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Research Article

Effects of the growth of breath capacities on *mean length of utterances*: How maturing production processes influence indices of language development

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ABSTRACT

Measures of "mean length of utterance" (MLU) involving morpheme counts in transcripts are widely applied to speakers of all ages and are generally interpreted as an index of developing grammar. Yet no study has examined how the growth of respiratory capacities influences MLU and numbers of forms in utterances. We review longstanding problems of MLU counts and investigate the effects of growing breath capacities using speech samples and measures of vital capacity (VC) of 50 speakers aged 5 to 27 years. The results show that VC correlates strongly with MLU, which associates with rising numbers of long lexemes. This suggests that, in normal development, the growth of VC offers the possibility of producing increasingly long utterances that can influence lexical diversity. Hence, interpreting MLU and co-varying indices of lexical development requires a consideration of the effects of maturing production processes in a perspective where developing speech and language are seen to intertwine.

1. Introduction

The development of oral language presents several milestones where emerging behaviors clearly intertwine with maturational changes in production processes. One remarkable example of this is the emergence of babble. Research has shown that infants are nasal breathers and produce nasalized vocalizations early in life (e.g., Thom et al., 2006). By six to ten months, however, supraglottal structures have undergone several changes including a decoupling of the naso-pharynx, and these changes which accompany a rise in rhythmic behavior lead to oral vocalizations and babble (Iverson et al., 2007; Kent, 1984; Oller, 1986, 2000; van der Stelt & Koopmans-van Beinum, 1986). In interpreting such development, one should not view the growth of production processes as *causing* the rise of babbling. In fact, several factors can influence the course of emerging speech. For instance, babbling is typically delayed in hearing-impaired children (Oller & Eilers, 1988), indicating that sensory stimulation is a factor. Nonetheless, maturational changes in production processes – not the development of hearing – basically account for the emergence of babble at 6–8 months. In other words, one can see that, in normal development, the growth of production structures is a *necessary* though not *sufficient* factor in explaining the rise of babbling at a given age.

Examples such as these illustrate the point that, in building an understanding of the time course of language development, one must consider not only the perceptual and cognitive abilities of children but also maturational changes in speech processes. This not only relates to changes in supraglottal structures that contribute to the rise of canonical and variegated babbling. Observing subglottal processes is also important since the growth of such aspects as respiratory capacities may well influence the length of utterances and the number of verbal forms they contain. Yet, such effects are most often overlooked in developmental linguistics, as illustrated in conventional measures of utterances. In particular, measures of "mean length of utterance" (MLU) involving counts of morphemes in

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transcripts of spontaneous speech are generally taken to reflect developing grammar – irrespective of the growth of speakers' breath capacities. In fact, following the work of Brown (1973), MLU has become a standard index, often used with other tests (see, e.g., Jalilevand & Ebrahimipour, 2014). In proposing this index, Brown referred extensively to linguistic theory (Chomsky, 1957, 1967/2006) and saw language as a "competence", an ability to combine syntactic elements separate from speech "performance". Accepting this division, the basic assumption underlying MLU is that, since many aspects of developing syntax imply additions of elements in utterances, counting MLUs in morphemes captures a "cumulative complexity", taken to reflect "knowledge" (see Brown, 1973, pp. 53, 173). Such interpretation overlooks the potential effects of the growth of breathing volumes on MLU, perhaps because of the idea that structures of performance have little to do with numbers of morphemes in utterances. However, it should be noted that morpheme counts of MLU strongly correlate with numbers of syllables and "words" (at $r = .91–.99$: Arlman-Rupp, van Niekerk de Haan, & van de Sandt-Koenderman, 1976; Ekmekci, 1982; see also Hickey, 1991; Parker & Brorson, 2005; Rom & Leonard, 1990). Because syllables reflect modulations of air pressure, it seems likely that MLU would vary with speakers' growing breath capacities and that this would impact any unit count of MLU. Yet, no study has examined these potential effects.

As a possible explanation of this oversight, one should note that, originally, Brown's index was limited to toddlers with MLUs of no more than four morphemes ("Stage V"), which normally appears at about 40 months (Miller & Chapman, 1981). At this young age, children are often unable to execute the maneuvers of standard measures requiring maximal respiratory effort (Desmond et al., 1997; Merkus, de Jongste, & Stocks, 2005) so effects of developing breath capacities on MLU are difficult to assess. However, applications of MLU currently extend to all ages (e.g., Behrens, 2006; Charness, Park, & Sabel, 2001; Justice et al., 2013; Miles, Chapman, & Sindberg, 2006; Rice, Smolik, & Perpich, 2010; Rondal & Comblain, 1996; van de Weijer, 1998). Hence, the validity of interpreting MLU as indexing knowledge separate from the growth of respiratory capacities can be evaluated. In this context, the present study examines how the growth of breath capacities can contribute to a developmental increase in MLU and the number of verbal units in utterances. These relationships can be clarified by using measures of MLU where "utterances" are seen as observable breath units of speech. This idea is not always accepted in the literature where MLU counts are often performed by reference to notions of *sentences*. On this point, the following discussion exposes some longstanding problems of Brown's MLU so as to clarify our measures and the relevance of data suggesting several effects of the growth of breath capacities on the length of utterances and the number of units they contain.

2. Measuring utterance length and effects of growing breath capacities

2.1. Defining utterances

Most studies that report MLUs follow the guidelines of Brown (1973, p. 54) who recommended that MLU be measured from 100 utterances of spontaneous speech using rules of morpheme count (for slightly different rules, see Johnston, 2001; Miller & Chapman, 2004; Miller & Iglesias, 2008; for varying sample sizes, see Gavin & Giles, 1996; Heilmann, Miller, & Nockerts, 2010; Hewitt et al., 2005; Klee, 1992; Rondal & Defays, 1978). However, it is important to note that Brown never defined the utterance. This problem of definition prevails in that available guidelines refer to conflicting criteria of utterance division leading to a lack of reliability in MLU, as several authors have remarked (Chabon, Kent-Udolf, & Egolf, 1982; DeThorne, Johnson, & Loeb, 2005; Eisenberg, Fersko, & Lundgren, 2001; Klee & Fitzgerald, 1985; Reed, MacMillan, & McLeod, 2001; Rice, Redmond, & Hoffman, 2006; Rollins, 1995; Rondal, Ghiotto, Bredart, & Bachelet, 1987). The difficulty essentially stems from the use of two differing concepts of the utterance present in the literature. The first concept is found in phonetic studies. In this work, an "utterance" is traditionally seen as a unit of speech or vocalization delimited by inspirations and bearing a declination in intensity and F0 (for a list of authors who use this definition, see Vaissière, 1983). The second concept appears in linguistics, where authors often attempt to divide utterances in terms of assumed "sentences" and "clauses". Both the above concepts are variably used in performing MLU counts, which points to a problem of validity. This can best be illustrated in terms of the characteristic shift in concepts that appears in developmental studies.

As an example of the application of the phonetic concept of utterance, Oller et al. (Oller et al., 1985; Oller & Lynch, 1992; see also Oller, 2000) reported syllable counts of MLU for babbling infants. In this case, utterances were taken as units bordered by breath noise and showing integrity in tone and amplitude (Oller & Lynch, 1992, p. 525). A more recent illustration is Fagan (2009) who also refers to utterances as breath units in observing the development of vocalization in infants. These applications differ from linguistic analyses of older children where another notion of utterance is applied that refers to grammar. A representative example is Miller and Chapman (2004) who prescribe that "When you segment the stream of speech into utterances you will use such cues as intonation, pausing, *and grammatical structure* to determine where one utterance ends and the next begins" (added emphasis).

In reasoning this shift in definition, it is not that utterances as breath units change. Obviously, speakers, young and old, keep producing breath units in speech. What changes is that, at some point when children begin to produce speech that is interpretable by an adult observer, utterances are divided by reference to notions of sentences. However, this shift from an objective division of utterances based on breath marks to one based on interpretations of grammatical units entails two questionable presumptions. The first is that utterances are *grammatical* units when, in fact, children vocalize and babble in breath-divided units well before they produce any discernible grammar. In other words, the shift implies a disregard of the *nature* of utterance-size chunks in speech. The