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ABSTRACT

A discussion of the biological and developmental issues in early second language learning first looks at psycholinguistic research on brain growth patterns and the relationship of first and second language learning. Focus is on three phenomena observed in the self-organization of living systems: selection of input data; organization of specialized systems; and the different states that order systems assume in the course of development. Psycho- and pragmalinguistic data suggest that additional languages develop and dissociate with varying intensity and speed depending on: (1) the biological, cognitive, linguistic, and emotional conditions of the individual child and (2) the onset and efficiency of the second language program. Examples of instances of early second language development illustrate the processes and stages of pattern generation in the individual linguistic domains and provide guidelines for assessment of language development. The role of input is then explored, particularly the variety of cues teachers might use to stimulate age-specific dispositions and to facilitate pattern formation. Special attention is given to variation within a single classroom. The impact of deficient input is also discussed. It is concluded that the natural approach to language learning is most appropriate developmentally. Contains 38 references. (MSE)

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EARLY FOREIGN LANGUAGE LEARNING: THE BIOLOGICAL PERSPECTIVE

by

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Summary

Early foreign language learning:
the biological perspective

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This paper draws on biological theories and developmental linguistics in an attempt to show that the dynamics already recognized as existing in other natural systems is likewise to be found in second language development too. The first part on key-issues of current psycholinguistic research provides a cross-correlation of first and second language development alongside with a discussion of brain growth spurts. The focus is set on three phenomena observed in the self-organization of living systems: the selection of input data, the organization of specialized systems and the different states of order systems assume in the course of development.

Psycho- and pragmalinguistic data suggest that additional languages develop and dissociate with varying intensity and speed depending on (1) the biological, cognitive, linguistic and emotional conditions of the individual child and (2) the onset and efficiency of the second language programme. Samples from various instances of early second language development illustrate the processes and stages of pattern generation in the individual linguistic domains and provide guidelines for the assessment of language development.

The final part turns upon the role of the input; particularly on the variety of cues teachers might employ to stimulate age-specific dispositions and to ease pattern-formation. Special emphasis is given to individual variation within one classroom.

The discussion of the impact of deficient input (experienced in the shortage and imperfection of linguistic data) on the development of a second language might answer some of the pending questions in the long-standing debate about the effectiveness of modern language learning and teaching. In a comparison of second language development within various programmes the medal clearly goes to a natural approach.

Early foreign language learning: the biological perspective

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0. Introduction

The study of language development has very much to do with our understanding of how human beings (and human brains) perceive, learn, control and coordinate complex behaviour. It comes therefore as no surprise that the study of early language development should involve an array of research on motor, perceptual and cognitive development. In fact, a cross-disciplinary approach is obligatory with young learners who largely depend on multimodal experiences and social/emotional embedding. In view of these demands we shall discuss recent advances in the field.

Psycho- and pragmalinguistic reports on second language development abound in data on the development of linguistic systems and communication. World-wide efforts have been taken to trace developmental sequences and natural orders in the emergence of patterns (see Larsen-Freeman and Long 1991, Kettemann and Wieden 1993, Ellis 1994). There is, however, surprisingly little to be found on biological matters. Since the development of cognition and hence of language(s) depends on the functional capacity of the underlying neuronal circuitry the issue of brain development will be given a more detailed discussion in this paper. The argumentation is based on the experience (psycholinguistic tests and pragmalinguistic analyses) gained from a longitudinal study of bilingual schooling (from the age of 6, in a multicultural setting) and one year of pre-school English (from the age of 4) plus two projects on very early language development (from 12 months) and language development in hearing and seeing, deaf, hearing impaired and blind children (from age 4) (see Peltzer-Karpf and Neumann 1994, Peltzer-Karpf 1994, Peltzer-Karpf et al. 1995, 1996).

1. First/second language development

Second language development has become a veritable hotbed for the study of language development at large. The reasons are obvious: the processes active in the organization of a new language provide excellent information about how language works. Furthermore, the advanced cognitive state allows for psycholinguistic tests and group studies. In comparison with the assessment of language development in infants the technical equipment can be kept minimal. The main differences between first and second language development to be taken into account are:

(1) the state of neuronal development
(2) age-specific cognitive capacities
(3) the system of the second language
(4) the input (quality/quantity/duration of contact)
(5) personal factors (motivation, social integration).

To what extent these factors influence the speed, the scope and the accuracy of second language development will be discussed in due course. First and foremost we should bear in mind that there are principles common to all instances of language development which are determined by our species-specific information processing. Decades of research have shown that acquisition is gradual, with each stage building on its predecessor(s) (Piaget 1959), and that the order of stages is the same for all children, allowing for individual variation (Grammont 1902, Stern 1914, Guillaume 1927, Wells 1986, Slobin 1975, Bates et al. 1988, Fletcher and Mac Whinney 1995). We may thus assume that first and second language development will essentially follow the same pattern.

True to our topic we will briefly sketch the stages of linguistic development in the first language up to the age of six; the respective neurobiological conditions will be delineated in the next chapter. The ensuing discussion will show that some of the processes enumerated below are mirrored in incipient second language development too. For a better orientation we give the complete charts of system-specific development. Reservations to

these lists should be made, however, for prespeech behaviour (except for bilingualism in infancy), the percolation of the early stages of phonological development, the perceptual predecessors to the formation of concepts and the basic processes of pattern-formation:

1.1 Communicative development

Proto-communication: smiles, baby/mother watching, extended visual contact, synchronous movements and vocalizations
from 3 months: first united actions; parents act both parts, turn-taking, smiling indicates awareness of objects
from 2 years: first discussions, due to short memory span and fluctuating concentration frequent change of topic
from 3 years: greater variety of topics, reduction of misunderstandings, still some lack of partner-orientation
from 4 years: real dialogues, immediate answers/reactions, regular patterning of different expressive states.

1.2 Phonological development

0-4 weeks: crying; prelinguistic vocalization and perception
4-6 weeks: differentiated crying
2-4 months: cooing, crying decreases
5-6 months: babbling, reduplications CVCV [dada]
6-12 months: phonetically consistent forms, *proto words*, patterned speech begins, CVC/VCV [mem/aga] intonation
1-2 years: expansion of sound inventory, clusters *up to*
6 years: completion of phonetic inventory (sibilants/liquids), extension of word length, production in all positions.

1.3 Morpho-syntactic development

9-18 months: first words embedded in babbling, one word sentences
18-30 months: combinations of 2-2.5 words, copying of chunks, intonation replaces syntax, semantic roles: existence, action/

agent, possession, localization; attributes; early word-formation (compounding, agentive derivation)
3 years: increasing length and complexity of sentences (conjoining/embedding), use of function words, morphological agreement
up to 6 years: basic syntactic and morphological processes.

1.4 Lexical development

6-10 months: understanding restricted to specific contexts, non-verbal signs (body-language)
12 months: first words, symbolization (relation object/word)
15-18 months: extension of focus; short, concrete words
2-3 years: categorization (prototypes); over-generalization. Concrete nouns predominate, followed by verbs denoting movement, adjectives denoting external features and prepositions for spatial concepts.
3 years: pace accelerates dramatically*, naming explosion; generalization (transfer of prototypical features). Comprehension of pronouns starts around 2.5 years, production at about 3 years
4-5 years: superordinate and subordinate terms (animal/poodle)

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* vocabulary growth in childhood: estimated 2.700 words/year

Summing up we can say that the given competence at the age of onset will determine all further linguistic activities. The following chapter will deal with the reasons for the regularity of these system-specific schedules (for further information see Clark 1993, Peltzer-Karpf 1994, Fletcher and MacWhinney 1995).

2. A brief of neuronal devlopment

A discussion of early second language development neglecting neural development would be lopsided and miss out on useful information. What is of special interest here are the complementary roles of maturational factors and experience in forming specialized systems (chapters 3-5 will provide an extensive discussion of this interplay).

Brain development can be described as a series of growth spurts. These spurts are determined by brain activity/metabolism, head growth/brain weight (335g at birth, 750g at 9 months, 1200g-1600g at 3 years) and synaptic density (engendering neuronal connections). In the given context we discard prenatal development and shall concentrate on the basic cellular events that underlie the postnatal development of the cortex (for details see Brown, Hopkins and Keynes 1991, Dawson and Fischer 1994, Rakic 1995).

Quantitative data on the course of postnatal synaptogenesis in the cerebral cortex are particularly relevant to the ontogeny of cognition/language. The following chart provides a list of the very specific (= critical) periods when the brain is most susceptible to changes:

Brain spurts:
3-4, 7-8, 10-11, 15-18 weeks
8, 12, 20 months
4, 7, 11, 15, 19/20 years

Of particular interest are the quite regular intervals of 3 to 4 years beyond the age of four, after a staccato of spurts during the first weeks and months.

The peak of synaptic density is reached by age two. This overshoot phase of synapses and neurotransmitter receptors (Leuba and Garey 1987, Huttenlocher and de Courten 1987, Garey 1995) is followed by a decrease of synaptic density, which shows regional differences, e.g. reductions in the visual and auditory cortices occur between the age of 12 months up to 6 and 10 years respectively, in the frontal cortex between age 7 and adolescence. We should like to add that visual and auditory segmentation become adultlike around age 6 and 9 respectively.

Later-developing cortical areas have more opportunity to be affected by incoming input. In normal humans marked decreases in cortical gray matter are observed from 8 until 30 years of age. Decreasing redundancy of cortical gray matter and connections may be linked to decreases in plasticity and increases in functional specificity of cortical processes during the peripubertal period

(for details see Changeux and Konishi 1987, Rakic and Singer 1988, Peltzer-Karpf 1994, Gazzaniga 1995).

Summing up we can say that the maturation of cortical functions involves changes from more diffuse to more refined mechanisms, i.e. connections in early childhood show less specificity and more redundancy. The point to stress here is that environmental stimulation sculpts the final pattern of neural organization. We could thus assume that childhood bilingualism (of whatever form, see Baker 1994, Bialystok 1994) is an eminent sculptor of the developing brain.

3. The self-organization of systems

Current research in neuroscience turns upon the assumption that there is a whole set of intellectual attributes which appear once a crucial level of intelligence has been reached and which are not coded for by the genes at all (see Jones 1994). Such claims ask for extensive experimental support which we are fortunate to have at our disposal. It is by now a widely accepted, empirically well-founded theory that the creation and evolution of patterned behaviour at all levels is governed by the processes of self-organization (see Prigogine 1988, Karpf 1990, Peltzer-Karpf 1994, Scott Kelso 1995 for details).

We subscribe to an interactionist view of language development, i.e. we assume that for the formation of appropriate connections neuronal activity and stimulation from the environment are crucial. The principal claims can be summarized as follows:

(1) Living systems interact selectively with the environment.
(2) The selection of data from the environment is carried out on the basis of the presently available criteria, i.e. the respective system determines and enlarges the basis for the further selection and organization of information.
(3) The processes active in these changes are self-organizing and irreversible. Irreversible processes do not only lead to increasing complexity but also to successive dissociations/modularity.

(4) The organization of non-linear dynamic systems shows degrees of persistent order.

In the following chapters this four-piece framework will be bolstered up with additional information and examples in order to show that self-organization can serve as a mainstay in the organization of teaching programmes for very young learners.

3.1 The selection of input data

Children are equipped with feature detectors, i.e. highly specialized perceptual filters that process postnatal stimuli according to their preprogramming. Cross-linguistic data suggest children's preferences in the selection of input data are in accordance with the principles of neuronal group selection, i.e. saliency, frequency and repeated occurrence in a comparable configuration play a dominant role in sorting out the patterns of the input (= figure-ground segregation in neuropsychological terms). These parameters should be taken into account in any attempt to grade languages according to their learnability.

A comparison of plural formation in various languages will illustrate the different exigencies of input segmentation and rule-finding. Since the morphological conditions of English, French, German, Italian or Spanish are presumably known we shall single out some more exotic languages. Thus, a child/learner might be faced with root inflection (Arabic, *kitab > kutub [book/books]*), prefixes (Suaheli, *wa-tu [men], mi-aka [years], ma-shamba [fields]*), transparent suffixes (Turkish, *adam-lar [men], tarla-lar [fields]*) or reduplication (Bahasa Indonesia, bunga-bunga [bunga2] [flowers]).

3.2 The dissociation of systems

The coming into being of dissipative structures can be explained as follows: in simple systems the balance (as one of the prime conditions for the organization of living systems) can be maintained with a homogeneous distribution. In complex systems, how-

ever, the competition among various subsystems will jeopardize the equilibrium. Once the informational load has surpassed a critical value the system begins to dissipate into specialized subsystems. It becomes modular (see Prigogine 1988).

The question of dissociation becomes of particular interest in the separation of systems within one language and of the second from the first language. Evidence from various instances of language development suggests that the relevant factor accounting for the dissociation is not so much the maturational stage of the learner but rather the state of complexity of a given system, i.e. dissociation starts in proportion to the onset of second language learning (alongside with the quality and the quantity of the input). According to our data it takes about five years for systems to develop their own language-specific structure.

3.3 Degrees of persistent order

The concept of organization allows for two interpretations. Organization may refer to the structure of a system as well as to the processes by which that structure is brought about. In nonlinear dynamic systems the latter imply stages of fluctuations and changing order eventually leading to stability. In the context of language development the following (abridged) chaotic itinerary has proved quite helpful (see Karpf 1994):

The **initial state** is dominated by the search for coherence, linguistic behaviour shows memorized (non-analyzed) chunks.

The **intermediate stages** are characterized by the reorganization into different clusters involving over-productivity and fluctuations.

The **final state** shows coherent clusters and uniform patterns with large internal coupling strength and a great stability towards unordered (and [e.g. phonetically] deficient) input.

A closer look at language development (with modularity in mind) reveals some interesting phenomena: experimental evidence sug-

gests that the onset of dissociation (engendering modularity) is accompanied with over-productivity and fluctuations, i.e. a changing partiality for individual paradigms.

4. Dynamic patterns in development

The charts of system-specific development depicted in chapter 1 are the result of self-organizing processes pertaining to the first language. The self-organization of dynamic patterns in any further language follows the same itinerary. There are of course differences in the phonological repertoire, the number of morphological processes, linked up with the number of lexical items and syntactic flexibility which determine the speed and scope of development. Still, it is beyond doubt that the basic processes of pattern formation will be identical in all instances (a more detailled discussion provides Peters 1983, 1995):

The separation of figure and ground, i.e. the recognition and extraction of single units from a stream of speech sounds.
The segmentation of the input into groups (and the interim storage of non-analyzed chunks).
The analysis of stored units and the extraction of the *gestalt* criteria.
The discovery and application of rules.

As discussed in chapter 3 the interplay of the brain and the (linguistic) environment results in growth spurts engendering an array of variegated systems. The ontogeny of these systems shows degrees of persistent order which (upon analysis) give information about the given state of development. In linguistic development, for instance, over-generalizations and a changing partiality for individual paradigms (fluctuations) herald dissociation and thus the incipient system-specific internal order, stability and autonomy. In plain words, the dallying with forms and rules precedes full mastership of a system.

A decisive argument for an early start into a second language is the observation that different subsystems display dif-

ferent degrees of experience dependent modification. That is to say, that lexical acquisition is entirely dependent on external input and shows considerable plasticity throughout adulthood while the acquisition of grammar appears to be maturationally constrained and displays distinct time periods in development when they require specific types of environmental input (for details see Peltzer-Karpf 1994).

5. Discussion

The finding that second language development in childhood is closely akin to first language development suggests very natural methods, i.e. a natural setting allowing for playful linguistic behaviour, the use of child-directed speech (CDS), authentic (teaching) materials, and not to be neglected, the use of the peer-group effect (see Halliwell 1994). Interpreted against the background of self-organization presented in the previous chapters this list comes up to providing children with an ample opportunity for pattern formation and rule discovery. The following discussion encircles the key-issues of self-organization (1) the quality and the quantity of the input and (2) the influence of individual neuronal/cognitive capacities.

5.1 The role of the input

Samples of child-directed speech (CDS) give evidence of the variety of cues parents/caretakers employ to stimulate inborn dispositions and to ease the search for coherence. Most of these cues have proved helpful in early second language too, namely reduced speed, pauses, the accentuation of key-words, repetitions, preference of unmarked forms. The higher pitch, the increased eye-contact and vivid facial expressions can/should be neglected with older children.

Two-way communication might be effective with pre-speech infants (with the parents taking both parts, see 1.1) but hardly with children, cf. the rather dampening effect of the prompting-technique in a dialogue between two pupils (P1 and P2, age 10)

and a teacher which we render in full length (with translations in brackets, comments in capitals; for more examples see Oktabetz 1992, Galler 1993):

P1: Was soll ich ihn denn fragen? *(What shall I ask him?)*
Teacher: Frag ihn doch wie er heißt. *(Ask him about his name.)*
P1: SILENCE
Teacher: Weißt Du nicht wie man das macht? *(Don't you know how to do it?)* PROMPTING What's your name?
P1: [wʌt ju: neim]?
P2: Robert SILENCE
Teacher: (addressing pupil 2) Jetzt bist Du dran. *(It's your turn now.)* What's your name?
P2: THIRD ATTEMPT [wʌt tus neim]
P1: Mario
Teacher: PROMPTING Where are you from?
P2: (addressing pupil 1) Nein, frag Du mich zuerst. (*No, you ask me first.*)
Teacher: IN A LOUD VOICE Where are you from?
P2: [wɛə a tu from]?
P1: France. Und you?
P2: Italy. SILENCE FALLS.

Generally speaking the input should take account of the order of acquisition, such as essential before less essential, simple and short before long and complex, gross and distinct before subtle and finer, regular (unmarked) before irregular (marked) forms, forms with more general before forms with restricted application (see the charts in chapter 1).

Teachers should be aware that impulses to communicate change as the brain develops, i.e. the choice of topics has to meet the communicative needs and interests of children (see Donaldson 1987). We cannot think of any age-group for whom questions such as *Do you have a knee?* or *Are you a boy or a girl?* (authentic examples) might be stimulating.

Apart from the communicative value the quality and the quantity of the input play a decisive role in the interplay of brain and environment. Compare the following samples collected in Austrian primary schools using the traditional system (one English lesson per week, starting in the third form, instruction by native speakers of German, Galler 1993) and a bilingual immersion programme (Vienna Bilingual Schooling, starting in the

first form, instruction by native speakers of both English and German):

Negation (age 9, primary school)
I like not bananas
Do you like English?
- No, I am not
- No, I haven't
- No, I can

Question (age 9, primary school)
What's time?
Excuse me, I clock?
Excuse me, one on the clock?
Where it's the time?

Question (age 10, primary school)
Excuse me, where o'clock?
Excuse me, what's is o' clock?
Excuse me, what's do the clock?
Sorry, what's the clock?

Samples of spontaneous speech (age 10, bilingual primary school)
Nina, age 10, on her summer holidays:
Sometimes I go swimming and sometimes I read and sometimes I play with my brother or sister.

Nina, age 10, talking about Christmas past and present:
One day before Christmas my brother, my sister and - and me we're going to my grandmother - and we sleep by them and the next when Christmas we go to my mother at home and there we celebrate Christmas.

Daniel, age 10, explaining defender (in football):
when the stürmers [strikers/forwards] came von the other side then I must stop it.

Florian, age 10, on swimming and diving:
My dad ... helps us when we come too much down and we schluck [*German for swallow*] water and then he guide us and took us out of the water.

Mini-competence on part of the teacher obviously does not suffice for teaching young children, i.e. adopting the linguistic input to the exigencies of a developing brain (as in the case of CDS) requires a full command a language (including the phonological system). Crucial factors in achieving the linguistic fluency (notwithstanding lexical interference and developmental errors) within the bilingual programme are the quality of the input

guaranteed by native speakers plus the additional information and the increased motivation conveyed by the peer-group.

A clear hint at the dissociation of systems (see 3.2) and the early plasticity of the auditory system (see 2) are the almost flawless pronunciation alongside with traces of German syntax, lexical interference (with English pronunciation) and incipient English inflection (e.g. the missing third person {s}, a problem shared with all L1 and L2 learners of English).

Please note that, given modularity, the scores achieved in the subtests on morphology, syntax and the lexicon did not necessarily match the results of spontaneous speech.

5.2 Individual variation

It is one of the advantages of the chaotic itinerary to provide a framework for the explanation of changes in the quantity and quality of forms and yet another to offer a grid for the assessment of individual differences. The following examples illustrate some private eddies within the overall dynamics (i.e. the percolation of the individual stages enumerated in 3.3). They are meant to show how individual German speaking children cope with the patterns of English. We present the two poles within one classroom:

Shopping dialogue (age 10, primary school)

A: Give me eine bananas
B: It's a bananas

A: What's in the basket?
B: It's six bananas, three hotdogs and popcorn
A: Oh, give me please the six bananas
B: Here you are
A: Thank you
B: Good bye.

Compare the extracts from a shopping dialogue after one year of tuition (3 x 20 minutes per week) in an Austrian kindergarden (age-group 4-6): *Can I have a here you are?* (note the non-analyzed chunk), *Can I have two napples?* (note the segmentation a/n apple; more information in Peltzer-Karpf and Neumann 1994).

Text production (age 12, grammar school)
When he climbes on the ladder, wobly it and fall and the glass with the cherries also fall.

Last Saturday I was at a fancy dress party. I was dressed up as a clown. I had my father's old jacket and a plastic nose. We played a lot of games and heared music. Later we had a coke and a good cake.

The linguistic competence to be encountered in a single classroom displays a scale of fluctuations between mature and early forms, with the two poles taken by linguistic prodigies and high-speed performers as opposed to late bloomers giving striking evidence of a protracted morpho-syntactic and/or lexical development.

6. Conclusions

In the chapter on self-organization we referred to the interplay of the brain and the environment. In the given context this involves the dialogue of a young brain with considerable plasticity active in creating (among others) the cognitive and linguistic networks of the first language alongside with an incipient second system within a bilingual environment of more or less uneven proportions (the amount of second language input depends on the teaching programme). It goes without saying that qualitatively and quantitatively impoverished input will not suffice to create more than a nodding acquaintance with a second language.

The conclusions to be drawn from the interdisciplinary approach proposed here are as follows:

The input has to meet the exigencies of a developing brain which must not be crammed with information. On the other hand impoverished input is equally harmful in not providing sufficient data for the extraction of patterns. Data from cross-linguistic studies suggest that a critical mass of information is a prime condition for rule-governed linguistic behaviour.

Teachers/trainers should use age-specific child-directed speech (characterized by reduced speed, pauses, accentuation of key-words, repetitions, preference of unmarked forms) to ease rule-sifting and pattern formation.

Current linguistic research suggests different conditions for lexical and computational (= morphology and syntax) systems. A factor not to be neglected is the complexity of the language in question and its structural affinity to the language(s) previously acquired. It goes without saying that to get a good start in language motivation and emotional involvement are essential.

Errors should be seen and accepted as a by-product of development, i.e. the transition from chunks to (initially faulty) patterns is an indicator of incipient rule-governed linguistic behaviour.

Plasticity plays a crucial role in the discrimination of speech. A young brain is highly susceptible to the acoustic quality of the input. Particularly with children up to the age of 8 or 9 a one-to-one correspondence of input/output is to be expected, i.e. the default proncunciation of a teacher will be multiplied across the classroom(s).

A child's progress will largely depend on the quality and quantity of the input provided by a given programme and on his/her biological prerequisites (= network density, problem solving capacity) which determine the speed and accuracy of scene segmentation and rule finding. The period of supernumerary synapses in the cerebral cortex can be considered a stage of maximal opportunity and minimal commitments, providing enormous capacity for the generation of cortical diversity beyond genes.

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Early foreign language learning: the biological perspective

Annemarie Peltzer-Karpf

Suggested topics for discussion

1. The competence of the child
1a The competence to be acquired in preschool programmes
1b The competence to be acquired in primary schools
   - cultural formulas
   - prefabs/morpho-syntactic patterns
   - the size of the lexicon
   - communicative competence
   - reading and writing skills

2. The competence of the teacher
   - Does mini-competence suffice for mini-schools?
   - Making use of the neuronal plasticity in childhood

3. The participation/involvement of native speakers
   - native speakers as teachers or assistant teachers

4. The size and homogeneity of groups
   - grouping according to age or developmental state
   - the peer-group effect

5. The materials and methods used
   - authentic vs. specially prepared teaching materials
   - natural setting vs. classroom situation
   - bilingual training or regular small doses
   - the continuity of training

6. The languages involved
   - the second language only/bilingual schooling
   - the use of CDS (child directed speech)/teacher talk

7. The assessment of first language competence prior to the start of the second language programme
   - special training for children with language problems?
   - compulsory second language training for all children?

8. The assessment of second language competence
   - external vs. internal assessment
   - psycholinguistic tests/pragmalinguistic analysis
   - classroom observation (supervision)