

ON THE NOTIONS OF *TARGET* AND *TARGET-UNDERSHOOT* IN THE PHONETICS OF L1¹

Adela Rechziegel

Abstract

In the description of the coarticulation and reduction phenomena the notions of *target* and *target-undershoot* (and *perceptual overshoot*) play an important role. The question is: are the canonical forms of phonemes to be considered a target? As follows from the functioning of the speech sounds in a communication, we should answer this question in the negative. The second, related, question, looks for an explanation of the fact that listeners can recognize the sounds in connected speech, although these are modified by coarticulation. Here, the manner in which the first language is acquired, offers the solution.

1. Introduction

During the last thirty years the technological tools for experimental analyses have undergone a rapid development. As a consequence of this, much attention in phonetic research has been paid to the difference between the so-called canonical forms of individual phonemes, especially those of vowels, and their acoustic realizations found in normal speech. This difference is the essence of a phenomenon which has been given the name *target-undershoot*; it has been studied and measured in a variety of communicative situations and under diverse conditions, mostly on English material (see e.g. an overview by Van Son 1993b). In the present paper I would like to concentrate on this phenomenon from the point of view of language acquisition, and of coarticulation factors which modify the production and perception of human speech. In my opinion the so-called canonical form of a phoneme should be interpreted as one of its variants realized under specific conditions, i.e. in isolation. I consider the notion of *target* and - consequently - also the notion of *target-undershoot* to be misleading, as they are not in agreement with the articulatory, acoustic, and functional facts.

¹ This paper is a revised and slightly modified version of a Czech paper "*K pojmu target a target-undershoot ve fonetice L1*" by Adela Rechziegelová (1998). L1= first language, i.e. native language.

2. The interpretation of the *target-undershoot* model

As opposed to the static approach of phonemes based on the study of isolated speech sounds (even artificially made) in the beginning of the nineteen sixties, the requirement of establishing the dynamic parameters of the spontaneous speech came to the fore. Phonetic studies founded on the analyses of segments of the type VC/CV or CVC/VCV, were confronted first and foremost with the problem of the reduction of articulation and with the connected question of coarticulation (Öhman 1965). The result of these two factors was a phoneme realization that differed to a large extent from the canonical form considered to be the articulatory aim, i.e. *the target*.

The terms *target* and *target-undershoot* in the production and perception of vowels were introduced already by Lindblom (1963); somewhat later, Stevens, House & Paul (1966) paid attention to this issue. Lindblom sees *target-undershoot* as the outcome of coarticulatory processes in connected speech, which are the more effective the shorter the articulatory phases are. Consequently, Lindblom holds the process of reduction to be identical with the process of coarticulation. This opinion was later revised by other authors (e.g. Koopmans-van Beinum 1980) and by Lindblom himself as well (Lindblom 1983).

In the first stage of the study of the phenomenon we are concerned with, the formulations show that the realization of a vowel in connected speech was considered a deviation from the desirable articulatory and perceptual model, cf. Lindblom & Studdert-Kennedy (1967:831), "...the speech organs sometimes undershoot the articulatory target of the vowel...Only rarely will its formants reach a steady state... Formant frequencies sampled at this moment, may be considerably displaced from their target values owing to the undershoot and perturbation effects" (underscores mine). In another place (Lindblom & Studdert-Kennedy, 1967:836) the authors defined *target-undershoot* as a move of the frequencies found in the formant centre in the direction to the frequencies of the neighbouring consonants.

In similar words, Stevens, House & Paul presented the data found by them in CVC-segments (1966: 123, 129), "During the initial part of the vowel, the talker maneuvers the articulatory structures from a configuration appropriate to the production of the initial consonant toward a target configuration appropriate to the vowel. Once an approximation to the vowel target configuration is achieved, or perhaps even earlier, motion toward the final consonantal configuration is initiated... There is an apparent undershoot in second formant frequency relative to target value..." (underscores mine).

The difference between the variants of one and the same phoneme, realized on the one hand in isolation (or in a so-called neutral context), and on the other hand in the natural flow of connected speech, was in this way apparently defined as a kind of articulatory defect. By this approach the need for a complementary theoretical model came into being, by means of which it would be possible to explain that phonemes, despite their not reaching the parameters of the ideal form (i.e. the canonical form, isolated sound), are nevertheless correctly identified by the listeners. Again it was Lindblom in co-operation with Studdert-Kennedy (1967) who - in the above-mentioned publication - described the hypothetical model and gave it the name of *perceptual overshoot*.

The wide-ranging literature on this subject has been reviewed extensively, including critical comments, by Van Son (1993b). The author came to the conclusion that the treatment of the problem is based on two contradictory statements. The first one presumes that the realization of each vowel contains certain invariable components which make it possible for the listeners to determine its identity. The principal thought in this statement was the conviction that these components are

situated in the centre of the vowel (the so-called *target-models*). The second approach, on the contrary, concentrates on the information drawn from the margins of the realizations which are influenced by coarticulatory factors: the listener estimates from the direction and the speed of the transients the measure of the articulatory 'undershoot' and compensates for it in the deduction of the proper canonical form (*perceptual overshoot-model*).

The results of experimental studies so far, however, did not confirm the existence of such a model (*perceptual overshoot-model*), as has been shown already in the article by Pols, Boxelaar & Koopmans-van Beinum (1984). In their experiments on vowel perception the authors gained evidence that the coarticulatory phenomena in the transients are of decisive importance for a correct identification of vowels. This conviction comes back in the more recent research by Pols and Van Son (1993) which again concentrates on the acoustics and perception of the dynamic parameters of vowels. The authors put forward the conclusion that there has been found no indication of the functioning of any perceptual compensatory mechanism, as described by Kanamori & Kido (1976) nor as it is presented in the data of Lindblom & Studdert-Kennedy (1967).

Van Son, too, examines the validity of the *perceptual overshoot-model* in his own experiments on synthetic vowels (Van Son 1993b) where he showed how listeners react to articulatory changes in the formant spectrum. While the identification of vowels that have been deprived of the appropriate context and are offered in isolation, caused difficulties on the part of the listeners, the identification of vowels in the original context and of those realized in isolation was identical. The author expressed his conviction that in all probability it is the context that provides the most important information for the right identification of a vowel and that it is not necessary to take into account any compensatory process.

3. Putting the problem differently

When examining the perception of phonemes, in the first place that of vowels, one of the most important questions is how is it possible that the listener interprets the sound segments properly, even if they are considerably modified by coarticulation and other factors such as rate, position in the word, stress etc., cf. Van Son (1993b): "The variability in vowel realizations could give the impression that vowels are difficult to recognize in normal, connected speech. But, in a normal utterance, vowels are generally identified accurately, whatever the context or speaker characteristics." In other words, the question is how a communication can ever turn out to be successful if it is realized by sounds viewed by some linguists as instances of permanent *target-undershoot*?

In my opinion the answer to this question can be found in the very beginnings of the functioning of the speech mechanism in human beings. The specific way in which children get acquainted with speech sounds provides sufficient explanation for the fact that in a later stage every speaker is able to recognize without difficulties all realizations of phonemes belonging to his mother tongue. In the following discussion I would like to make clear my point - i.e. the conviction that the answer to the above question should be sought in the L1 acquisition process.

3.1. The identification of phonemes

The examination of the differences between the canonical form of phonemes (in the first place of vowels) and the form in which they are realized in normal speech,

yielded on the one hand exact descriptions of the stated divergences, on the other hand studies which aim at resolving more general questions. To the latter belongs e.g. Koopmans-van Beinum (1980), concerning the identifiability of vowels under various communicative conditions. To this purpose she conducted an examination of the acoustic and perceptual features of two groups of Dutch vowels, realized in isolation (or in one-syllable words) as well as in the flow of connected speech. We think it important that Koopmans-van Beinum correctly characterizes the conditions of realization of the first group as extraordinary (*unusual speech conditions*), while she typifies the realization of the second group as usual, normal (*normal speech*). By contrast, the more recent study of Van Bergem shows another characteristic: the vowels in common speech he indeed sees as normal (*normale spraakuitingen*), but the vowels realized in isolation as ideal² (Van Bergem 1995:152). Koopmans-van Beinum stated that while the perception of vowels has already been studied in great detail with respect to various speech styles, the information about the perception of vowels during a free conversation is still lacking, although just this is the most usual style (1980:79). Her experiment confirmed the results of the study conducted so far from which the author quotes in the beginning of her book, namely: the vowels realized in the natural flow of speech and offered in the framework of an experiment as isolated segments are very difficult to identify. The mutual acoustic contrast is much smaller than the contrast between the canonical vowels. The conclusion of Koopmans-van Beinum, that the relevant information is gained from transients and from the neighbouring consonants (1980:153), subsequently found support in many further experimental data, also from her own research (Koopmans-van Beinum et al. 1984).

Nowadays the phonetic studies, so far directed overwhelmingly at vowels, finally start examining coarticulation and reduction in consonants as well. This gives rise to the question whether these phenomena are comparable for both groups of phonemes. The recent work by Van Son and Pols (1996, 1997), which proceeds methodically along four criteria (formants values, duration, 'main' frequency and the difference of sound energy between consonants and vowels), answers this question in a positive way.

However, the problem of the coarticulatory context has until now not been explored sufficiently in all its aspects. For instance, the boundaries of the coarticulatory influence that obviously exceed directly neighbouring phonemes, have not yet been experimentally determined. As is well known, in the VCV segments the initial vowel is modified not only by the consonant, but also by the vowel which follows it, and the other way round (Öhman 1965). A significant contribution to this issue presents the recent paper by Van Son and Pols (1999). The authors looked at the role of the so-called *perisegmental* or *local context*, (i.e. a context broader than transitions only) in the recognition of vowels and consonants in a long text fragment, read aloud. They stated that, although the importance of the perisegmental speech may depend on a number of variable conditions such as speaking style, the phoneme identification clearly benefits from the perisegmental speech. There is, moreover, an asymmetry following from the position of the phonemes towards each other and the offered context: the context added in front of the identified phoneme appeared to be more decisive than the context added after the identified phoneme. This knowledge can explain the difference which exists between the intelligibility of pre- and post-vocalic consonants.

² "...vowels pronounced in isolation (which can be regarded as 'ideal' vowels)..."

3.2. How the child comes to his speech sounds³

Our discussion now turns to the issue that can offer the solution of the problem of correct identification of phonemes from realizations which are systematically modified by coarticulation. This concerns the acquisition of human language. There exists an extraordinary extensive and manifold literature on first language acquisition, throwing light on the development of a single individual as well as of groups of children. One of the earlier, but still important studies is Ferguson's article concerning the speech development of a French girl (1968). The author refers to the pioneering contribution of Jakobson (1941) and explicitly agrees with the claim of the latter that child language is always a coherent system of its own which in its development undergoes similar changes as the development of the human language in general. Ferguson emphasized the contrastive approach in the description of child language and illustrated his argument with two examples: the first one is a comparison of the acquisition of speech sounds by a child in three stages of his language development, the second compares the system of the child language to that of adult speakers (*model-replica processes*, 1968:106). In Ferguson's view the first contrastive approach can teach us about the acquisition processes generally, e.g. at what stage some phonetic contrasts are perceived and applied by the infant. The second one offers such data on the given language system as we could not have laid bare without that comparison.

Since 1970 the studies concentrating on all aspects of the acquisition process increased explosively. The objectively determinable phases of the physiological development of the speech organs were described and the age limits of sound production established, starting with crying, through humming and babbling until the very first words. The chronological order in which a child acquires particular phonemes has been established, the frequency of occurrence examined and, moreover, the regularities revealed of the substitution of certain phonemes by other phonemes (in the case of difficult pronunciation of some special phonemes).

As a consequence the interest arose for another, closely connected terrain: the talk of adults to children, formerly called *baby talk (BT)*, nowadays treated as *infant directed speech*. During the nineteen seventies and eighties the attention paid to the interaction between adults and children gained considerable strength. New periodicals devoted to these questions appeared, such as *Journal of Child Language* and *First Language* and, moreover, the *International Association for the Study of Child Language* was founded which was occupied among other things with organizing regular conferences.

A comprehensive review of the recent situation in the field mentioned is given in the book *Input and interaction in language* by Gallaway and Richards (1994). Many articles in this volume point out C.A. Ferguson as an initiator of the study on *baby talk*, who every time brought a new impetus for exploration of further aspects of this problem, cf. Snow (1994:4) and Cruttenden (1994:135). Cruttenden stated, however, that the results of the study on *BT* often contradict each other. He also drew attention to somewhat surprising data in the paper of Shockey & Bond (1980). These authors found in the articulation of consonants more reduction phenomena when it concerned the conversation of adults directed to children than when conversation between adults only was involved (Cruttenden 1994:137).⁴ Shockey and Bond explained this fact in the following way: phonological reduction induces a feeling of intimacy between

³ Henceforth 'he', 'his', 'him' etc. also means 'she', 'hers', 'her' etc.

⁴ Similar data have also been presented by Bard and Anderson (1983) who tested the perception of isolated words collected from a conversation adult:child and adult:adult. The listeners found the words in the adult:child speech less understandable than those in the adult:adult speech.

mother and child and strengthens their solidarity. Cruttenden obviously was not satisfied by this explanation, as we can deduce from the following comment: "Shockey and Bond...have to wonder how children ever learn full forms", but he is quick at repartee: "This of course is not a problem in itself if they have learnt them at an earlier stage" (Cruttenden 1994:138). If we would like to continue this imaginary dialog, the question: When and how? would be in place.

3.3. The acquisition gives access to coarticulation and reduction in L1

At this point of our discussion we would like to put together two issues: on the one hand the study on phoneme identification and on the other hand the study of FLA (first language acquisition). The former, as already has been mentioned, is occupied with the question how a listener can correctly recognize the phonemes in fluent speech if they are significantly modified by the context and consequently do not match the characteristics of the canonical forms. With respect to the latter, as witnessed by the founding of the theory of *perceptual overshoot* (and even the above quotation from Cruttenden), it can be concluded that many linguists are still going on the assumption that an infant learns from his parents the canonical forms of phonemes (*full forms*). Both these issues are thus concerned with the canonical (full) forms of phonemes.

However, if we take into account the way in which an infant is exposed to speech, we can easily see that no canonical forms of phonemes are involved. For the parents don't teach the child isolated phonemes (no *full forms* whatsoever), they offer the child a chain of sounds, accompanied by the appropriate pragmatical and systematical devices. In this connection we can take into consideration two channels of speech: the *infant directed speech* itself and the speech which is not directed to the infant (these two types of speech may differ from each other in articulatory and acoustic parameters, cf. Shockey & Bond 1980 and Bard & Anderson 1983).⁵ As the child tries hard to imitate the sound image of the adult speech (*adult target sounds*, cf. Ferguson & Yeni-Komshian 1980:3), we are certainly dealing here with a target, but it has nothing to do with canonical forms of phonemes.

In relation to the central question of the present paper, i.e. the inadequacy of the notions of *target* and *target-undershoot*, it is thus important to bear in mind that in the communication between an adult and a child the elementary - building stones are not phonemes, but larger entities. The parents address the child with **connected speech**, in this way preparing him for the future task of recognizing all speech sounds of his native language in **all contexts in which they can occur**. In the course of time the language learner is thus gaining the knowledge of still more contextual variants of one and the same phoneme. Consequently, the systematic coarticulatory modifications of the spectral parameters and the modifications due to reduction are known to him and become a part of his competence.

The process of increasing the repertory of variants on the one hand and getting them more precisely on the other hand could be seen as a process of forming an *invariant* of sound and meaning. The infant at first produces a considerable number of variants of a phoneme, because it cannot manage to imitate the offered sound material properly. Step by step some of the variants will - as a consequence of the reaction obtained from the parents - appear to be **not functional** and these will eventually be eliminated. By contrast, the variants which prove to be **functional**, are kept. At the age of about 1 year when the first words are formed, the awareness of invariant becomes successively clearer. The recent study by Koopmans-van Beinum & Van der Stelt (1998) claims that the interaction between the mother and the child causes the

⁵ Following Jusczyk (1997:229), the manner how infants draw information from fluent speech still wants due attention.

release of the primary production elements of the child and on the base of generalization it leads to the forming of permanent variants connected with the concepts of meaning. A similar information on this point is given by Palková (1994:347), "It is characteristic, that in this stage the exact phonetic imitating weakens, the child ceases to distinguish "non-substantial" differences, the sound form of the words is treated by him more freely, he simplifies inside the framework of the type already found. The sign-principle of the functioning of language has gone through."⁶

The child thus from the very beginning perceives the sounds of his L1 in their appropriate context, and **not in isolation**. Significantly, the infants' production neither shows inclination to realizing individual phonemes. Next to the own experience of everybody who ever was in contact with children, the literature about child language offers enough evidence for this fact. The studies in this field agree on the point that even the earliest child production has a syllabic form, cf. e.g. Stark (1980:74), "The babbling is characterized by a series of consonant - vowel (CV) syllables in which each syllable is perceived as being similar to every other...", or Wilkinson (1971:53), "The baby's early noises become syllabic, and repetitive." Similar results have been obtained from a longitudinal study on 14 children in the age from 9 months up till 2 and a half year (Bloom 1993), cf.: "The units of speech production consist of syllables, which are larger vocal-articulatory gestures than single phonemes... In babbling, the baby's vocalizing has a clear syllabic form, consisting of a series of consonant-vowel combinations" (Bloom 1993:67).

At the age when the native speaker has reached the full extent of his vocabulary, he is under normal conditions able to recognize all the sounds of his L1. To these belong the coarticulated forms of vowels and consonants as well as their canonical forms. Here we can recall the above (in section 2) mentioned statement of Van Son (1993b) that the results of the identification test on vowels offered in the original context and of vowels realized in isolation were identical. This is not surprising if we become aware of the fact that regarding the communicative function, both coarticulated as well as isolated phonemes are 'full forms', i.e. so far as the communication turns to be successful, they both evidently carry as much information as is needed for the given purpose.

3.4. Isolated and other specific sound realizations

In contrast to the manner in which under normal circumstances the acquisition and recognition of the L1 speech sounds takes place, the so-called canonical form of a phoneme, i.e. the phonetic realization of a phoneme in isolation stays for a long time practically unknown to the language learner. The systematic exercise of this variant of a phoneme generally comes into effect only when the child starts learning to read and write. It can be assumed that in this phase the child adds the canonical form to the collection of the variants of the separate phonemes which are already known to him; the canonical form serves henceforth as a kind of prototype.

This prototype has nothing at all in common with the notion *target*, because in normal communication the speaker certainly does not attempt to arrive at it. Doubts about the helpfulness of the notion *target* were explicitly expressed by Boersma (1998) in his description of reduction and coarticulation phenomena. In my view all the variants of phonemes, characterized by their **systematic coarticulatory** and **reduction** modifications being the result of phonemic context, situation, rate of

⁶ "Je charakteristické, že se přitom oslabuje přesné fonetické napodobování, dítě si přestává všimát "nepodstatných" rozdílů, se zvukovou formou slova zachází volněji, zjednodušuje v rámci již nalezeného typu. Prosadil se znakový princip fungování řeči."

speech, accurateness (spontaneous vs. read text), word- or sentence stress, mood of the speaker etc. may be considered to be the target. As we have concluded in the foregoing section, the attainment of this target can only be checked by - and there is no other way to do it - the result, i.e. by the communicative success or failure of the actual speech act.

In the terms of *markedness - unmarkedness* the phonemes produced in isolation belong, in contrast to the unmarked phonemes realized in connected speech, to the marked type. To this type can be ranged some other (kinds of) speech sounds which are realized under specific conditions, as are whispered and sung phonemes, with which the child is confronted during the process of acquisition only to a minor extent. This proves insufficient in adulthood whenever the listener has to identify sounds in a whispered speech or in a sung text. Everybody knows from their own experience that identification of whispered phonemes is difficult, as some distinctive features, e.g. voicedness, may be lacking. On the other hand, the sung phonemes are to a large extent adapted to the text, rhythm and melody, which can cause their deformation. For this reason the sung text is often hard to understand or it is incomprehensible at all. An inspiring study of Ondráčková (1973) is dedicated to this so far little explored field. Having thus a thing in common with the whispered and sung sounds, i.e. the specific realization conditions, the canonical forms of phonemes differ from them, of course, by the prototypical function which they fulfill.

4. SLA as the 'mirror image' of the FLA

I would like to conclude the present discussion by pointing to the other language, which plays an important role in our communicative actions: the *second language* (foreign language, L2) in dealing with the present matter. The acquisition of L2 and identification processes which take place in it, proceed differently from those in L1. However, the causal relationship between the way of acquisition and the identification of phonemes is the same as in L1.

In the framework of phonetic descriptions, until now comparatively little attention has been paid to above processes in second language, although the acquisition has been thoroughly treated in applied linguistics for pedagogical purposes. An interesting contribution was made by Cucchiari (1993), concerned with the reliability of identification in the native language as opposed to that in the foreign language. The results of her tests confirmed that phonemes which do not originate from the listener's native language, are identifiable with great difficulty, as he is not able to supply the missing lexical and phonetic context.

I think that exactly here lies the central point of the identification problem. The acquisition of the second language usually starts in a later stage of life in a professional teaching institute. The student gets acquainted with the sounds of L2 (in Lesson 1) by means of an enumeration of the phonemes, first looked at in their written form, then read aloud in their canonical form. At the same time the learning of words begins, and namely from their written form. Because the coarticulatory regularities are not known to the student, he will try to pronounce these new words with the knowledge taken from the native language. This will place him before serious difficulties when he will have to recognize sounds in connected speech, in a normal conversation.

Everybody will have been confronted with the obstacles that foreign family names may cause in a communication, in the first place in a telephone call⁷: as the participant does not find support for the presented sound structure in his perceptual experience, the name appears unintelligible to him and must be spelled to be understood. It need not only concern 'exotic' phonemes, but just usual ones; yet, their phonetic realization has different articulatory and acoustic parameters from those he is used to in his mother tongue. Besides, in the foreign language, combinations of phonemes may occur which are impossible in speakers' L1. Also the reduction and coarticulation is not decipherable in a foreign language and therefore it cannot lead to correct identification of realized phonemes. Of course, nowadays we have the language laboratories to listen to the connected pieces of text in L2 and to do some practice on them. But it cannot be compared with the exposure of a child to speech in his daily interaction with the parents.

Thus, it could be assumed that we have to do with a kind of reverse process taking place in L1 and in L2, and, moreover, this can explain the easiness with which the speaker recognizes the sounds in his native language and the difficulties which accompany the same effort in the second language, even if his command in the second language is very good.

Referring to the rather metaphorical comparison in the title of this section, I would like in conclusion to give, very schematically, the idea of the 'mirror image' in the following figure:

	L1	vs	L2
acquisition starts with :	coarticulated and reduced sounds, from hearing		isolated phonemes, in written (read) form
proceeds via:	words, sentences, in spoken form		words, sentences, in written and spoken form
ends with:	isolated phonemes, in written form		limited knowledge of coarticulated sounds

Recently, a sudden increase of interest for these phenomena in the second language can be observed. The possibility to compare the data from the first language to those of the second language is, of course, most appealing. Especially the acquisition in L2 enjoys much attention, as it became a separate object of study and is treated under the distinct abbreviation SLA (Second language acquisition).⁸ Flege (1991,1995) compared the capability of identification in L1 and L2 and stated that the ability to identify correctly is limited by age and by the acquaintance with the language. He argues, however, that the discriminating ability which is present in every infant, can be got back by proper training, in other words, according to him it must be possible to learn a foreign language as well as the native. At this point Flege is perhaps too optimistic, considering the experience with foreign language teaching.

⁷ My own family name which is foreign in the country I live in, regularly meets a big consternation on the part of the listener on the phone, although I pronounce it as distinctly and calmly as possible. But the reaction is infallibly as follows (Here is Mrs. R. speaking), -"Who?!" uttered with something of a panic and a triple emphatic stress on the *who*.

⁸ Book Gazette (John Benjamins Publishing) announces no less than five publications on SLA to appear in winter 1998-1999.

The importance of the native language in the identification process should not be underestimated. Many results on this issue are put forward in the literature as facts of general validity, while they only hold true in the domain of the mother tongue and probably may, moreover, be language specific. It is certainly one of the urgent and challenging tasks ahead of contrastive linguistics and phonetics to collect sufficient material to the end of comparing the acquisition, perception and identification in the native and in the foreign language.

5. Conclusion

In studying perception and identification problems, in my opinion two sources of information are of primary importance. This concerns in the first place the manner in which a child acquires the sound picture of L1 and the knowledge of all variants of one and the same phoneme which can occur in it. Secondly, many new insights would be gained by a contrastively based examination of the second language, which is by definition an antipole of the first language. Therefore the data from acquisition, perception and identification processes could be compared to each other in a fruitful way.

The difference of the articulatory and acoustic parameters between phonemes realized in isolation and in connected speech cannot be seen as deviations from the norm (*full form* vs. *target-undershoot*). Coarticulation and reduction are systematic processes with which the language user gets acquainted from the very beginning of his communicative activities. These processes, hand in hand with the lexical and situational context, are indispensable for making possible the transmission of the message in the communication.

6. References

- Bard, E.G. & Anderson, A. (1983), "The unintelligibility of speech to children", *Journal of Child Language* 10, 265-292.
- Bergem, D.R. van (1995), *Acoustic and lexical vowel reduction*, Ph.D. thesis, University of Amsterdam, *Studies in Language and Language Use* 16.
- Bloom, L. (1993), *The transition from infancy to language. Acquiring the power of expression*. Cambridge University Press, Cambridge.
- Boersma, P. (1998), *Functional phonology. Formalizing the interactions between articulatory and perceptual drives*. Ph.D. thesis, University of Amsterdam. Holland Academic Graphics, The Hague.
- Cruttenden, A. (1994), "Phonetic and prosodic aspects of Baby Talk", in: C. Gallaway & B.J. Richards (eds.), *Input and interaction in language acquisition*, Cambridge University Press, Cambridge, 135-152.
- Cucchiari, C. (1993), *Phonetic transcription: a methodological and empirical study*, Ph.D. thesis, University of Nijmegen.
- Ferguson, C.A. (1968), "Contrastive analysis and language development", in: *Report of the Nineteenth Annual Round Table Meeting on Linguistics and Language Studies*, Georgetown University Press, Washington, D.C., 101-112.
- Ferguson, C.A. & Yeni-Komshian, G.H. (1980), "An introduction to speech production in the child", in: G.H. Yeni-Komshian, J.F. Kavanagh & C.A. Ferguson (eds.), *Child phonology*, Vol. I, Academic Press, New York, 1-8.
- Flege, J.E. (1991), "Perception and production: The relevance of phonetic input to L2 phonological learning", in: C.A. Ferguson & T. Heubner (eds.), *Crosscurrents in second language acquisition and linguistic theories*, John Benjamins, Amsterdam-Philadelphia.
- Flege, J.E. (1995), "Second language speech learning: Theory, findings, and problems", in: W. Strange (ed.), *Speech perception and linguistic experience: Theoretical and methodological issues*, York Press, Timonium, Md.

- Galloway, C. & Richards, B.J. (eds.) (1994), *Input and interaction in language acquisition*. Cambridge University Press, Cambridge.
- Jakobson, R. (1941), "Kindersprache, Aphasie und allgemeine Lautgesetze". Uppsala. Reprinted in: *Roman Jakobson Selected Writings I*, Mouton & Co. (1962), The Hague.
- Jusczyk, P.W. (1997), *The discovery of spoken language*, MIT Press, Cambridge, Massachusetts.
- Kanamori, Z. & Kido, K. (1976), "Perception of vowel stimuli characterized by time-varying formant frequency", *Journal of the Acoustic Society of Japan* **32**, 277-279.
- Koopmans-van Beinum, F.J. (1980), *Vowel contrast reduction. An acoustic and perceptual study of Dutch vowels in various speech conditions*, Ph.D. thesis, University of Amsterdam.
- Koopmans-van Beinum, F.J., Wouters, H.A.L., Buiting, H.J.A.G & Pols, L.C.W. (1984), "The influence of response categories on the identification of vowels excerpted from conversational speech", *Proceedings of the Institute of Acoustics* **6** (4), 363-370.
- Koopmans-van Beinum, F.J. & Van der Stelt, J.M. (1998), "From universal to language specific. Mastering basic elements in early speech development", in: S. Gillis & A. De Houwer (eds.), *The acquisition of Dutch*, John Benjamins, Amsterdam-Philadelphia, 101-162.
- Lindblom, B. (1963), "Spectrographic study of vowel reduction", *Journal of the Acoustic Society of America* **35**, 1773-1781.
- Lindblom, B. (1983), "Economy of speech gestures", in: P.F. MacNeilage (ed.), *The production of speech*, Springer Verlag, New York, 217-246.
- Lindblom, B. & Studdert-Kennedy, M. (1967), "On the role of formant transitions in vowel recognition", *Journal of the Acoustical Society of America* **42**, 830-843.
- Öhman, S.E.G. (1965), "Coarticulation in VCV-utterances: spectrographic measurements", *Journal of the Acoustical Society of America* **39**, 151-168.
- Ondráčková, J. (1973), *The physiological activity of the speech organs*, Mouton, The Hague.
- Pačková, Z. (1994), *Fonetika a fonologie češtiny*, Univerzita Karlova, Praha.
- Pols, L.C.W., Boxelaar, G.W. & Koopmans-van Beinum, F.J. (1984), "Study of the role of formant transitions in vowel recognition", *Proceedings of the Institute of Phonetic Sciences* **6**, Amsterdam, 371-378.
- Pols, L.C.W. & Van Son, R.J.J.H. (1993), "Acoustics and perception of dynamic vowel segments", *Speech Communication* **13**, 135-147.
- Rechzieglová, A. (1998a), "K pojmu target a target-undershoot ve fonetice L1". in: *Prace Filologické, tom 43*, Institut jazyka Polskiego, Wydział Polonistyki Uniwersytetu Warszawskiego, 375-383.
- Shockey, L. & Bond, Z.S. (1980), "Phonological processes in speech addressed to children", *Phonetica* **37**, 267-274.
- Son, R.J.J.H. van (1993a), *Spectro-temporal features of vowel segments*, Ph.D. thesis, University of Amsterdam. *Studies in Language and Language Use* **3**.
- Son, R.J.J.H. van (1993b), "Vowel perception: a closer look at the literature", *Proceedings of the Institute of Phonetic Sciences* **17**, Amsterdam, 33-64.
- Son, R.J.J.H. van & Pols, L.C.W. (1996), "A comparison between the acoustics of vowel and consonant reduction", *Proceedings of the Institute of Phonetic Sciences* **20**, Amsterdam, 13-25.
- Son, R.J.J.H. van & Pols, L.C.W. (1997), "The correlation between consonant identification and the amount of acoustic consonant reduction", *Proceedings Eurospeech '97*, University of Patras, Vol. **4**.
- Stark, R.E. (1980), "Stages in speech development in the first year of life", in: G.H. Yeni-Komshian, J.F. Kavanagh & C.A. Ferguson (eds.), *Child phonology*, Vol. **I**, Academic Press, New York, 73-92.
- Stevens, K.N., House, A.S. & Paul, A.P. (1966), "Acoustical description of syllabic nuclei: An interpretation in terms of a dynamic model of articulation", *Journal of the Acoustical Society of America* **40**, 123-132.
- Van Son, R.J.J.H. & Pols, L.C.W. (1999), "Perisegmental speech improves consonant and vowel identification", in press.
- Wilkinson, A. (1971), *The foundations of language. Talking and reading in young children*, Oxford University Press. Oxford.

