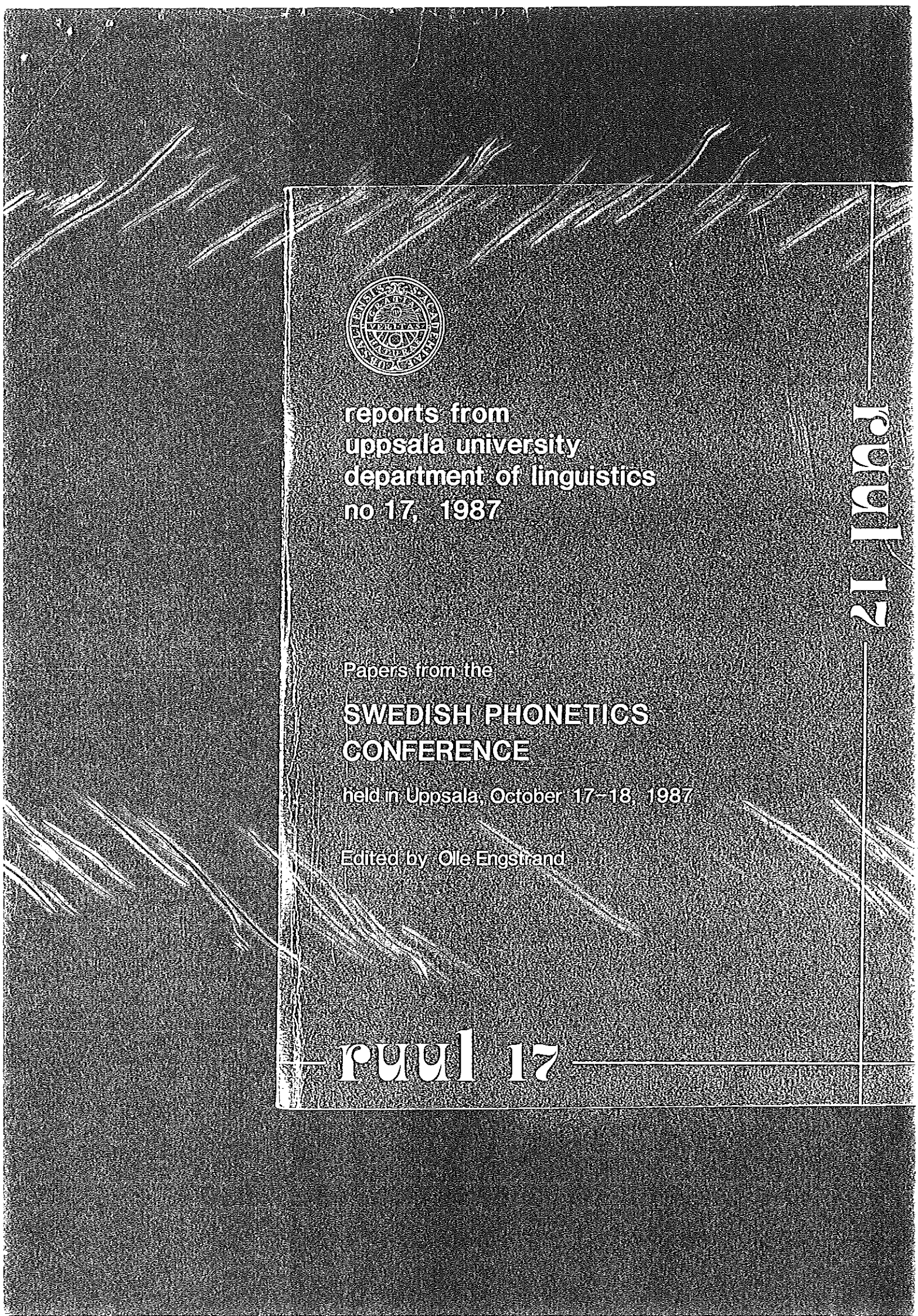

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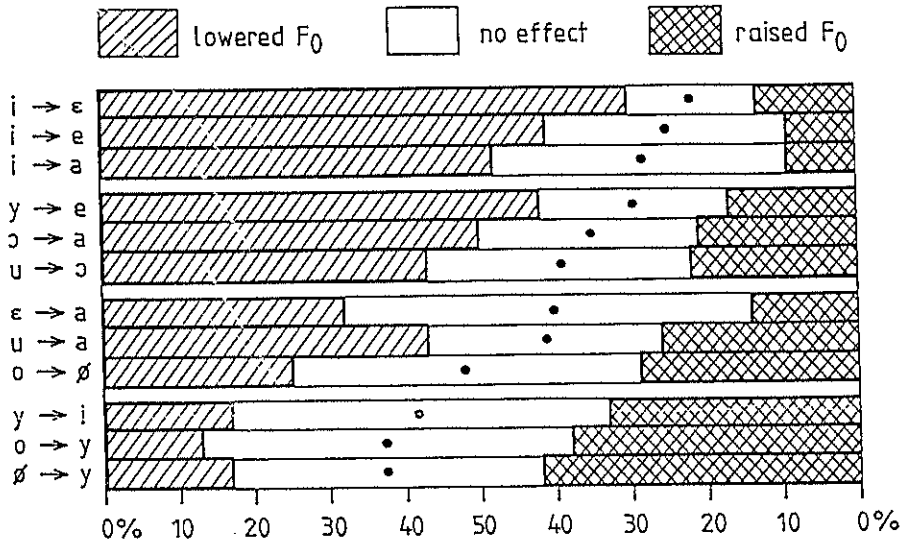

Durational correlates of post-vocalic voicing in English spoken by English and Spanish speakers

Una M. Cunningham-Andersson
Department of Linguistics
Uppsala University

Abstract

This investigation is designed to establish the theoretical status of the variation of vowel and post-vocalic stop closure duration as a function of post-vocalic consonant voicing. Two experiments are performed, one with native English speakers and one with native Spanish speakers uttering similar sets of English speech material. The Spanish informants differ so widely from each other that it must be concluded that there is a basic articulatory effect by which the vowel preceding a voiceless stop is shorter than the vowel preceding a voiced stop and a voiced stop has shorter closure duration than a voiceless one, but that this effect is exaggerated in English - an enhancement that only one of the Spanish speakers has learned.

Background to this investigation

One of the most discussed aspects of the segmental timing of English and other languages is the relative timing of vowels and post-vocalic consonants. It has been established that the duration of the vowel changes according to the voicing of the following consonant: Lisker (1957); Peterson and Lehiste (1960); House (1961); Chen (1970); Mitleb (1984). It is further known that post-vocalic stop closure durations are greater if the stop in question is voiceless: Lisker (1957); Chen (1970). These two phenomena give rise to an inverse durational relationship between vowels and post-vocalic voiced versus voiceless consonants which may or may not be attributable to a temporal compensation mechanism: Port, Al-Ani and Maeda (1980); Fitch (1981).

It has been suggested that this temporal relationship might be a linguistic universal. Chen (1970) examines French, Russian, Korean and English speech material and finds that a vowel is invariably longer before a voiced consonant and that the occlusion time before the release of voiceless stops is longer than for voiced stops. Chen concludes that this variation of vowel duration as a function of voicing in the following consonant is a linguistic universal, and proposes that it may be explained in articulatory terms by a difference in the rate of transition from vowel to stop. Since the glottis closes during voiced stop production, pressure builds up only in the mouth cavity such that there is relatively low intra-oral pressure, while for voiceless stops pressure is also built up in the lungs. Chen suggests that it is the anticipation of the difference in muscular effort in the closed position for Cs that

causes the transition from vowel to voiceless stop to be faster than the transition from vowel to voiced stop, which in turn results in different vowel lengths.

Mitleb (1984) challenges the assumption that vowels are universally longer before voiced consonants than before voiceless ones and presents spectrographic evidence that this is not the case in Arabic. Mitleb claims that there was not any effect when Arabic speakers pronounced English words either.

The experiments

This investigation is constructed such that similar sets of English speech material are presented to four informants, two of whom have British English as their first language (L1) and two native speakers of Castilian Spanish for whom English is L2. The hypothesis is that if the temporal relationship between V and C is caused primarily as an effect of the articulatory mechanism, then there will be no difference between the L1 and L2 informants; while if the effect is primarily a learned method of distinguishing between voiced and voiceless post-vocalic consonants, the Spanish informants will not have learned it, or at least not be able to use it consistently. The features being tested by the experiments are:

1. that the vowel before a voiced stop is longer than the vowel before a voiceless stop;

2. that the closure of a voiceless stop is longer than the closure of a voiced stop.

Let us deal first with the experiment performed using native English speakers as informants. Twenty-four test-words of the form CVC were chosen such that the consonants /p,b,t,d,k,g/ and four vowels occurred in all possible combinations in the VC positions. In order to have a complete set of all the combinations of V and C, test words which happen not to be existing English words were included, though all were possible words of English. The test words were the following:

beep, beeb, beat, bead, beak, beag,
dip, dib, bit, bid,dick, dig,
burp, berb, bert, bird, berk, burg,
pup, pub, but, bud, buck, bug.

The test-words were set into a frame:

It's _____ I'm saying now.

The use of a frame helps the informant to maintain a more constant rate of utterance than would otherwise be possible. The frame sentence was designed to ensure release of the final stops of the test words. Two phonetically naive informants, A.R. (male) and F.S. (female), both native speakers of British English, recorded four

tokens of each test sentence. The durations of the vowel and final consonant closure were measured for each example of each word from oscillograms.

The same test words were used in the experiment involving native speakers of Castilian Spanish as in the previous one, although the frame sentence used was changed to:

I say _____ every day.

The recordings and measurements were made in the same way as for the previous experiment, except that the two informants, M.P. (female) and M.G.P. (male) recorded ten examples of each test utterance.

It must be said that both M.P. and M.G.P. know English well, and both were in England to study the principles of English language teaching. They both worked as English teachers in Spain prior to coming to England.

Results

Vowel duration effect

One-tailed Mann-Whitney U-tests were taken to compare the durations of the vowels preceding voiceless consonants with those before voiced consonants. (One-tailed tests are used when a prediction regarding the direction of the difference between the sets of data is made such that a difference will only be regarded as significant if it is in the predicted direction.) Table I shows whether the difference in the vowel duration followed by voiced and voiceless stops is significant at the 1% level of significance. (S indicates a significant difference while NS indicates no significant difference.)

Table I Result of Mann-Whitney U-test. Difference in vowel duration (1% level)

WORD PAIR	FS	AR	MGP	MP
beep beeb	NS	S	S	NS
beat bead	S	S	S	NS
beak beag	S	NS	S	NS
dip dib	S	NS	S	NS
bit bid	S	NS	S	NS
dick dig	S	NS	S	NS
burp berb	S	NS	S	NS
bert bird	NS	NS	NS	NS
berk berg	S	S	S	S

pup	pub	NS	NS	S	NS
but	bud	NS	NS	S	S
buck	bug	S	S	S	NS

The difference between the informants here is quite remarkable. M.G.P. almost invariably has significantly longer vowels before voiced stops than before voiceless stops and so is much more consistent than even the more stable of the two L1 speakers, F.S.. M.P. on the other hand manages to reach the 1% significance on only two occasions, although in most cases the difference is in the right direction, as was the case for A.R. who had marginally more significant results.

Consonant closure duration effect

One-tailed Mann-Whitney U-tests were taken to compare the durations of the closures of the voiced and voiceless post-vocalic stops. The results obtained are shown in the same form as for table I.

Table II Result of Mann-Whitney U-test. Difference in stop duration (1% level)

WORD PAIR		FS	AR	MGP	MP
beep	beeb	NS	S	S	NS
beat	bead	S	S	S	S
beak	beag	S	NS	S	NS
dip	dib	S	NS	S	NS
bit	bid	S	S	S	NS
dick	dig	S	S	S	NS
burp	berb	S	S	S	S
bert	bird	NS	S	S	NS
berk	berg	S	S	S	NS
pup	pub	NS	NS	S	NS
but	bud	NS	NS	S	NS
buck	bug	S	NS	S	S

As was the case for the vowels, M.G.P.'s speech is as claimed by the hypothesis, and much more regular than either of the native English speakers, while M.P.'s speech shows nothing more regular than a tendency for voiced stops to have shorter closure than voiceless stops, although again this difference is only significant in three cases.

Discussion

All four informants tended to have differences in vowel and stop closure duration as a function of consonant voicing. There was however a difference in the extent to which these relationships operate. F.S. maintained the durational distinctions fairly consistently, while A.R. had much fewer significant results. The difference between the L2 informants M.P. and M.G.P. was more marked. M.G.P. had significant differences in almost every case while M.P. had very few significant durational distinctions, although in most cases where the result was non-significant, the durational differences were in the expected direction.

These results are open to various interpretations. It could be the case that M.P. was simply mispronouncing the test words, perhaps confusing voiced and voiceless stops some of the time. Since in Spanish the distinction between phonologically voiced and voiceless stops is principally one of voicing, and post-vocalic stops have fricative realizations it may well be that the two informants have different ways of producing a contrast between the stops in English. An alternative explanation would be that the inverse VC relationship is a learned feature of English (and possibly other languages), and that M.G.P. has learned to use it while M.P. uses it only sporadically. That M.G.P. has much more consistent results than even the L1 speakers is very interesting, and would point to a complete mastery of this feature of English. However, neither of these interpretations are entirely satisfactory.

Chen (1970) claims it is the increased muscular effort associated with voiceless stops which causes the command to form the closure for the stop to be executed more quickly than for voiced stops, which leads to a shorter vowel and longer closure for voiceless stops. This would account for the temporal relations exhibited in the speech of all four informants, but not for the differences between the informants. Let us assume that due to the way the articulatory mechanism works there is a minimum phonetic effect, as described here, associated with post-vocalic consonant voicing. In English (and possibly in other languages), however, the durational differences are greater than they would be if they were due only to the characteristics of the articulatory mechanism. The temporal effect is enhanced for linguistic purposes in English. M.P. and M.G.P. differ considerably in how well they have learned this feature of English. M.G.P. uses the enhanced durational differences completely consistently (even more so than the native English speakers), while M.P. apparently does not use the enhancement at all and so has only the basic effect associated with the articulatory mechanism. This being the case, it is unsurprising that there is a difference in the extent to which A.R. and F.S. display the effect. Such differences between native speakers are just the kind of individual variations which are to be expected with such an enhanced effect.

The attractiveness of this account is increased by the fact that the relative duration of both the vowel, (Wang (1959), Raphael (1972) and O'Kane (1978)) and the stop closure (Wang (1959) and Port (1978)) were found to be used as cues in speech perception.

References

Chen, M. (1970). Vowel length variation as a function of the voicing of the consonant environment. Phonetica, 22, 129-159.

Fitch, H. L. (1981). Distinguishing temporal information for speaking rate from temporal information for intervocalic stop consonant voicing. Haskins Lab. Status Report, 65, 1-32.

House, A. S. (1961). On vowel duration in English. Journal of the Acoustical Society of America, 33, 1174-1178.

Lisker, L. (1957). Closure duration and the intervocalic voiced-voiceless distinction in English. Language, 33, 42-49.

Mitleb, F. M. (1984). Voicing effect on vowel duration is not an absolute universal. Journal of Phonetics, 12, 23-27.

O'Kane, D. (1978). Manner of vowel termination as a perceptual cue to the voicing status of post-vocalic stop consonants. Journal of Phonetics 6, 311-318.

Peterson, G.E. and Lehiste, I. (1960). Duration of syllable nuclei in English. Journal of the Acoustical Society of America, 32, 693-703.

Port, R. F. (1978). Effects of word internal versus word external tempo on the voicing boundary for medial stop closure. Journal of the Acoustical Society of America, 63, S20 (Abstract).

Port, R. F., Al-Ani, S. and Maeda, S. (1980). Temporal compensation and universal phonetics. Phonetica, 37, 235-252.

Raphael, L. J. (1972) Preceding vowel duration as a cue to the perception of the voicing characteristics of word final consonants in American English. Journal of the Acoustical Society of America, 51, 1296-1303.

Wang, W. S.-Y. (1959) Transition and release as perceptual cues for final plosives. Journal of Speech and Hearing Research 2, 66-73.

FOREIGN ACCENTS AND PERCEPTUAL PROCESSING

Maria Wingstedt and Richard Schulman
Department of Linguistics
University of Stockholm

Introduction

This paper accounts for an investigation, the main purpose of which is to study the strategies a listener employs when trying to understand a speaker with a heavy foreign accent.[1]

A foreign accent can be seen as the consequence of a speaker applying the phonological rules of a language - usually the mother tongue - upon a target language. In other words, instead of learning new phonological rules, the speaker transfers the already known rules of production from one language to another. Such transfer may affect the intelligibility of the speech. If the interfering phonological rules are many, comprehension can at times be impossible. Will, then, communication improve only if the speaker can better his pronunciation, or is it possible that the listener can learn to interpret the foreign accent by continued exposure? A basic assumption in this investigation is that the more the listener is exposed to the accent, the better his ability to interpret it will become. The question asked, then, is: By what means will the listener accomplish this? What are the strategies employed during the process of learning to interpret a particular accent?

One hypothesis is that the listener, when exposed to the foreign accent, analytically will form general phonological perception rules roughly corresponding to the production rules which gave rise to the accent. The perception rules would be formed by inferences from the increasing corpus of erroneous pronunciations, generalizations which will guide the listener in decoding pronunciations of words not heard earlier. Another hypothesis is that the listener uses a gestalt strategy, whereby specific words are stored in an "equivalence lexicon". In this case, a particular pronunciation is identified as being equivalent the intended word, but no phonological analyses or generalizations are made to extend this to other words. We believe that both processes are real and may interact with each other, though interpretation by rule formation is the primary means for comprehension.

In summary, the hypotheses in the investigation were the following: