Modality disambiguation and tonal correlates

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The present study concerns an experimental analysis of modality disambiguation and tonal correlates in Greek. Two female and two male speakers produced two sets of utterances with the lexical modality distinctions "bo'ri" (fairly close to "may") and "'prepi" (fairly close to "must") in two different contexts. In the first context the modal verbs express "necessity" whereas in the second context these very same verbs express "probability". Tonal analysis was carried out, according to which the necessity production was associated with focus assignment whereas the probability production had no specific focus assignment at the domain of lexical modality.

1. Introduction

The present study is within an experimental phonetics and computational linguistics research context in the analysis and modeling of prosody (Botinis, Gawronska, Bannert & Sandblom, to appear). The long-term target of this research paradigm is the development and formalization of prosodic rules and prosodic modelling with reference to segmental, lexical, syntactic, semantic, and discourse correlates. A crosslinguistic analysis of prosody is carried out, including English, German, Greek and Swedish and the resulting model will be associated with multiple applications, in the first place text-to-speech conversion, but also machine translation as well as pedagogical and medical applications.

In this paper, we concentrate on the relation between prosody and modality semantics. In particular, we report on an experimental analysis of lexical modality and tonal disambiguation in Greek. We concentrate on two modal verbs, i.e. "bo'ri" (fairly close to "may") and "'prepi" (fairly close to "must"). "bo'ri" may convey "ability" and "probability" whereas "'prepi" may convey "obligation" and "logical entailment". Thus, both verbs are typical modal verbs in Greek with distinct meanings. In addition to these meanings, both verbs may however convey a variety of other meanings, which may also overlap, in accordance with the linguistic context and the pragmatic interpretation of the utterance.

Modality and similar terms, such as "mode", "mood" and "modus" are found rather interchangeably in the international literature. Traditionally, these terms are mostly associated with morphological or lexical representations, whereas in modern linguistic theory the contribution of intonation is widely acknowledged in standard modality distinctions such as declaratives, vocatives, optatives, etc. (Hirst and Di Cristo, 1998). This implies that intonation may have grammatical functions either in combination or in the absence of formal linguistic representations such as morphology and syntax (Botinis, 1998; Hirschberg & Avesani, 2000). The main question in the present study is whether disambiguation of lexical modality in Greek is a function of tonal distribution across declarative utterances.

2. Experimental methodology

Two female and two male Athenian speakers produced the modal words "bo'ri" and "'prepi" in a carrier sentence, in five repetitions. In order to elicit the modality distinctions a short paragraph context was introduced, according to which the indented meaning and the semantics of the utterances were disambiguated (see Table 1). The context was read aloud by each speaker before the sentences in question were uttered. The speech analysis was carried out with the WaveSurfer and the statistical processing with StatView.

Table 1. Modality semantics, elicitation context and speech material.

Meaning and linguistic context	Speech material
Ability	
[i maˈria ðe θa ˈpai puθeˈna ta xriˈstuɣena ce o erɣoˈðotis tis tin ˈeçi aˈnaɟi kaˈta tin peˈrioðo ton ɟorˈton │ eˈcini ðen ˈeçi ˈprovlima na erˈɣazete]	[i maˈria boˈri na ðuˈlevi stin eˈlaða ta xriˈstuɟena]
(Maria is not going anywhere during Christmas and her employer needs her for the period of the holidays. She has no problem with working).	(Maria may be working in Greece during Christmas).
Probability	
[i maˈria aˈpo ˈoso ˈksero ðe θa ˈpai puθeˈna stis ɟorˈtes ce ˈeçi aˈnaɟi apo ˈxrimata aˈfto to ɟeˈro │ ˈine poˈli piθaˈno na erˈazete]	[i maˈria boˈri na ðuˈlevi stin eˈlaða ta xriˈstuɟena]
(Maria, as far as I know, is not going anywhere for the holidays and she needs money these days. It is highly probable that she will be working).	(Maria may be working in Greece during Christmas).
Obligation	
[ti maˈria tin ˈeçi aˈnaɟi o eroˈðotis tis kaˈta tin peˈrioðo ton ɟorˈton ce ðen tis ˈðini ˈaðia na ˈfiɟi aˈpo tin eˈlaða]	[i maˈria ˈprepi na ðuˈlevi stin eˈlaða ta xriˈstuɟena]
(Maria is needed by her employer during the period of the holydays and he does not give her permission to leave Greece).	(Maria must be working in Greece during Christmas).
Logical entailment	
[i maˈria aˈpo ˈosa ˈksero ɟa aˈftin xoˈris na ˈime poˈli ˈsiɣuros ˈine piθaˈno na erˈɣazete eˈðo kaˈta ti beˈrioðo ton ɟorˈton]	[i maˈria ˈprepi na ðuˈlevi stin eˈlaða ta xriˈstuɟena]
(Maria, as far as I know about her, without being so sure, it is probable that she will be working here during the holidays).	(Maria must be working in Greece during Christmas).

3. Results

A typical example of each modality distinction is shown in figures 1-2. Quantitative results, on the other hand, are shown in figures 3-4.
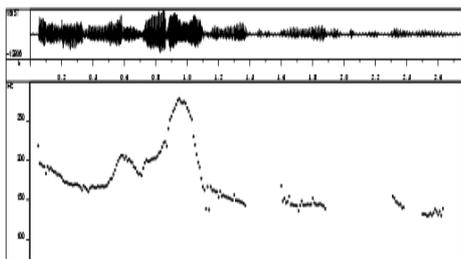
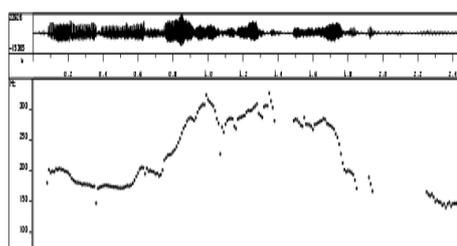Figure 1a. Tonal structure of **"bo'ri"** necessity modality distinction (see text).

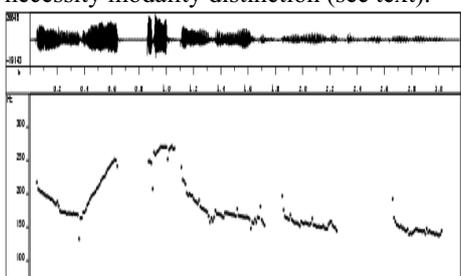Figure 1b. Tonal structure of **"bo'ri"** probability modality distinction (see text).

Figure 2a. Tonal structure of **"'prepi"** necessity modality distinction (see text).
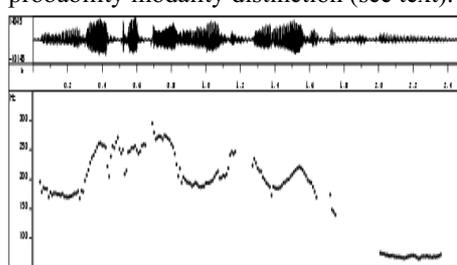

Figure 2b. Tonal structure of **"'prepi"** probability modality distinction (see text).
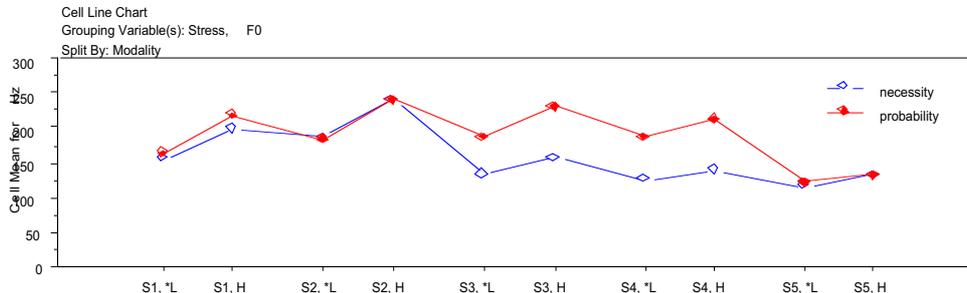

Figure 3. Measurements at L(ow) and H(igh) tonal points in Hz, in accordance with stress groups 1-5 (S1-S5) as a function of necessity and probability modality distinctions.
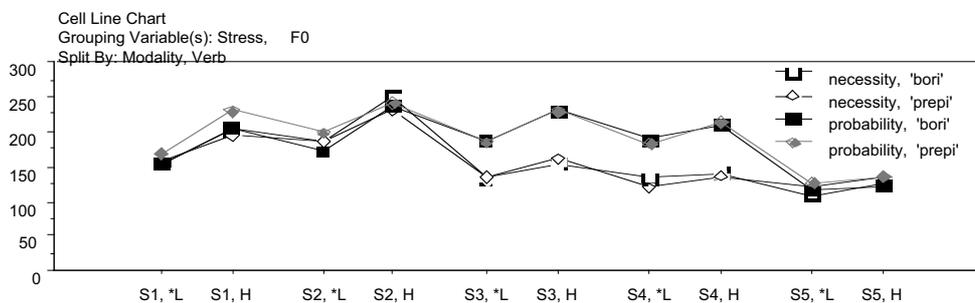

Figure 4. Measurements at L(ow) and H(igh) tonal points in Hz, in accordance with stress groups 1-5 (S1-S5) as a function of modality distinctions and modal verbs.

In Figures 1a and 2a the tonal range of the key words "bo'ri" and "'prepi" is considerably expanded, whereas the rest of the utterances is deaccentuated. In Figures 1b and 2b, on the other hand, there is considerable tonal variation in accordance with the stress groups, especially the VP stress groups. These two distinct tonal patterns correspond to necessity and probability modality functions, respectively. Particularly, in accordance with the question put in the introduction and the corresponding methodology, the modal verb "bo'ri" conveys here ability (Figure 1a) and probability modality (Figure 1b), whereas the modal verb "'prepi" conveys obligation (Figure 2a) and logical entailment modality (Figure 2b). Thus, the distinctions of modality examined in this study are mainly characterised by the application of focus. The necessity distinction is realized with a narrow focus on the modal verb ("bo'ri / 'prepi"), whereas the probability meaning has a broad focus which encompass the whole verb phrase ("bo'ri / 'prepi na ðuˈlevi"), including the place adverbial phrase ("stin eˈlaða"), but not the time adverbial phrase ("ta xriˈstuɟena") which is deaccentuated.

In Figures 3 and 4 quantitative data of the results is presented. In Figure 3 the first, second and last stress groups have the same tonal realisation, whereas the third and fourth stress groups have different tonal range realisations, as a function of modality distinction, in accordance with the qualitative analysis above (see Figures 1-2), which reaches a high significant level (F=42.5; P<0.0001). The five stress groups have a large variability of tonal realisation (F=42.2; P<0.0001). There was a significant interaction between stress groups and modality (F=11.2; P<0.0001). In Figure 4, there is no distinct tonal pattern between the verbs "bo'ri" and "'prepi" (no significant effect at 0.05 level), but the modality distinction is kept constant, by and large much the same, as in Figure 3, as well as in Figures 1-2.

4. Conclusions

The results of the present study indicate that the necessity distinction is mainly realised by narrow focus on the modal verb itself, whereas the probability distinction is mainly realised by broad focus application, which has a larger domain, encompassing the verb phrase and the following adverbial phrase. The investigated modality verbs "bo'ri" and "'prepi", on the other hand, do not show any distinct tonal pattern.

5. References

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