The role of intonation for the perception of sentence types in Greek

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1 Introduction

The present experimental study focuses on the effects of intonation on sentence type-perception in Greek. It aims to investigate whether intonation can be a decisive factor for the perception of statements, polar questions, wh-questions and commands.

For this purpose two experiments were carried out: (a) one based on artificial (hum) sound analogs, where all linguistic information, except prosody, is eliminated (Chaida, 2008), and (b) one based on flat synthetic stimuli, where all intonational information was eliminated.

1.1 Background

It has often been assumed that one of the most uncontroversial functions of intonation is that of conveying different illocutionary aspects or modes (Hirst & Di Cristo, 1998).

Different sentence types are usually associated with both local and global tonal structures. Questions e.g., in comparison to statements, are mostly associated with higher tonal structures, such as a higher tonal register, less tonal declination or a final tonal rise (among others, Gussenhoven, 1984; Grønnum, 1998; 't Hart, 1998; van Heuven & Haan, 2000; Botinis, et al., 2001; Makarova, 2001).

Although several linguistic factors may be associated with different sentence types, such as lexical, syntactic and prosodic ones, the prosodic factor is critical, especially in languages where different sentence types may differ only in prosody, such as polar questions in Greek and Italian. In the absence of any morphological or syntactic markers, the distinction between sentence types is assumed to be based on the prosodic form.

Studies in Greek prosody have indicated that there are several tonal characteristics, which may uniquely distinguish each sentence type (Botinis, 1998; Baltazani, 2002, 2003, 2007; Chaida, 2007, among others). More specifically, the following (see Figure 1 from Chaida, 2007) typical tonal structures have been found to correspond to statements, (polar and wh-) questions and commands.

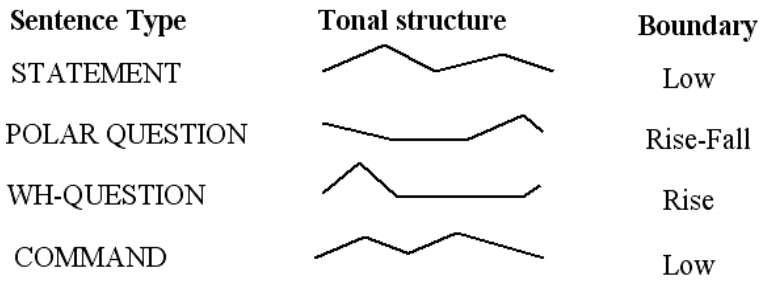

Figure 1. Stylized tonal structures and tonal boundaries in four main sentence types in Greek.

2 Experiment A

A main question posed for the first experiment (preliminary data were reported in Chaida, 2008) is whether prosody alone can be a decisive factor for the perception of statements, polar and wh- questions and commands.

For that purpose, artificial (hum) sound analogs were used, without any linguistic information, except for prosody.

2.1 Methodology A

A representative set of utterances produced by three female speakers in their early twenties, with standard Athenian pronunciation, was selected from Greek speech material used in previous studies (Chaida 2007). The speech material included variations of the simple sentence |o ma'nolis ma'zevi le'moɲa| (‘Manolis is picking lemons’), and the complex sentence |o ma'nolis ma'zevi le'moɲa ce/ 'otan/ pa'rolo pu i ma'ria mi'razi ba'loɲa| (‘Manolis is picking lemons and/when/although Maria is distributing balloons’), both coordinated and subordinated produced as statements, polar questions, wh-questions and commands, mainly by prosodic means and minor alterations (such as the addition of the wh-word ‘jati’-why for wh-questions and the use of the imperative form of the verb for commands).

This set of 20 recorded utterances was randomized in five different lists. These utterances comprised the perception test stimuli, which were processed with Praat 4.5.21 (Boersma & Weenik, 2007), in order to create sounds with the algorithm described at Point Process: To Sound (hum), in which the glottal source sound was replaced by a hum source (“Pitch (hum) resynthesis”). This process aimed to create stimuli for which prosody would be the only factor judged without any lexical, morphological or syntactic influences.

The synthetic stimuli were presented to 32 informants, male and female, 20-40 years old, native speakers of Greek, with no hearing problems, through a program designed for this perception test on C#, functioning on .Net framework.

The experiment took place in a quiet room through headphones (Sennheiser HD205 closed back headphones, response bandwidth 14-20000 Hz). The informants were asked to select the most suitable answer for each of the stimuli in one closed set test. They were instructed to identify statement, question and

command, after they heard each stimulus, and then grade their answer within a 1-6 scale of certainty (1=least certain, 6=most certain).

Statistical analysis was carried out with Statgraphics 5.0 and StatView 5.0.

2.2 Results A

The results of the first experiment are shown in Figures 2-5. In the first instance, it is evident that, although overall identification rates are not as high as might be expected, the majority of identified sentence types match the intended ones, ranging from 35 to 72%.

Statements (Figure 2) were identified as intended by 52.08% of the listeners, while 29.43% identified them as commands and 18.49% as questions. The mean grade for listeners' certainty was 3.32 (out of 6), but the ANOVA table showed that certainty was not a significant factor for statements ($p>0.01$, $F(2,381)=1.33$).

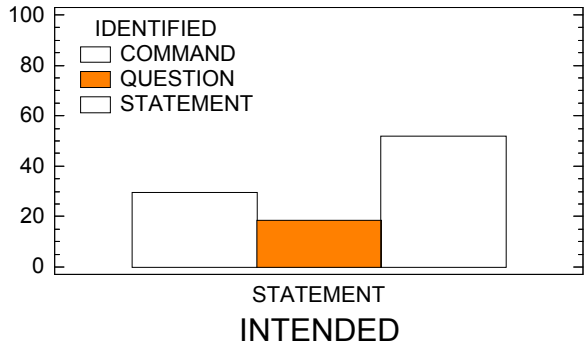

Figure 2. Identification rates (%) for intended productions of statements.

Commands (Figure 3) were identified as intended by 35.42% of the listeners, while 32.47% identified them as questions and 32.12% as statements. The mean grade for listeners' certainty was 3.41 (out of 6), but the ANOVA table showed that certainty was not a significant factor for commands ($p>0.01$, $F(2,573)=2.53$).

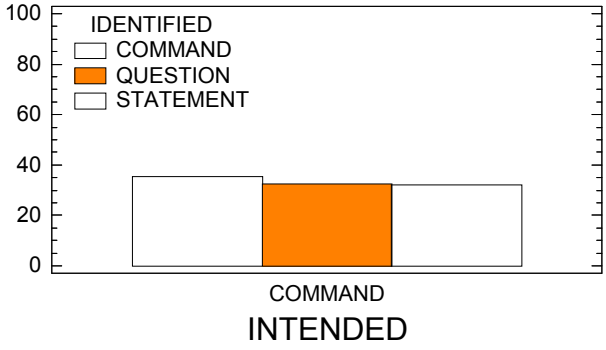

Figure 3. Identification rates (%) for intended productions of commands.

Wh-questions (Figure 4) were identified as intended (questions in general) by 72.92% of the listeners, while 11.72% identified them as commands and 15.36% as statements. Certainty was a significant factor for wh-questions, as shown by the ANOVA table ($p<0.01$, $F(2,381)=24.37$).

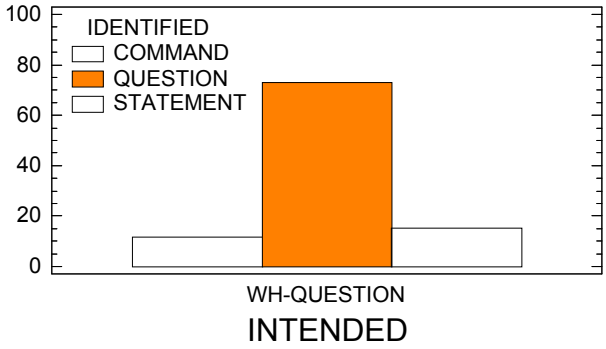

Figure 4. Identification rates (%) for intended productions of wh-questions.

Polar questions (Figure 5) were identified as intended (questions in general) by 45.31% of the listeners, while 21.70% identified them as commands and 32.99% as statements. Certainty was a significant factor for polar questions, as shown by the ANOVA table ($p<0.01$, $F(2,573)=35.80$).

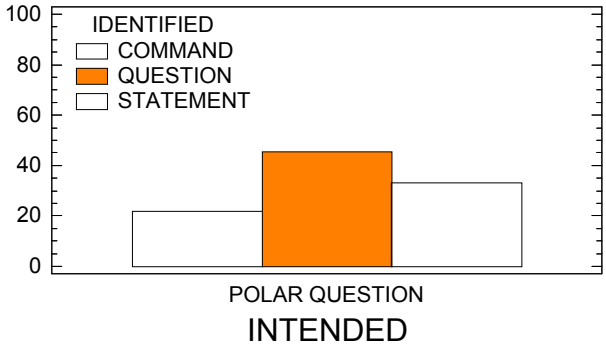

Figure 5. Identification rates (%) for intended productions of polar questions.

According to the chi-square test, the observed value of 'intended' is related to its value for 'identified' in all cases at the 99% confidence level ($x^2=288.57$, $df=6$, $p<0.01$).

Concerning the factor of certainty, the relevant chi-square test carried out revealed that the observed value of 'certainty' is related to its value for 'answer' at the 99% confidence level ($x^2=86.19$, $df=5$, $p<0.01$).

Sentence complexity is proved to be a significant factor for sentence-type perception, related to the listeners' answers at the 99% confidence level (x^2=8.39, df=1, p<0.01). An interesting observation is that simple sentences had lower rate of correct identification (42.86%), compared to complex ones (50.82%). Furthermore, conjunctions seem to influence listeners' choice, since conjunction variation is related to the answers given at the 99% confidence level (x^2=18.72, df=3, p<0.01). Additionally, ANOVA tables split by sentence types show that conjunctions are significant for commands (F(3,572)=8.92, p<0.01), for polar questions (F(3,572)=13.39, p<0.01), and for wh-questions (F(3,380)=9.94, p<0.01), but not for statements (F(3,380)=0.75, p>0.01).

3 Experiment B

The second experiment, in comparison to the first one, aimed to investigate the perception of sentence types without the influence of intonation, based only on linguistic information, with the aid of duration and intensity.

The basic question investigated through this experiment is how important is the effect of intonation on the perception of sentence types in Greek, in particular of statements and polar (yes/no) questions. The experiment aims to examine if and to what extent sentence types can be recognized based only on morphosyntactic information.

3.1 Methodology B

This experiment involved statements and polar questions and the same set of natural utterances was used, including simple and complex sentences. The material used consisted of 4 natural statement utterances and 4 natural polar question utterances of simple and complex sentences. The speech material included variations of the simple sentence |o ma'nolis ma'zevi le'moɲa| (Manolis is picking lemons), and the complex sentence |o ma'nolis ma'zevi le'moɲa ce/ 'otan/ pa'rolo pu i ma'ria mi'razi ba'loɲa| (Manolis is picking lemons and/when/although Maria is distributing balloons), both coordinated and subordinated (see 2.1).

The material was produced by two women in their late twenties at the time of the experiment, native speakers of standard Athenian Greek.

The natural stimuli were processed with Praat 4.5.21 (Boersma & Weenik, 2007), in order to convert the F0 to a flat contour, based on the mean of tonal width of each utterance, so as only linguistic information – with duration and intensity – would be the only factors judged without any intonational influences.

The synthetic stimuli were mixed with natural stimuli. Thus, a set of 16 utterance (8 flat synthetic + 8 natural) was set up, which was randomized 5 times.

These stimuli were presented to 30 informants, 15 male and 15 female, in their early twenties, native speakers of Greek, with no hearing problems, through a program designed for this perception test on C#, functioning on .Net framework.

The experiment took place in a quiet room through headphones (Sennheiser HD 205 closed back headphones, response bandwidth 14-20000 Hz). The informants were asked to select the most suitable for them answer for each of the stimuli in one closed set test. They were instructed to identify statement, question and command, after they heard each stimulus, and then grade their answer within a 1-6 scale of certainty (1=least certain, 6=most certain).

Statistic analysis was carried out with Statgraphics 5.0 and StatView 5.0.

3.2 Results B

The results of the second experiment are shown in Figures 6-9. It is worth mentioning that the natural stimuli alone were identified as intended 99% of the times. However, the results for flattened synthetic stimuli were disparate, since statements received quite high identification rates (80 %), while questions received quite low identification rates (23 %).

In Figure 6 the identification results of the natural and flat synthetic statements, in total, are presented, and in Figure 7 the identification results of the natural and flat synthetic questions, in total, are presented.

Statements, natural and synthetic, in total, were identified as statements 89.5 % of times and only 10.5 % as questions. Questions were identified as questions 60.67 % of times, while 39.33 % of them were identified as statements. However, it is reasonable to have such high percentages of correct identification, since in the total of answers identification of natural stimuli is also included.

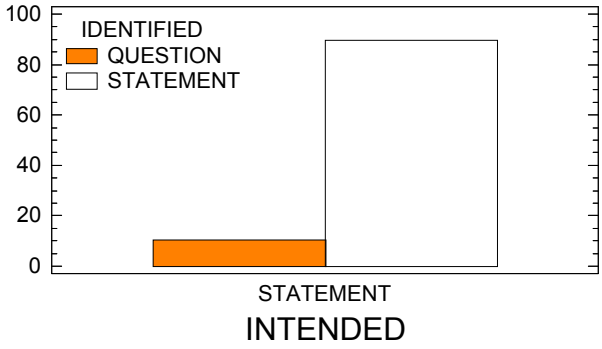

Figure 6. Identification of statements, natural and flat synthetic in total (%).

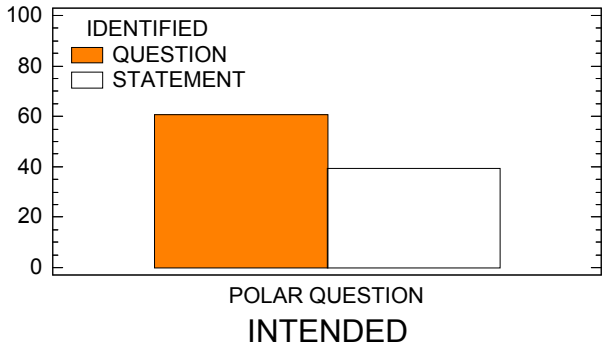

Figure 7. Identification of polar questions, natural and flat synthetic in total (%).

In Figure 8 the identification results of flat synthetic statements are presented alone, and in Figure 9 the identification results of flat synthetic questions are presented alone.

It is shown that out of 300 flat synthetic statement stimuli 80.33 % of them were identified as statements 19.67 % of them as questions. However, the identification results for questions are of more interest, since 76.33 % out of 300 flat synthetic questions stimuli were identified as statements, while only 23.67 % of them were perceived as questions, and thus as intended.

According to the chi-square test, the observed value of 'intended' is related to its value for 'identified' at the 99% confidence level (x^2=327.20, df=1, p<0.01). The ANOVA table showed that the gender of speakers or listeners was not significant (F(1,1198)=2.539, p>0.01). Concerning the factor of certainty in all cases, the relevant chi-square test showed that it is related to its value for 'answer' at the 99% confidence level (x^2=, df=, p<0.01).

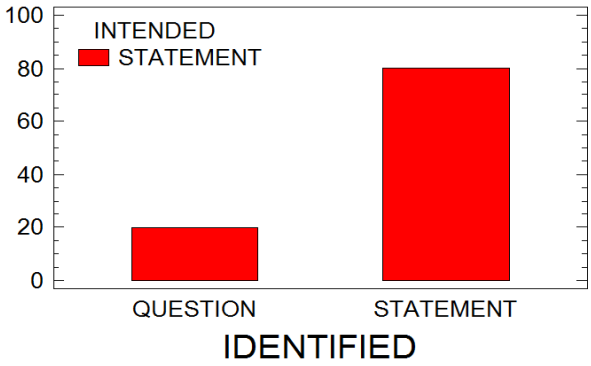

Figure 8. Identification of flat synthetic statements (%).

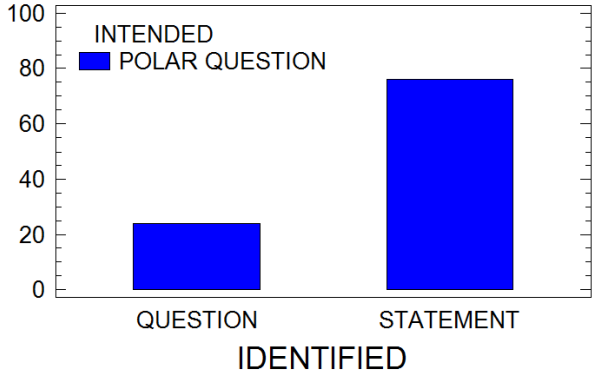

Figure 9. Identification of flat synthetic polar questions (%).

Certainty ratings were fairly high, in general: 4.66 mean value for statements and 5.11 for questions (out of 6). Concerning the factor of certainty, in all cases, the chi-square test showed that the observed value of 'certainty' is related to its value for 'answer' at the 99% confidence level (x^2=51.18, df=5, $p<0.01$). Certainty was statistically significant for answers ($F(1,1198)=24.601$, $p<0.01$).

4 Discussion

The results of the present study indicate that intonation is a very important factor for the perception of sentence types in Greek.

On one hand, the first experiment showed that sentence types may be identified through prosody, but it seems that this might not be the only distinctive cue for perception, since the identification rates were not very high in all cases. However, identification rates could not be expected to rise higher, because of the nature of the stimuli, which were obtained by synthetic modification (hum), as other studies with synthetic stimuli also indicate (e.g. Makarova, 2001). Thus, in the present experiment, an identification of 50-60% might be considered as an indicator of categorization between the 3 sentence types (statement, question, command). Apart from that, statistic analysis revealed that the listeners' choices were not random, since it was closely related to all factors that contributed to the experiment (sentence type, complexity, conjunctions). Wh-questions received the highest identification rates, while for the other sentence types falling boundary tones seem to be confusing for listeners. The findings of the first experiment (see also Chaida, 2008) agree with earlier studies demonstrating that in many languages low or falling boundary tones elicit 'declarative judgments', and high or rising tones lead to 'interrogative' (e.g. Thorsen, 1980, Makarova 2001).

On the other hand, the second experiment showed that intonation is crucial for the perception of sentence types, since linguistic and other prosodic information

are not sufficient. In particular, it was shown that without any intonational information statements and questions could not be distinguished adequately.

Quite apart from that, according to the results of the second experiment, listeners tend to "prefer" statements for sentences with SVO structure. The fact that statement is taken as a "default" by listeners, when no intonational cues are present requires more investigation, since it might involve psycholinguistic processes.

In general, each sentence type has an acoustically distinct tonal structure, characterized in Greek by the type and location of tonal prominence (nucleus) and boundary tone (Botinis et al., 2000; Baltazani, 2002, 2003; Chaida, 2005, 2007). Actually, findings from previous studies showed that natural stimuli achieved one-to-one identification (Chaida, 2005).

In conclusion, according to the findings of this study, it seems that other linguistic or/and phonetic factors contribute to the perception of sentence types in Greek, however intonation plays a decisive role.

Acknowledgments

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