcome the unique challenges of testing very young children. These challenges included

obtaining representative samples of children's abilities in a short amount of time and the difficulty getting young children to comply with a standardized protocol. The definition, the key skill elements, and tasks/items were brought together in the form of two alternative experimental GOMs, each with alternate forms for measuring and procedures for scoring children's expressive communication.

In a series of brief trials preceding the pilot study, these two formats were tested and refined in an effort to improve interobserver agreement on coding. In the pilot study, these two measures were administered once to each of the 25 children. A criterion measure of expressive communication was also administered. These data were then correlated to probe sensitivity to chronological age, reliability, and criterion validity.

Measures

Key skill elements. Based on a review of the communication and language development literature relative to infants and toddlers (e.g., Dale, 1996; Fenson, et al., 1994; Wetherby & Prizant, 1993b), key skill elements were identified that related to the general outcome and were appropriate for measurement of children in this age range. From this review, the developmental path for expressive communication included prelinguistic (gaze or social attention, gesturing, and vocalization) and linguistic forms (single and multiple word utterances) of communication.

Proficiency in expressive communication involved more than a single skill and followed the development of communication skills demonstrated by typical infants and toddlers. Infants two to three months of age use gaze, gestures and vocalizations that caregivers interpret as prelinguistic communication (Crais & Roberts, 1996). By eight or nine months, infant communication becomes increasingly intentional (Carpenter, Mastergeorge, & Coggins, 1983; McLean, 1990). For example, an infant reaching for a toy and vocalizing, often looks (i.e., social

attention through gaze) from the toy to the caregiver and then back to the toy several times, communicating to the caregiver that he/she wants help reaching the toy. Infants often use gestures as a reference to an object or event, and to share it with another person (e.g., requesting a cup of milk by pointing a finger or giving a ball to a play partner to request that play continue). Vocalizations include babbling of vowel sounds or consonant-vowel sound combinations. Research has shown that the amount of vocalization children use in the prelinguistic period is predictive of later speech development, including word use at one year of age, amount of talking at three years of age, and vocabulary development (e.g., McCathren, et al., 1996).

Words in communication appear by about 12 months of age, and begin to first supplement and then supplant gestures and vocalizations (Acredolo & Goodwyn, 1988; Crais & Roberts, 1996). Between 18-24 months, children typically are combining two or more words forming multi-word utterances (Bates, et al., 1987). Between 24-36 months, differences in vocabulary size of children are evident that are predictive of later language and cognitive development (Hart & Risley, 1995; Walker, et al., 1994).

Experimental GOMs. Developmental work on the GOMs resulted in two measurement formats that contained key elements that met Deno et al.'s (1982) criteria (e.g., sensitive to growth, reliable, valid, efficient, frequently repeated, etc.), and addressed the unique challenges of assessing young children. These were a semi-structured format called **Communicative Evoking Situations (CES)** and an unstructured format called **Naturalistic Observation Situation (NOS)**.

The CES was adapted from the Communication Symbolic Behavior Scale (Wetherby & Prizant, 1993a) and the Abridged Early Social Communication Scales (Mundy, Hogan, & Doehring, 1996). In the 18-minute CES format, children were presented with nine different

toys/activities selected to evoke communication. Each assessment situation was set up so that the toy or activity evoked communication rather than the adult; toys were selected to evoke different types of communication from children (e.g., comments/sharing about the toy, requests for help to get a toy, and requests for more or to engage the toy again). The assessor did not directly prompt communication (i.e., ask questions) except in a limited number of conditions. For example, the assessor would ask questions when presenting toys designed to prompt the child to ask for “help” or “more.” If the child did not make these requests in response to the presentation of the toy, the assessor provided an additional prompt by saying “Do you want help?” These questions were allowed only at specified points in the assessment.

Nine different toys/activities were tested for effectiveness because they had the potential of evoking a range of communication for children across the entire age span of 3 to 36 months (i.e., bubbles, box of blocks, teddy-go-round, peek-a-boo, wind-up boat, wind-up bear, container with toy, bag of toys, bucket of shapes). These toys engaged children quickly and they remained interesting to most children when used repeatedly. After presentation of a warm-up toy (i.e., Skwish[®] or rainstick), each toy was presented for two minutes, unless the child stopped attending to the toy or became distressed, at which point the next toy was presented. Testing was discontinued at any point when the child could not be re-engaged in the toys. It was anticipated that the length of the CES would be reduced in future work, however, all toys were evaluated in Study I to determine which ones met the established criteria to be considered for further study.

Compared to the CES, the 8-minute NOS was a naturalistic play situation for children. It included toys that children typically enjoy and the involvement of adults as play partners who engaged in typical play behaviors. NOS had two alternate forms: the Fisher-Price[®] House and Fisher-Price[®] Barn. No limitations were established on the manner in which the adult play

partner (assessor) played with the toys and child; however, the adult was encouraged to follow the child's lead and to refrain from quizzing the child to evoke communication. The NOS lasted eight minutes, with no warm-up toy because it was observed that children could be engaged immediately with the play set. Both forms of the NOS were given to each child.

Data were recorded on paper and pencil coding forms and later entered into a computer database (i.e., Visual d-BASE) for subsequent charting and analysis in other software (i.e., MS-EXCEL, SPSS). Assessors were project staff and graduate research assistants trained to meet a 90% criterion for administration reliability on assessments conducted over at least three days with children of different ages. Key elements of children's expressive communication were recorded using the same procedures on both CES and NOS.

Frequencies of Social Attention (gaze), Gestures, Vocalizations, Single Words, and Multi-Word Utterances were recorded (see Table 1). While a single behavior could be placed in only one category, a child could simultaneously engage in several behaviors that could be placed in several communication categories [e.g., a child could give a toy to the adult (gesture) while looking at the adult in the eye (social attention) and saying "Here is the dog," (multi-word utterance)]. The frequency of each key element category was calculated along with an overall total communication score that was the sum of the category totals. The rates of each key element and for total communication were also calculated by dividing the frequencies by the number of minutes in each assessment format.

Procedures

After orienting and recruiting prospective childcare center staff, parental informed consent was obtained. Children were tested in their childcare centers by project staff who served as assessors for CES and NOS assessments. A few very shy children were allowed to play with

their parent or caregiver during the NOS assessment. Project staff played with children in their classrooms for a short period of time before making the transition to the assessment situation conducted in another room or a corner of the childcare classroom. All assessments were completed within a two-month period and each was videotaped for purposes of assessing interobserver agreement and coding key elements.

Interobserver agreement for the GOMs. Interobserver agreement was assessed for 21% of all 56 CES and NOS assessments by a second person who independently coded the same videotaped session. A frequency ratio (Kazdin, 1982) was used to compare two observers agreement. The ratio was computed by dividing the smaller score into the larger times 100. The mean agreement ratios were 85% for the CES and 74% for the NOS. Low levels of agreement occurred most often with occasional poor sound quality on the videotape or when children displayed very low levels of communication.

Criterion Measures. Two criterion measures were selected to assess expressive communication and to provide a multi-method, multi-informant dimension to the study. The Preschool Language Scale – 3 (PLS-3; Zimmerman, Steiner, & Pond, 1992) was used. The PLS-3 is a standardized norm-referenced measure of receptive and expressive language skills. Because the CES and NOS were intended to measure expressing meaning communication, only the expressive subtest of the PLS-3 was used. Each child received an individual assessment with the PLS-3, either in his/her childcare classroom or a separate testing room at the center. The PLS-3 manual reported inter-rater reliability agreement of 89% with a reliability coefficient of 0.98 for items requiring some scorer interpretation. Test-retest reliability coefficients ranged from 0.82 to 0.91 The PLS-3 yields raw, standard, age equivalent, and percentile rank scores. Only the raw scores were used for data analysis in this study.

The investigators developed the second criterion measure to tap the intimate knowledge parents have of their child's language and communication (e.g., Dale, 1996). The goal was to gather additional information that might not be apparent from only assessments taken in the childcare setting. The Caregiver Communication Measure (CCM; Walker, Hart, Linebarger, & Parsley, 1998), based on a review of literature¹, generated a parent's report of the child's use of gestures, sounds, understanding of words, use of specific words, and grammar. An initial version of the CCM was piloted with parents as part of Study 1.

Analytical procedures. Simple descriptive statistics were used to describe the mean, standard deviation, and range of total communication scores overall and across three age cohorts. A 3 (age cohorts, 0-12, 13-24, and 25 months of age and older) x 2 (CES and NOS format type) ANOVA for repeated measures was used to assess sensitivity to age and differences in formats. Pearson correlation was used to examine relationships between and within particular measures. Of particular interest were key skill elements that changed with age, indicating a potential for measuring change over time.

Results

Sensitivity to Age

The mean rate of total communication was 5.31 responses per minute for the CES (SD = 2.82), which was not significantly different from the mean rate of total communication for the NOS (M = 5.18, SD = 3.62). Rates of total communication did vary predictably across age cohort [F (2, 22) = 18.70, p < .0001]. Younger children had lower rates of total communication than did older children at 2.77, 5.77, and 8.59 by age cohort respectively (see Figure 1). Tukey HSD post hoc tests of the age effect indicated significant differences between cohort 1 versus 2, 2 versus 3, and 1 versus 3 (p values ranged from .024 to .001). The interaction of age and format

was also significant ($F(2, 22) = 6.43, p < .006$). CES estimates were lower than NOS estimates for the youngest two cohorts but higher at the oldest cohort (see Figure 1). These results indicated that both assessment formats held promise for measuring growth over time.

Of particular interest was the change in each key skill element by age cohort and thus, its potential for measuring change over time (see Figure 1). As can be seen, rates of single and multiple words increased across each of the older age cohorts on both measures. Rates of gestures and vocalizations tended to increase slightly for 13 to 24 month olds compared to 0 to 12 month olds, but then decreased for children 25 to 36 months of age, as children began using words to communicate. Rates of social attention, however, increased on the NOS (0.71, 0.85, 1.77 in order of age cohort) but remained relatively unchanged on the CES (1.74, 2.06, 1.84) by age cohort.

Validity

Each assessment format was examined to determine its correlation with the criterion measures, the PLS-3 and the CCM. The first analysis examined the relationships between the two GOMs and criterion measures. CES and NOS both were significant correlates with the PLS-3 ($r(24) = .67$ and $.72, p < .001$ respectively). They also were significant correlates of the CCM ($r(24) = .69$ and $.89, p < .01$ respectively). These results indicated that both CES and NOS measured expressive language. The next analyses examined the relationship between the two criterion measures. The locally developed CCM was highly correlated with the PLS-3 ($r(24) = .94, p < .01$) indicating that they shared 89% in common variance measuring expressive communication.

Practicality

A final test of the CES and NOS measures was determining if they met the GOM criteria of efficiency, standardization, and repeatability. To meet these criteria, a GOM would need to be brief, easy to administer and score, and repeatable in a short period of time. In this study, the CES and NOS took 18 and 8 minutes, respectively; therefore, neither was yet considered efficient. Thus, work turned to shortening the time required.

It was decided that three CES toys could be eliminated from further consideration. Two toys (i.e., peek-a-boo and wind-up boat) did not evoke language as well as the other items; and for safety reasons, wind-up bear was eliminated because of its number of small parts that were potentially dangerous for young children. The remaining seven toys were retained for inclusion in Study II. The next step further reduced the number of toys used in each assessment thereby further increasing efficiency and the number of possible alternate forms.

Toys were initially put into two sets of four, and tried with a small group of children weekly for a month. The children quickly tired of the set of toys; therefore, toys were randomly paired to make them more variable and interesting. Data for the amount of communication evoked by each toy were examined and toys were paired to evoke the widest range of communication from children. Ten alternate forms of two toys each were developed in this way for use in Study II. Thus, each of the alternate forms took only four minutes in total (two minutes for each toy). The CES was thus reduced from 18 to 4 minutes making it much more efficient and practical for repeated use.

The NOS toys, the Fisher-Price[®] House and Barn, were found to be approximately equal in their ability to evoke children's communication. Both forms were kept as alternate toys for

Study II. The NOS was shortened from eight to six minutes to make it more practical and equivalent to the CES.

Discussion

This study demonstrated that the assessment formats and coding system for expressive communication were successful with young children three months to three years of age. Children participated in the assessments, appeared interested in the toys; and these formats provided children numerous opportunities to express themselves in a play situation with an adult. Results indicated the total rate of children's communication reflected a range of individual differences and co-varied with age. As expected, rates of key elements changed with increasing age. Rates of gestures and vocalizations were highest in younger children and declined in the oldest age group while single and multiple words were lowest in younger children. The implications of these competing but complementary trends in key skill elements with respect to forming a single growth indicator like total rate of communication suggested the need to explore weighting of its calculation in future work to account for these opposing dynamic changes. With respect to social attention, parallel increases in rates across the three age cohorts were not obtained and it was unclear why. Because of this finding, and considering the sizable effort required by observers to track and record social attention, it was decided to drop social attention from the coding scheme in future research.

The GOMs, while not yet as easy to administer and score as CBM reading probes, appeared promising because assessors could learn them quickly and use them in daily practice. The GOMs correlated highly with one another and did not differ significantly in the type of communication evoked. They also correlated well with a standardized language measure and a parent questionnaire indicating validity measuring expressive communication. Changes were

made in the assessments to make them more sensitive, practical, efficient, and replicable. While this study did not answer all questions about the GOMs' utility and technical adequacy, it provided the information necessary to design a longitudinal study to examine these issues further.

Study II - CES versus NOS Technical Adequacy

Purpose

The purpose of Study II was to examine the technical adequacy of the CES and NOS developed in Study I. The following research questions were addressed: (a) What were the psychometric properties of the experimental measures (i.e., interobserver agreement, magnitude and variation in expressive communication rate, reliability, and criterion validity), and (b) What were the GOMs' sensitivity to growth over time and child characteristics?

Method

Participants

Fifty children with a mean age of 17.3 months ($SD = 8.5$ months, range = 3 to 34 months) at the beginning of the study participated. Forty-eight percent of the children were female, 52% were male. Nine of the 50 children were receiving special services for children with developmental delays. These children were identified through information provided by parents about specialized services children received. Three children were receiving at-risk services through Early Head Start; six children had identified disabilities and IFSPs. Parents were not asked to specify the type of disability the children had, but most of the children with identified disabilities would be considered to have a general developmental delay. The mean ages at initial

assessment of children who had disabilities was 20.1 months compared to 17.1 months for other children and were not significantly different across groups.

One child was assessed at home; the rest attended five different childcare centers in two Midwestern cities. With the exception of the child assessed at home (2% of participants) – 4%, 8%, 16%, 20%, and 50% of children were from the five centers. One center was associated with a local university in one city and included typically developing children as well as children with disabilities. Four others were located in the second city; two were inner city and two suburban. One center was a community-based center that included many children with disabilities. Two of these centers had as a primary mission serving the children of teen parents attending special high school programs. All five centers served children from a number of cultural and linguistic groups, with two centers having a majority of the children from non-white families. Thirty-seven (47%) of the children were Euro American, 8 (16%) were African American, 3 (6%) were Hispanic, and 2 (4%) were of mixed race. The attained education level of the participating children's mothers ranged from less than high school (19%), to High School diploma/GED (8%), to some college or college degree (42%), to some graduate school experience (31%).

Design

A longitudinal design with repeated measurement was used to evaluate the CES and NOS with respect to psychometric properties and sensitivity to growth over time. The complete assessment protocol included nine monthly measurements of CES and NOS. Intermittent assessments of the Preschool Language Scale: (PLS-3) (once at the start of the study and again 6 months later), and Caregiver Communication Measure: CCM criterion measures (once every 3 months) were conducted.

Experimental GOMs. The improved CES and NOS measures previously described in Study I were used. With exception of one child assessed at home, children were assessed at their childcare centers either in the classroom or in a separate testing room. Assessors played in the classrooms so the children would become familiar with them. At the first session each child received a CES assessment, then at the second session two weeks later, the child received a NOS. Children who were absent for one assessment cycle were given the last assigned assessment format at the next assessment session. This alternating cycle produced monthly measures for each GOM. While an assessor administered the GOM, all assessments were observed live by a second assessor who coded the details of the child's communication and session duration. Unlike, Study I, Study II assessments were not videotaped. Only the child's communication was recorded; adult behavior was not.

Based on Study I findings, a single indicator of the rate of total expressive communication was calculated combining the frequencies of key skill elements and dividing by elapsed assessment time (i.e., 4 minutes for CES; 6 minutes for NOS). In this calculation however, single word utterances and multi-word utterances were weighted to give more credit to the greater sophistication of spoken communication and to counterbalance anticipated declines in gestures and vocalizations. Use of words and multi-words also required greater effort and time to produce. For example, a child would receive the same credit for pointing at the dog as she would for saying "Look the doggie go outside." This was determined to be more practical and efficient than counting actual words spoken. Single word utterances were given a weight of two (each word was multiplied by two); multi-word utterances were given a weight of three (each word was multiplied by three). The number of observations actually completed per child ranged from

four for 6% and 8% of children for CES and NOS, respectively, to nine for 60% and 62% of children for CES and NOS respectively.

Interobserver agreement for the GOMs. Interobserver agreement for all GOM coding was assessed on 10% of all assessments (90 out of 883) by a second person independently recording the same child live during an assessment. Frequencies of key elements category (i.e., gestures, vocalizations, single words, multi-word utterances) were totaled and combined for the overall total communication score. As in Study I, the frequency ratio was used to compute agreement (Kazdin, 1982).

The mean overall reliability was 90%. Similar values for the key elements were gestures (81%), vocalizations (80%), single words (70%), and multi-word utterances (72%). Lower levels of agreement occurred most often when there were few instances of a behavior; for example, the primary coder would note one instance of a behavior, but the reliability coder would note two instances. Interobserver agreement for NOS coding was conducted on 12% of assessments (52 out of 445) and overall agreement was 89%. The similar value for CES coding, conducted for 9% of assessments (38 out of 438) was 92%.

Criterion Measures. The PLS-3 and CCM used in Study I were again used in Study II.

Analytical Procedures

As in Study I, simple descriptive statistics (mean, standard deviation) were used to describe the magnitude of the rate of expressive communication and individual variation around the mean and over time. Pearson correlation, Cronbach's alpha, and dependent t -tests were used to assess alternate-form, internal consistency, and split-half reliability as well as criterion validity relationships between different measures (i.e., GOMs versus PLS-3 and CCM) at specific points in time. Several additional analytical procedures were used in Study II. Hierarchical Linear

Modeling (HLM; Bryk & Raudenbusch, 1992; Bryk, Raudenbush, & Congdon, 1996) was used to examine growth over time. HLM - Level 1 analyses were used to compute slope (rate of growth) and intercept parameter values for individuals and groups. HLM - level 2 analyses were used to model growth as a function of age cohort (0 - 12, 13 - 24, and 25 - 36+), word use at first assessment (yes, no), and disability status (yes, no). It was hypothesized that children with known developmental delays compared to children without delays would show slower progress developing expressive communication.

A unique advantage of HLM analysis is the ability to compute a group mean at a single point in time or test for mean differences between groups using a centering procedure (Bryk & Raudenbusch, 1992). While centering at a point in time produces a unique value for the mean intercept, the value of the linear slope is unaffected by centering. Unless otherwise indicated, the intercept means in this study were centered at measurement month 5, the middle of the 9-month study, or at 19.5 months of age, the midpoint of the 0-39 month chronological age range of children participating in the study.

Results

Key Skill Elements

The effect of age on children's growth in key skill elements was modeled using HLM - level 2 analyses to examine the importance of each element as a child outcome. As seen in Figure 2, age related change in the rates of key skill elements varied in theoretically predictable ways. For children 0 – 12 months of age, vocalization and gestures were the most prominent forms of communication. Growth was noted in vocalizations, gestures, and words (upper panel, Figure 2). For children 13 - 24 months of age, vocalizations and gestures remained dominant but declined over time. Compared to the younger children, use of words and multiple words were

elevated and accelerating (see middle panel, Figure 2). Use of single and multiple words continued to accelerate in the communication of children 25 - 36+ months of age while declines in vocalizations and gestures were noted (lower panel, Figure 2).

Individual Differences in Growth

To describe the rate of total expressive communication, mean intercept and slope estimates for CES and NOS were computed (see Table 2). The mean intercept for the CES at wave 5, the central measurement point, was 7.59 responses per minute. The slope of the CES was 0.54 ($N = 50$), meaning that children were growing at just over half of a response per minute per month. Similar values for NOS were higher at 8.14 responses per minute for mean intercept and 0.75 for mean slope. HLM tests showed that each of these values was significantly greater than zero indicating considerable rates of communication with positive acceleration over time.

Individual differences in growth were reflected in the standard deviations and ranges for these parameters. Also important with respect to the 'bounce' in rate estimates one month to the next was the standard error of estimate (Fuchs & Fuchs, 1999). For both GOMs, the standard error was small relative to the mean intercept and slope values (see Table 2). Correlations between CES and NOS parameter estimates were large and statistically significant [intercept $r(48) = 0.87, p < .0001$; slope $r(48) = 0.58, p < .0001$]. Dependent t-tests indicated no significant differences between CES and NOS estimates of intercept and slope (see Table 2).

Reliability for the Experimental GOMs

Cronbach's alpha was calculated for each CES toy pair to evaluate internal consistency across the different key skill elements. These values ranged from 0.49 - 0.75, $M = 0.62$. To evaluate the alternate-form point reliability of children's rate of total communication on the

NOS, the correlation between alternate forms administered less than 1-week apart was examined. Reliability for NOS was 0.72.

Split-half reliability was conducted by separating odd (1, 3, 5, 7, 9) and even (2, 4, 6, 8) monthly assessments for all children who had 9 data points ($n = 25$). Odd and even intercept and slope parameters for each participant were computed for each child using HLM. These estimates were then used to examine convergence and divergence. Results indicated moderate reliability correlations for CES and NOS based on half the available data that increased, to a range from 0.62 to 0.89, using the Spearman-Brown formula when all data were considered (see Table 3). T-tests between odd/even parameters were not significantly different.

Criterion Validity for the Experimental GOMs

The concurrent, criterion-related validity was examined by correlating the rate of total expressive communication estimates (point, level, and slope) with the PLS-3 and CCM. Point estimates refer to data obtained from one set of assessment tasks. Level estimates are the mean of all 9 waves of data to examine performance over time on a repeated measurement. Slope estimates represent growth or rate of progress over time (Kaminski & Good, 1996). For the CES, significant, positive correlations were found for point and level estimates (Range = 0.51 to 0.59, $p < .01$). Slightly higher values were obtained for the NOS (Range = 0.56 to 0.62, $p < .01$). Slope estimates were not significantly correlated with either criterion measure ($r = .1$ or less). See Table 4 for specific results.

Practicality

A number of practical issues related to the end users' (e.g., school psychologists, early interventionists, and speech-language pathologists) needs were examined. Across all practicalities, the NOS was superior. It provided a more naturalistic assessment play structure

with reduced item complexity, required less training time, and had a lower cost, a lower child refusal rate, and a higher probable preference by the end user. Because the two formats were psychometrically equivalent, practical considerations determined that the NOS was the preferred format. Therefore, analyses examining sensitivity were performed only for the NOS.

NOS Sensitivity to Differences Across Age, First Word Use, and Disability Status

Sensitivity of rate of total communication to age. An analysis of rate of total communication at the 5th monthly measurement indicated that older children had significantly higher mean intercepts than younger children, 4.78 versus 8.26 versus 11.74 [$t(49) = 4.95$, $p < .001$], in order by age cohort (see Figure 3, upper panel). There were no differences in slope.

Sensitivity to disability status. As seen in the lower panel of Figure 3, children without disabilities had higher mean intercepts than children with disabilities (8.82 versus 5.01 responses per minute [$t(49) = -1.99$, $p < .05$]). The difference in slope was not significant.

Three-year Developmental Trajectory

Given evidence that the NOS was sensitive to growth, a total expressive communication growth trajectory spanning the developmental range of birth through three was computed. The goal was to link age at measurement to normative growth rate. This HLM- level 1 analysis used age at measurement as the time scale rather than consecutive months as in prior analyses (see Figure 4). The mean intercept for children assessed at 19.5 months of age was 7.7 responses per minute ($SD = 2.50$) and slope of 0.40 responses per minute ($SD = 0.27$). Also included were trajectories reflecting plus and minus 1 standard deviation from the mean trajectory. This graph illustrates the trajectory of communication growth by age along with an indication of the spread of scores along this trajectory.

General Discussion

Results from an effort to develop a GOM system for monitoring the individual growth and development of expressive communication for infants and toddlers (birth to three) were reported. Following from initial work in Study I guided by procedures described by Deno et al. (1982), two experimental GOMs (CES and NOS) were developed and determined feasible for further investigation. In Study II, the technical adequacies of these GOMs were evaluated in a longitudinal investigation spanning nine months. Results in Study I supported the removal of social attention as a key skill element and retention of gestures, vocalization, and single and multiple word utterances as key skill elements of expressive communication. And, because key elements changed over age, some increasing and some declining, weighting of single and multiple words was suggested as a means of forming a single total communication indicator that would be sensitive to growth in proficiency. Study II results indicated that both CES and NOS reached reasonably high levels of technical adequacy including interobserver agreement, display of group and individual differences in intercept and slope reflecting growth over time. Both measures also reached moderate to high alternate-forms reliability (NOS), internal consistency (CES), and test-retest reliability, and high criterion validity with respect to a standardized (PLS-3) and an investigator-developed (CCM) criterion measure of expressive communication.

A primary concern was the low slope reliability coefficients in this research. However, comparing these values to those in the 0.50 – 0.60 range reported in other GOM research (e.g., Kaminski & Good, 1996; Willett, 1989), the current values appeared equivalent. Correcting slope reliability estimates based on half of the data using the Spearman-Brown Formula (Ferguson, 1966, pg. 378) to estimate reliability on all the data indicated that the coefficient would increase to 0.62 (NOS) and 0.68 (CES).

Criterion-related validity was based on instruments that tapped two independent sources: professional administrator (PLS-3) and parent (CCM). Results produced moderately high point correlations between the PLS-3 and CCM in convergence with each other and in convergence with both the CES and NOS. Slope estimates were not significantly correlated with either criterion measure. These findings supported the argument that both GOMs were indeed measuring aspects of expressive communication. The lack of a relationship between standardized measures of expressive communication and the GOM slope estimates may reflect the inability of the single point criterion measures to capture growth over time. Additionally interesting were the large positive correlations between CES and NOS growth parameters.

Comparing CES and NOS with respect to selecting one for use by practitioners or by researchers, a number of conclusions were reached. With respect to technical adequacy, both met reasonably high standards, and in many ways, appeared relatively equivalent. However, the NOS offered technical and practical advantages. Technically, it provided a larger mean slope at 0.75 versus 0.55 communicative responses per minute per month, suggesting greater sensitivity to growth over time. It also produced a larger standard deviation at 0.86 versus 0.57 indicating better sensitivity to individual differences in growth. In HLM analyses, the NOS also provided better overall reliability estimates for intercept and slope (see Table 3).

Practically, because of its natural play structure, the NOS resulted in fewer children refusing to participate in the assessment and fewer children quitting the assessment prematurely. This anecdotal observation suggested that very young children preferred the NOS, perhaps finding it more appealing and providing more opportunities for self-selection or choice. Second, given its informal structure and fewer items, it was less complex, less costly, and thus, easier to train and implement by others. Thus, NOS was selected for additional analyses of sensitivity.

To be suitable as a GOM of expressive communication, it would be expected that as children age, they demonstrate higher rates of spoken communication and lower rates of gesturing and vocalizing. Results based on the NOS indicated that older children did have significantly higher communication scores; however, there were no significant differences in their rate of growth. Children in all three-age cohorts increased proficiency in communication at the same rate. Thus, NOS rate of total communication was sensitive to age. These findings based on rate total of communication suggested that the proficiency in communication skills was fairly linear. However, examination of growth in key skills elements showed children relied on different elements at different ages (see Figure 2). These findings provide critical support for use of NOS as a progress-monitoring device.

Third, given the developmental significance of communication in early childhood, we expected the rate of the total communication measure to discriminate the performance of children who were typically developing and those with developmental delays. To be used effectively by early childhood interventionists and others working with children with disabilities, a GOM must be sensitive to differences in proficiency resulting from disabilities that delay language development. Significant differences in the mean levels (intercept) of children who had disabilities indicated that they indeed had lower communication scores than children without identified disabilities.

Limitations. These findings provided preliminary support for a GOM system for infants and toddlers. In the two studies, the results should be considered preliminary because the relatively sample sizes were small, however, findings in Study I were replicated in Study II suggesting some generalizability of reliability and validity relationships. Also increasing the generalizability of findings was the fact that children were repeatedly measured (50 children x 9

measurement occasions = 450 data points for just the NOS); thus, measurement error related to small samples sizes was reduced (McCall, 1977; Rudinger & Wood, 1990). Future research using the NOS, should be undertaken to demonstrate its sensitivity to individual growth as a function of specific intervention(s). Additional research should examine the feasibility of measurement implemented more frequently. The current data were collected monthly; however, the manner in which the measures function when used more frequently (e.g., weekly) to monitor progress under intervention conditions is currently under investigation (Carta, 1998; 1999). Additionally, studies demonstrating that interventions for infants and toddlers informed by GOM measures are more effective than interventions without GOM will be needed.

Implications for Practice

This tool has the potential to be very valuable for school psychologists. It may prove useful for screening, evaluation to determine eligibility for services, and progress monitoring of growth for expressive communication. Unlike many measures used with infants and toddlers, the NOS fulfills both the requirements for technical adequacy and practicality. The NOS has a number of advantages over existing communication assessment instruments designed for young children. Notable advantages are ease of use and flexibility. While data were collected using two assessors in this research, NOS is intended for use by an individual assessor. The assessor could code the child's communication using a paper-pencil format as in this study or by using a mechanical counter, or computer program on a portable computer (e.g., MOOSES; Tapp, Wehby, & Ellis, 1992). With this kind of flexibility school psychologists could easily use the instrument along with a colleague or parent in the role of play partner/assessor with psychologist recording; or alone, filling the roles of both assessor and data recorder. An additional example of flexibility is that NOS can be used to monitor the progress of children receiving a variety of

interventions while not being tied to a specific intervention or program (Deno, 1997). Although not tested with play based assessment procedures (e.g., Linder, 1990), the NOS has the potential to fit into that assessment structure without adding unduly to cost in materials or time. Future research is needed to explore this possibility.

Another advantage is that the tool has face validity for other early childhood practitioners. Early childhood educators are often concerned that standardized instruments do not accurately reflect children's skills because the tests are limited by the requirement for standardized procedures and materials that may not be compatible with children's interest and developmental levels (Bagnato & Neisworth, 1991). In contrast, the NOS is relatively naturalistic and allows children to engage in typical, age-appropriate behaviors. The key element skills (gestures, vocalizations, and single and multiple words) are components of early communication development practitioners as well as parents, would agree are important.

Finally, the resulting data are clear and easy to understand. The graphical representation of data allows parents and other early childhood educators to see how the child is performing in comparison to other children, as well as how well the child is progressing over time and in response to specific interventions. Data such as these are needed not only to understand children's progress, but also to examine the performance of programs.

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Footnotes

¹ Adapted from: The social world of children learning to talk (Hart & Risley, 1999), MacArthur Communicative Development Inventory (Fenson, et al., 1993), Kent Infant Development Scale (Reuter & Bickett, 1985), Assessment, Evaluation, and Programming System (AEPS) Measurement for birth to three years (Bricker, 1993), Communication Symbolic Behavior Scale (Wetherby & Prizant, 1993a), Preschool Language Scale-3 Family Information Form (Zimmerman, et al., 1992), and the Denver Developmental Screening Test-II (Frankenburg, et al., 1990).

Table 1

Definitions of Expressive Communication Key Skill Elements

Element	Definition
Social Attention	Sustained gaze directed toward the partner's face that appears to be intentional. An episode ends when the child looks away from the partner's face.
Gesture	Any physical movement made by the child in an attempt to communicate with the partner (e.g., showing, giving an object or toy, pushing away or rejecting a toy, reaching for a toy, pointing to a person or object, nodding or shaking his/her head to indicate 'yes' or 'no')
Vocalization	Non-word utterance voiced by the child to a partner (laughing, making animal sounds, sounds that appear to be unintelligible words).
Single Word	An utterance used in isolation (not part of a longer intelligible utterance).
Multi-Word Utterance	Intelligible utterance of two or more words understood by the coder.

Table 2

CES and NOS Rate of Total Communication Linear Parameters from HLM

GOM	Variable	Intercept at			Reliability	Slope	Slope		
		5 Months	<u>t</u>	<u>p</u>			<u>t</u>	<u>p</u>	Reliability
CES	<u>M</u>	7.59	11.98	0.0001	0.79	0.54	3.7	0.001	0.30
	<u>SD</u>	4.01				0.57			
	<u>Range</u>	0.78-19.76				-1.13-3.16			
	<u>SE</u>	0.63				0.15			
NOS	<u>M</u>	8.14	11.22	0.0001	0.84	0.75	4.41	0.0001	0.51
	<u>SD</u>	4.74				0.86			
	<u>Range</u>	0.98-19.45				-1.86-3.18			
	<u>SE</u>	0.73				0.17			

Note. Abbreviations are: GOM = General Outcome Measure, CES = Communication Evoking Situations, NOS = Naturalistic Observation Situation, M = Mean, SD = Standard Deviation, SE = Standard Error of Estimate, HLM = Hierarchical Linear Modeling; Centered at the Fifth Monthly Measurement

Table 3

Odd-Even Split-Half Reliability for CES and NOS Rate of Total Communication Using Only Children with 9 Measurement (n = 25)

GOM	Parameter	Variable	Odd	Even	t	p	Pearson Correlation	Spearman Correction
CES	Intercept at 5 Months	<u>M</u>	9.47	10.52	-1.38	0.184	0.71****	0.83
		<u>SD</u>	4.66	4.49				
		<u>SE</u>	1.02	0.98				
	Slope	<u>M</u>	0.78	0.96	-0.71	0.487	0.52*	0.68
		<u>SD</u>	1.01	1.27				
		<u>SE</u>	0.22	0.28				
NOS	Intercept at 5 Months	<u>M</u>	9.88	9.82	0.08	0.941	0.80****	0.89
		<u>SD</u>	4.74	5.35				
		<u>SE</u>	0.97	1.09				
	Slope	<u>M</u>	0.93	0.83	0.65	0.522	0.45*	0.62
		<u>SD</u>	0.67	0.77				
		<u>SE</u>	0.14	0.16				

Note. Abbreviations are: GOM = General Outcome Measure, CES = Communication Evoking Situations, NOS = Naturalistic Observation Situation, Centered at Month 5

*p < .02, **p < .01, ***p < .005, ****p < .001

Table 4

Experimental GOMs Criterion Reliability for Total Rate of Communication

Variables	CES intercept	CES slope	NOS intercept	NOS slope	CCM Wave 1	PLS-3 Wave 1
CES intercept	1.00	.319*	.865**	.331*	.506**	.591**
CES slope		1.00	.210	.584**	.018	-.015
NOS intercept			1.00	.392**	.556*	.617**
NOS slope				1.00	.104	.082
CCM Wave 1					1.00	.924**
PLS-3 Wave 1						1.00

*p < .05, **p < .01

Figure Captions

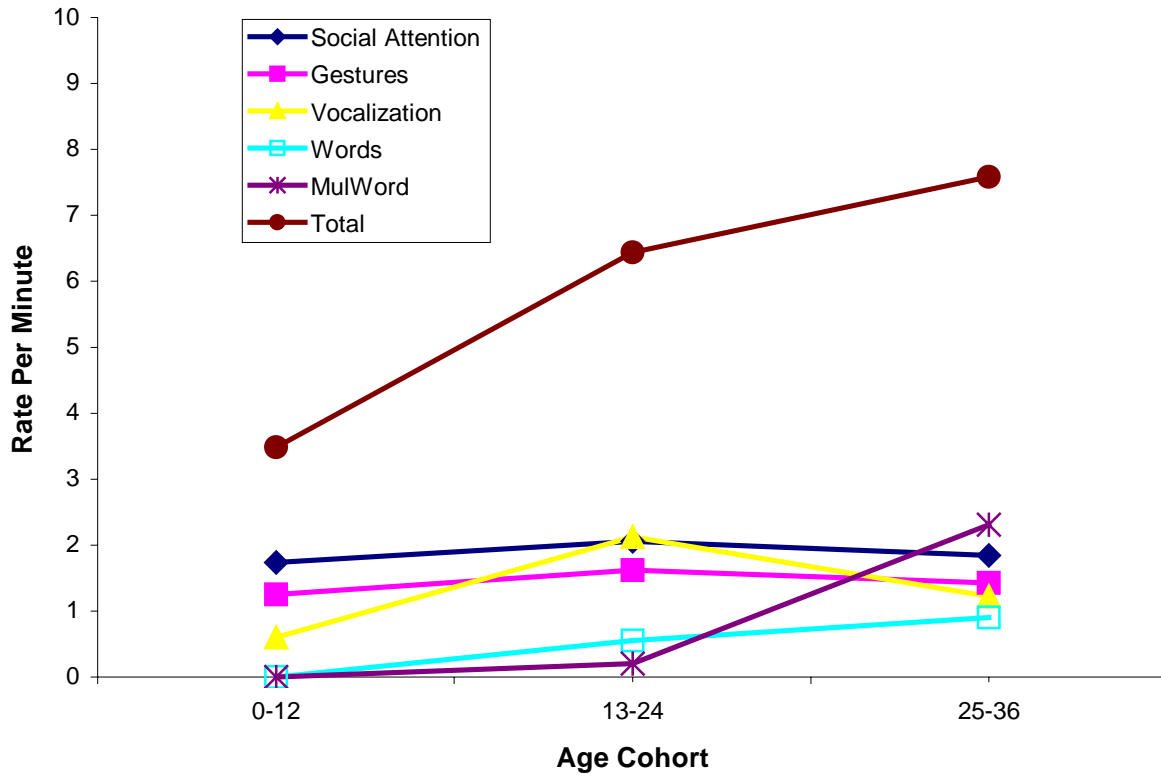
Figure 1. Rates of total expressive communication and key skill elements over three age cohorts for the CES (upper panel) and NOS (lower panel) in Study I.

Figure 2. Fitted linear NOS growth trajectories for key skill elements (gestures, vocalizations, single word, and multiple word utterances) by age cohorts (0-12 months of age - upper panel, 13-24 months of age -middle panel, and 25-36+ years of age -lower panel) in Study II.

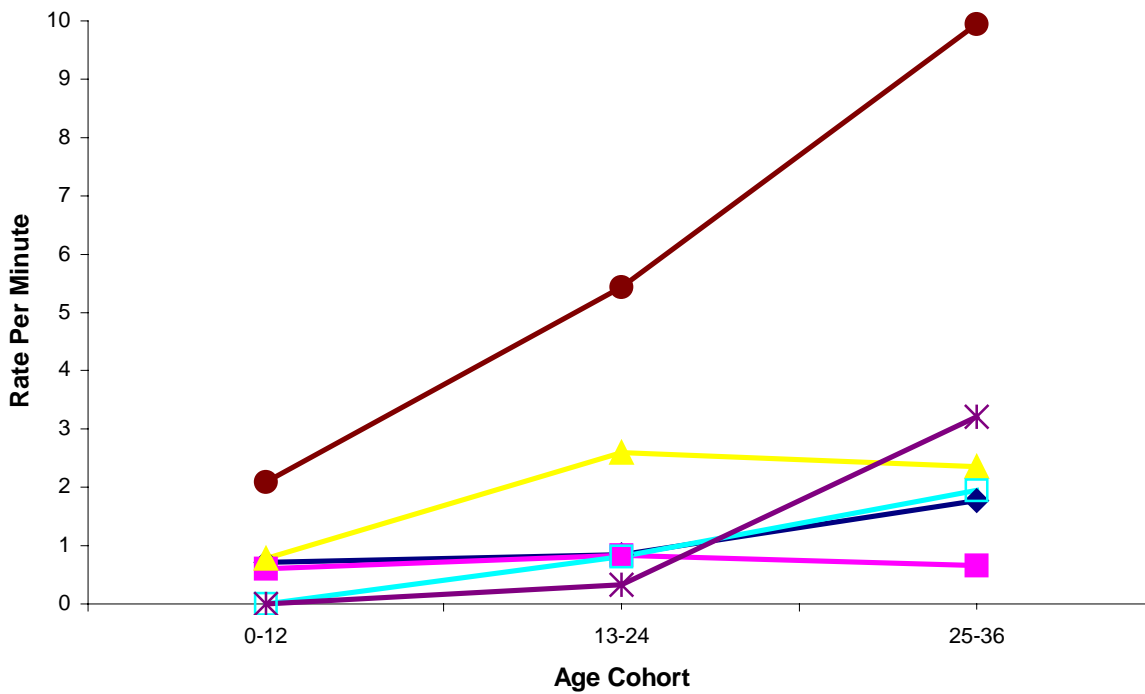
Figure 3. Fitted linear NOS growth trajectories for rate of total expressive communication by age cohorts (upper panel), and disability status (lower panel) in Study II.

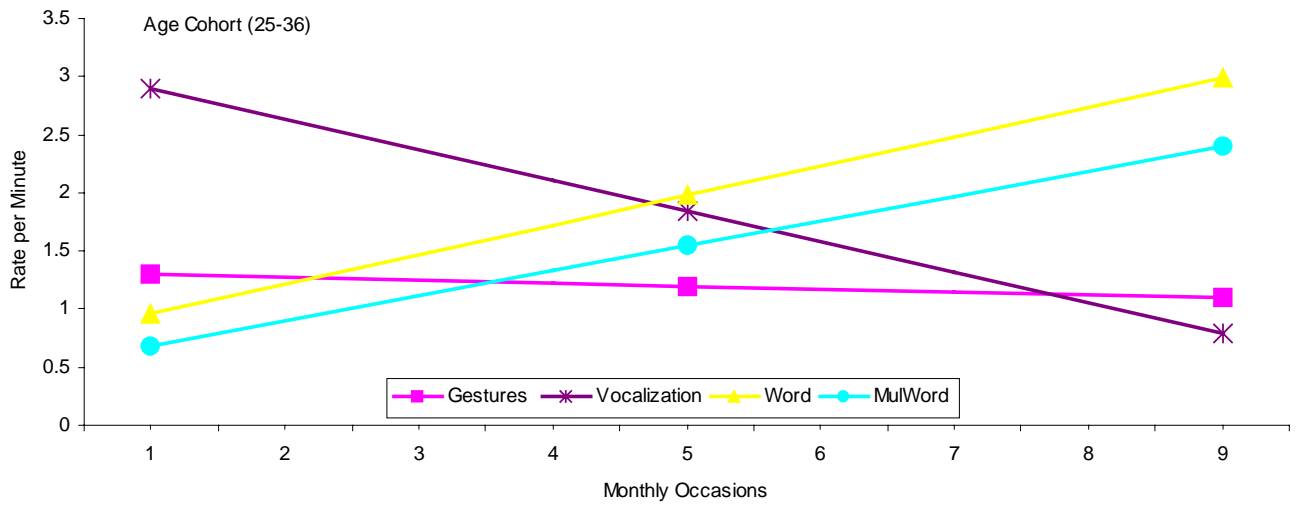
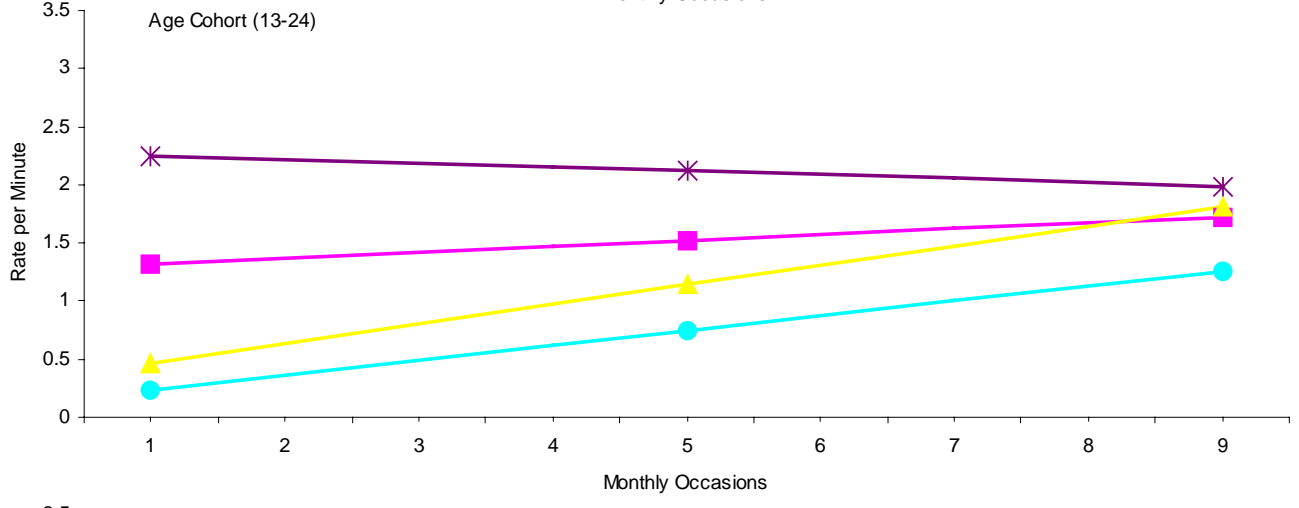
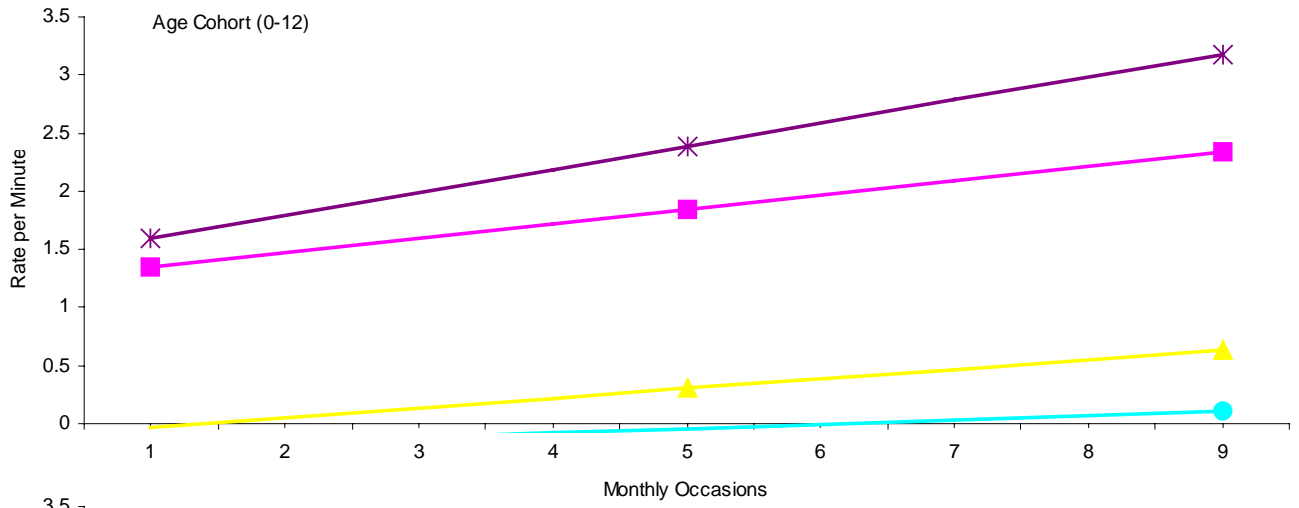
Figure 4. Fitted linear NOS growth trajectory for rate of total expressive communication by age cohorts (upper panel) and plotted from 1 to 38 months of age at time of measurement (lower panel) in Study II.

CES



NOS





■ Gestures
 ✱ Vocalization
 ▲ Word
 ● MulWord

