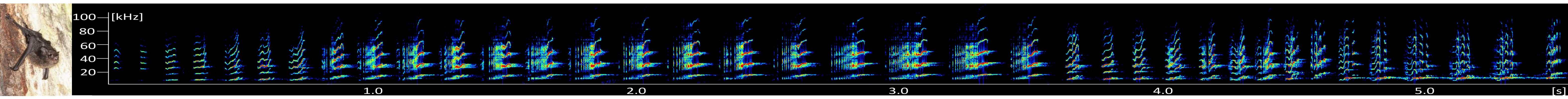


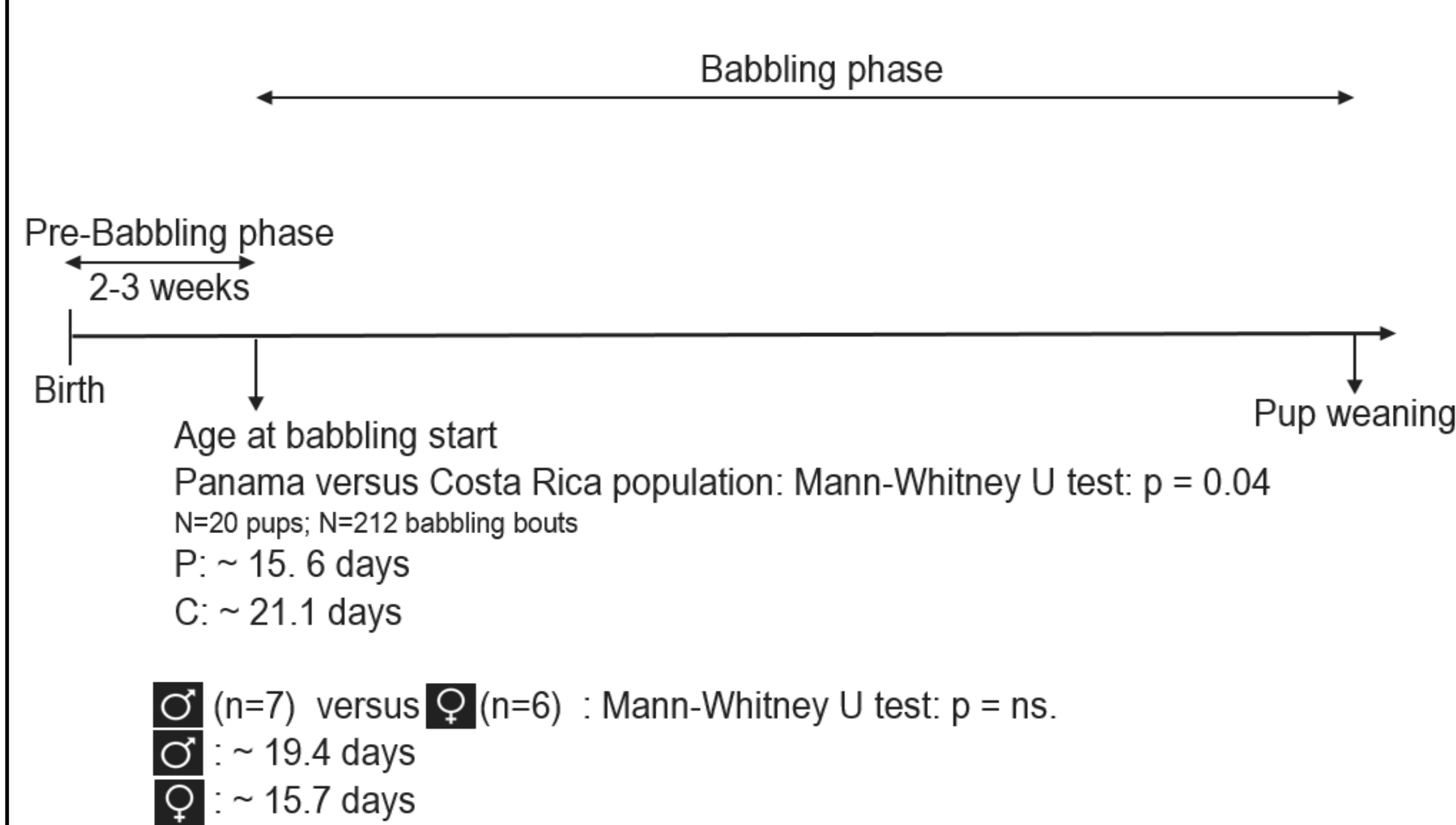
# Babbling bat pups and human infants: common features in the babbling behaviour of vocal learners



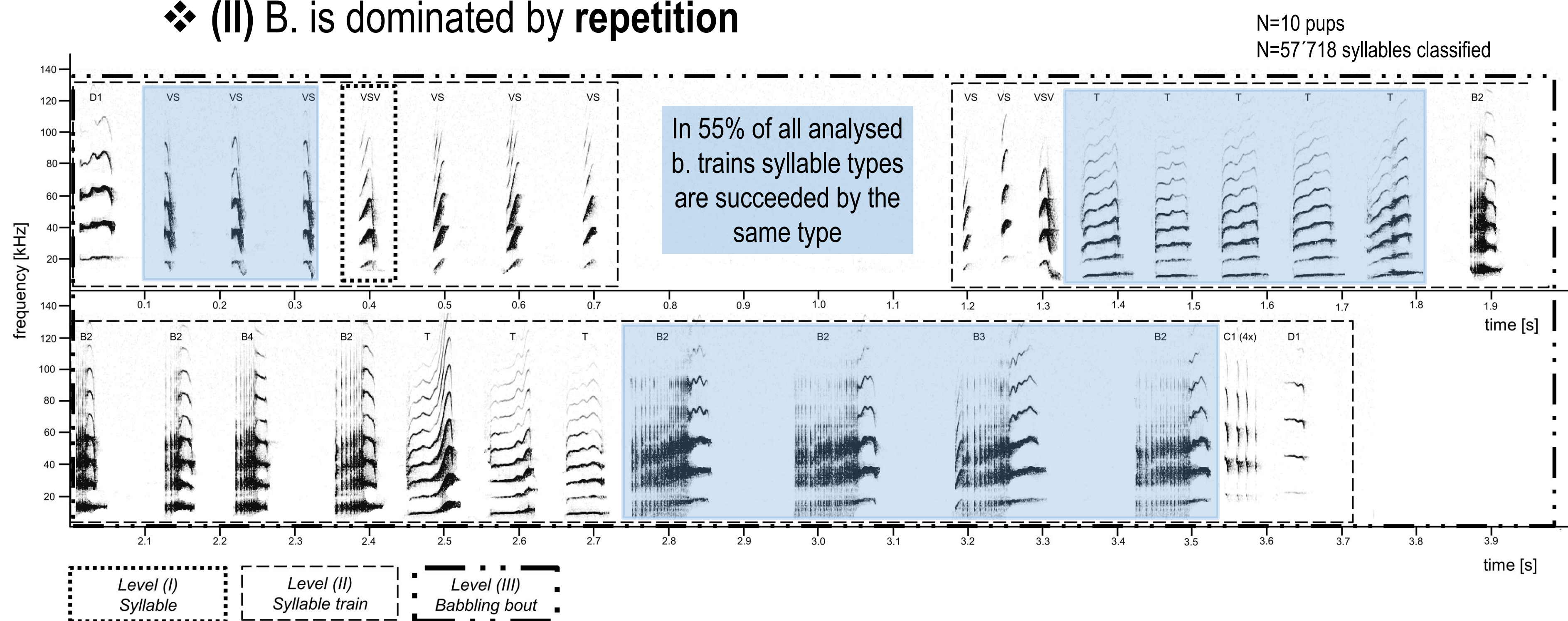
## Are there shared common features in infant canonical babbling and pup babbling of the bat *Saccopteryx bilineata*?

Canonical babbling is considered to be a crucial step during early language acquisition in human infants<sup>1,2</sup>. So far, vocal repertoire ontogeny reminiscent of canonical babbling has only been described in songbirds (plastic song) and certain primates<sup>3-5</sup>. *Saccopteryx bilineata* exhibits a complex vocal repertoire which is acquired by pups through a conspicuous babbling phase. We hypothesized that babbling is a critical developmental stage for acquiring a complex vocal repertoire. Thus, babbling should be characterized by the same universal features (I-VIII) shared among infant canonical babbling and bat pup babbling.

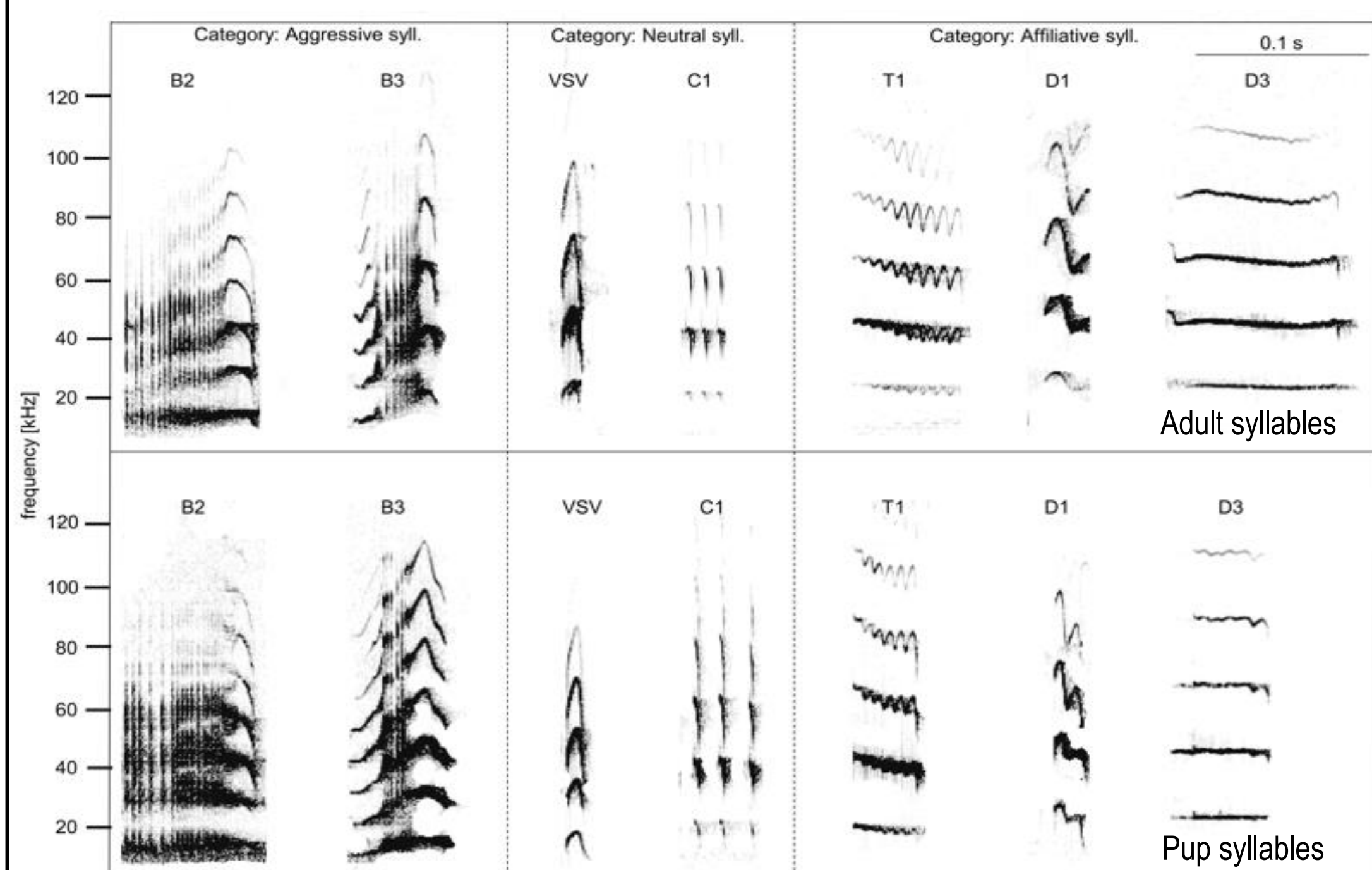
### ❖ (I) Babbling (B.) starts early during ontogeny



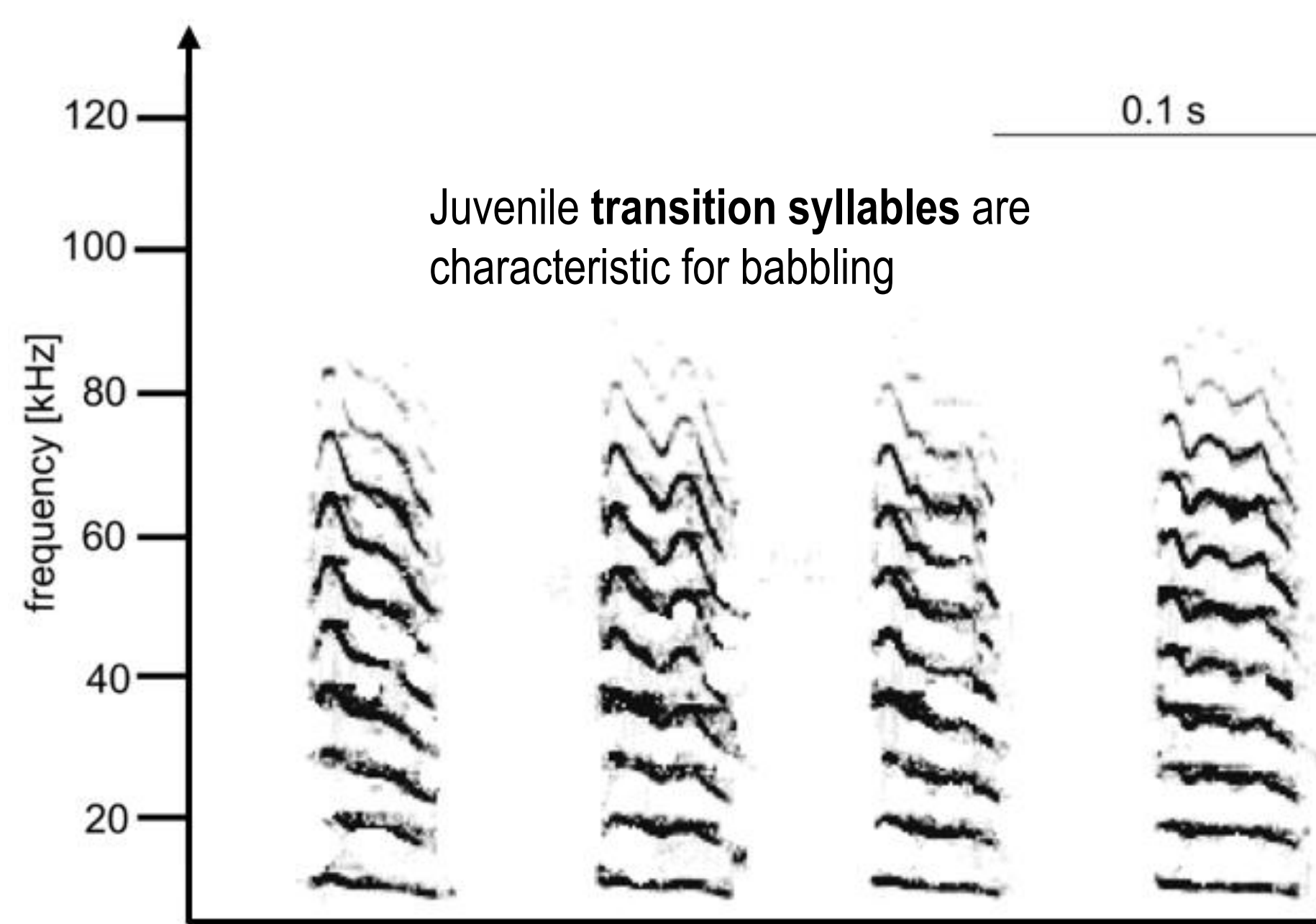
### ❖ (II) B. is dominated by repetition



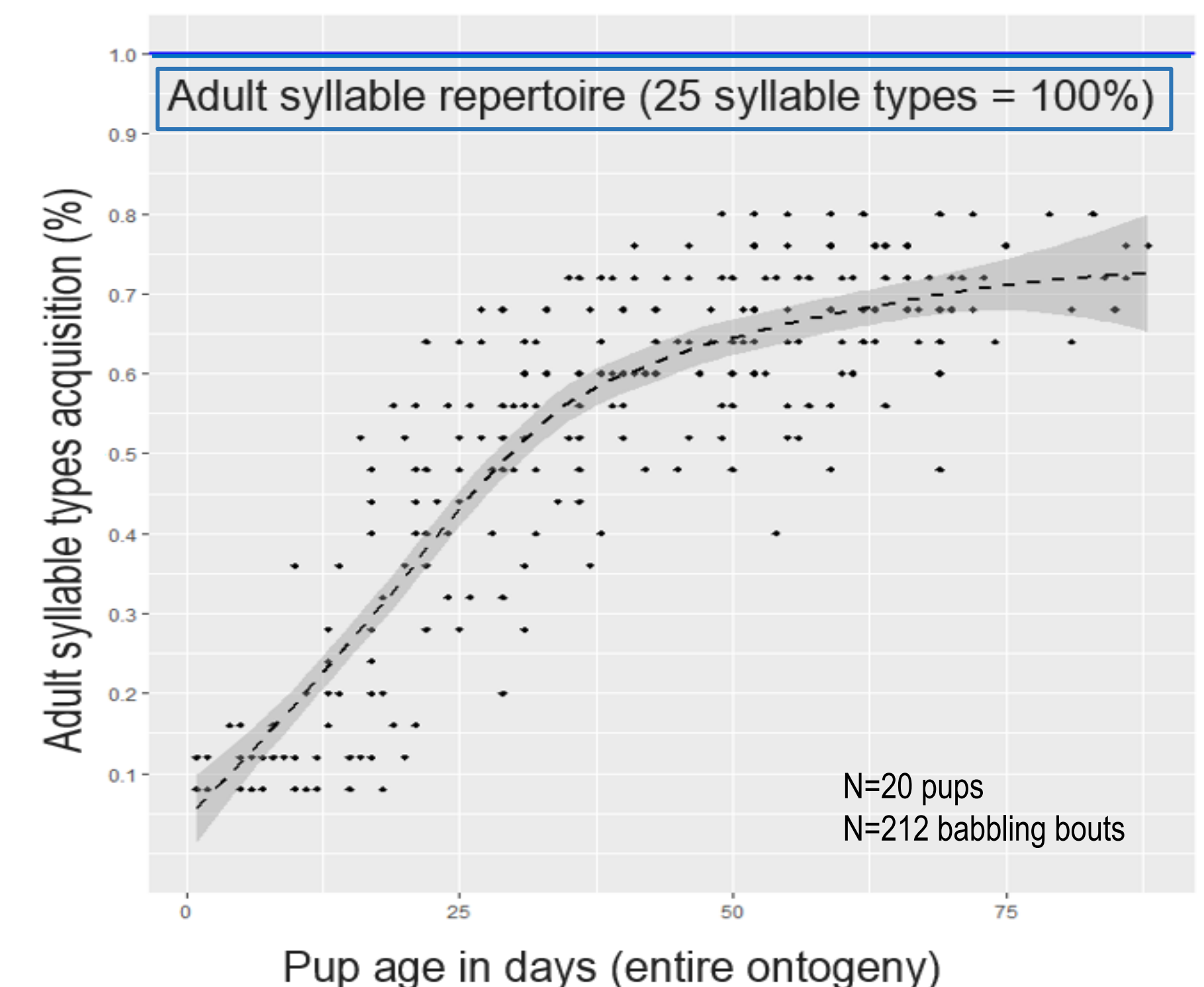
### ❖ (III) B. is composed of adult syllable types and juvenile transition syllables



### ❖ (IV) Vocal overproduction (i.e. transition syllables are not part of adult repertoire)



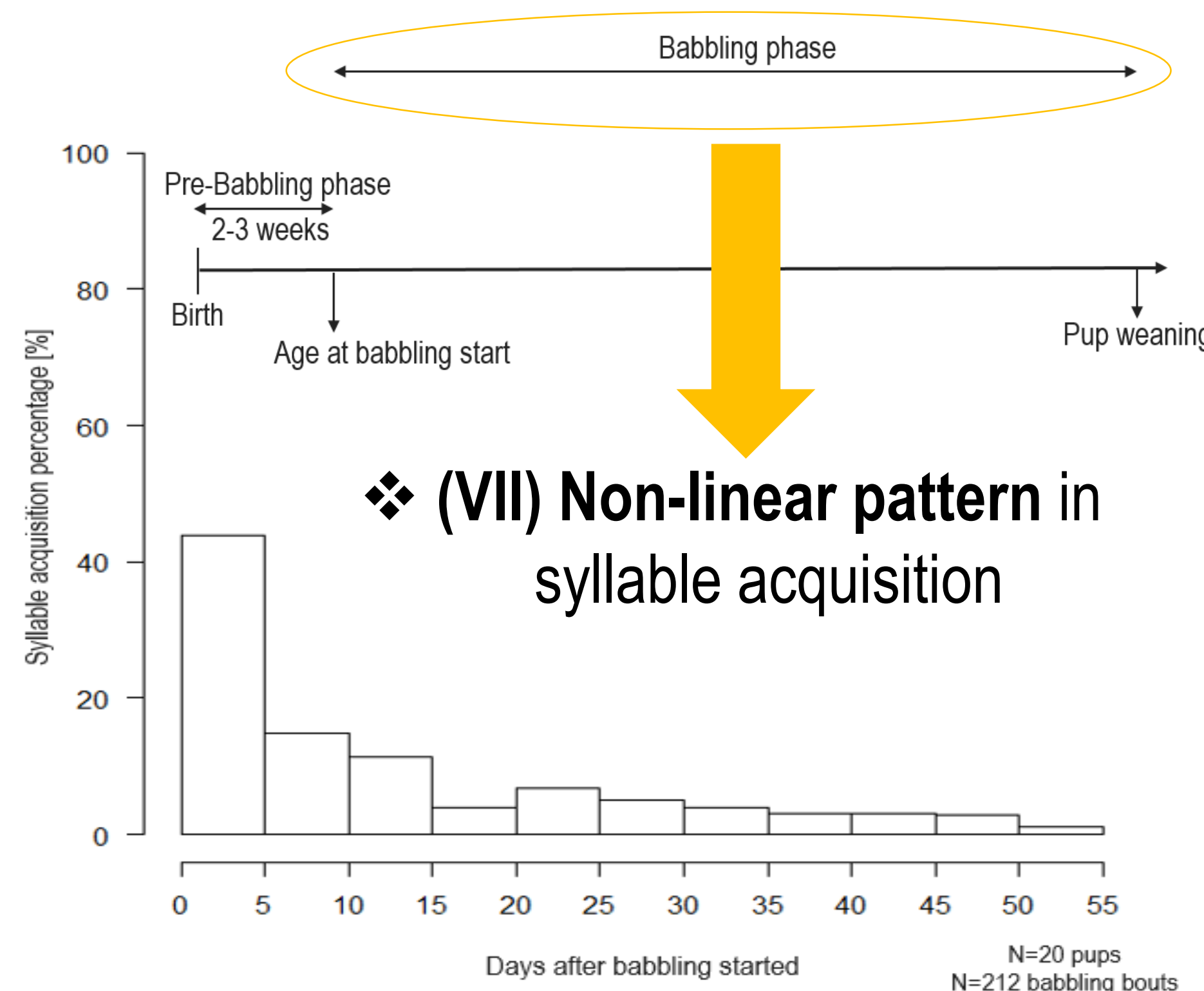
### ❖ (V) Acquisition of a subset of the adult repertoire



### ❖ (VI) Meaninglessness

- Juxtaposition of syllables not consistent with typical pattern found in adult vocalizations / calls
- Lack of typical context of syllable types in babbling bouts in terms of how and when adults use the same syllable type

### ❖ (VII) Non-linear pattern in syllable acquisition



### ❖ (VIII) Universality

Babbling features	Panama N=10 pups	Costa Rica N=10 pups	♂ N=7	♀ N=6
Early in ontogeny				
Repertoire subset	TRUE	TRUE	TRUE	
Vocal overproduction	TRUE	TRUE	TRUE	TRUE
Adult syllable types	TRUE	TRUE	TRUE	TRUE
Repetitiveness	TRUE	TRUE	TRUE	TRUE
Non-linear acquisition	TRUE	TRUE	TRUE	TRUE
Age at babbling start	P. starts significantly earlier		no difference	
Babbling phase duration	no difference		no difference	
Repertoire size	no difference		no difference	

**Conclusion:** By now, besides humans, *S. bilineata* is the only mammalian species capable of true vocal imitation and simultaneously going through a conspicuous babbling phase. The babbling behaviour in *S. bilineata* is characterized by the same main features describing the so called canonical babbling phase in human children. These facts render this bat species very promising for **further comparative biolinguistic research**.

**Methods:** Vocal recordings & behavioural monitoring (ad lib.) throughout ontogeny during two consecutive field seasons (2015/16)

N=20 pups; 2 genetically different populations (Panama & Costa Rica); 8 colonies.

» Classification of subset of pup syllable repertoire: N=10 pups, 5 colonies, acoustic parameter measurements of 528 syllables, DFA's for syllable types

» Annotation of syllable sequences (N = 57'718 syllables) for calculation of repetitiveness

» Annotation of babbling bouts (N=212 babbling bouts) for calculation of accumulation curves, acquisition pattern, universality features