Is children's laughter related to their language development?

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This paper aims at studying the acoustic development of child's laughter and its relation to language acquisition. To our knowledge, the first study dealing with the acoustic proprieties of laughter is due to Habermann (1955). In this work, the author provided anemographic data and defines laughter as a reflex-phenomenon with expiratory movements stopped by aspiratory pulses. Luchsinger and Arnold (1965) completed these findings using ultra-rapid imagery. They showed that laughter is characterized by a larynx in low position with expanded resonance cavities. As for its acoustic dimension, Trouvain (2003) defines laughter as a pattern of alternating non-voiced and voiced similar to a consonant-vowel syllable structure. Indeed, in the literature, laughter is often described along two segmental levels: a lower level, consisting of units that can be treated as consonants and vowels and a higher level that would be equivalent to the syllable (Bickley & Hunnicutt, 1992; Rothgänger *et al*., 1998; Apte, 1983; Provine, 1993, 2003; Savithri, 2000). Unfortunately, very few studies were conducted on children's laughter (Nwokah et al., 1999; Mowrer, 1998; Tennis, 2009), while it first appears at about 4 months of age (Sroufe et Waters, 1976).

Our question can be formulated as follows: in laughter what is the part of physiology and what comes from linguistic development? We hypothesized that some acoustic characteristics of laughter are linked, on the one hand, with some physiological characteristics and, on the other hand, with speech properties. Thus, a study comparing laughter produced by congenitally deaf speakers and normally hearing speakers showed similar acoustical properties, which is consistent with the fact that laughter is established by human biology (Makagon et al., 1998). In terms of physiological changes, movements of the larynx, jaw and tongue are known to affect children's vocal repertoire, especially *f*o (Vihman, 1996; MacNeilage, 1998). Menard & Thibeault (2009) have shown that there were similarities and differences between children and adults as for prosodic representations. These differences in *f*o and amplitude of the voice can be linked to developmental movements of the larynx, glottal articulators being mastered earlier than supraglottal articulators. In terms of linguistic development, we know after Hallyday (1975) that syntax – which emerges gradually between 18 and 36 months – may affect the duration of laughter. The emergence of phonemes is also progressive and goes on, for French, until 48 months (Rondal, 1990). The production of certain segments in speech (such as open or closed vowel, oral or nasal sounds, occlusive or fricative consonants) may also be found in laughter. Therefore, we postulate that laughter segmental and supra segmental characteristics, measured trough the evolution of *f*o, the number of syllables and the nature of articulated sounds, will evolve along with physiological and linguistic development.

We used longitudinal data of three native French children (recorded from 18 to 36 months). Children were videotaped in natural interactions with their parents, so that their speech, moves and laughs were spontaneous and not artificially elicited in laboratory. Recordings are part of the Paris corpus, available on the CHILDES database. In order to establish the degree of linguistic development of each child, we measured their Mean Length of Utterances (M.L.U., Brown, 1973). The subject's fundamental frequency (*f*o) was calculated using an autocorrelation-based technique (Boersma, 1993). We performed acoustic analyses on 11 different parameters: total duration, proportion of voicing, fundamental frequency (mean *f*o, max. *f*o, min. *f*o, initial *f*o, final *f*o, max.-min. *f*o in semi-tones), number of syllables, number of phonemes and relative intensity. Then we determined the melodic type of each laugh. Statistical analyses were conducted with these 11 parameters, 3 subjects and 40 laughter series per subject (n= 120). We calculated ANOVAs for each dependant variable to determine if they could vary in function of several factors (i.e. age, M.L.U and/or subject).

Results showed that among the 11 acoustic parameters we investigated, only the relative intensity increased significantly with age ($F_{(1,118)=}$2,78, p< .05). This is probably due to the progressive maturation of the subglottic and glottic mechanisms. Indeed, during the development, *f*o and intensity are controlled before the supraglottic mechanisms (Vihman, 1996). Moreover, we noticed that laughs were produced with a large majority of rise-fall *f*o contours (60 % of all contours) and that their amount increases with age. This is in contradiction with the results of Savithri (2000) who showed that the most frequent *f*o contour in adults is a

falling one. It seems that melodic configuration of laughter differs for children and adults. We also noticed a great inter-individual variability between children, which had already been observed in adults (Rothgänger et al., 1998). Ongoing analysis of the other parameters (i.e. duration of laughter, number of phonemes and formant structure of laughter) will show their (co)relation with MLU. We expect to observe an evolution of laughter as function of speech development. Statistical analysis and final results will be presented at the Workshop.

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