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Greek non-negative *min*, epistemic modality, and positive bias

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Abstract
Modern Greek displays two variants of the word *min*; one corresponds to a negative marker, and the other corresponds to an epistemic modal. We focus on the latter and provide, for the first time to our knowledge, experimental evidence on its exact interpretation, showing that (i) non-negative *min* is incompatible with the overt realization of polar propositional alternatives $\{p, \neg p\}$, (ii) it conveys medium speaker certainty with respect to the expressed proposition p, and (iii) it encodes speaker bias in favor of p. Our findings support the novel generalization that non-negative *min* is uniformly interpreted as conveying that the speaker is neither unbiased nor negatively biased (as suggested by the previous literature on the topic), but positively biased with respect to a proposition p. We argue that non-negative *min* is a biased epistemic modal that needs to be licensed by an external non-veridical operator.

Keywords *min* · epistemic modality · positive bias · experimental approach · Modern Greek

1 Introduction

A speaker feels, admittedly, most confident when they can contribute information to a discussion by means of an unmitigated assertion, as in (1) from Greek.

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(1) Tros pola ghlika.
eat.2SG many sweets
'You eat a lot of candy.'

If our speaker is being cooperative (Grice 1989), their uttering (1) means that they know the expressed proposition corresponding to *The addressee eats a lot of candy* to be true (Austin 1962; Searle 1969). However, they can also find themselves in complete ignorance of their interlocutor's diet. In that case, the assertion above would be replaced by the polar question that follows.

(2) Tros pola ghlika?
eat.2SG many sweets
'Do you eat a lot of candy?'

The utterance in (2) conveys that the speaker does not have access to the truth of the expressed proposition *The addressee eats a lot of candy* (in the spirit of Searle 1969) and therefore believes both this proposition and its polar alternative, namely *The addressee doesn't eat a lot of candy*, to be possible (Giannakidou 2013; Farkas 2020; Giannakidou and Mari 2021).

Interestingly there is a third possibility, that lies conceptually in the middle of the two situations described above. Specifically, a speaker may be ignorant regarding the truth of a proposition p, that is they believe both p and $\neg p$ to be possible, while considering one alternative as more likely than the other. This is usually dubbed in the linguistics literature as *bias*.

Positive or negative bias, broadly defined as the speaker's epistemic preference for the expressed proposition p or its polar alternative $\neg p$ respectively, has most often been related to negative polar questions, like (3) (Pope 1976; Büring and Gunlogson 2000; Romero and Han 2004; Reese 2006; Reese and Asher 2009; Krifka 2017, 2021; Arnhold et al. 2020; among others).

(3) *Dhen* tros pola ghlika?
NEG_1 eat.2SG many sweets
'Don't you eat a lot of candy?'

Specifically, such questions are reported to be ambiguous, depending on whether negation is interpreted at the propositional level or at a higher level (Ladd 1981; Holmberg 2013; among others). Under the propositional negation reading, (3) conveys that the speaker has at least some evidence supporting the negative answer—i.e., *The addressee doesn't eat a lot of candy* (Pope 1976; Büring and Gunlogson 2000; Sudo 2013; Krifka 2021). Under the higher negation reading, (3) is attributed to a speaker who believes the proposition corresponding to the positive answer (i.e., *The addressee eats a lot of candy*) to be more likely than the complementary proposition (i.e., *The addressee doesn't eat a lot of candy*) (Romero and Han 2004; Reese 2006; Reese and Asher 2009; Krifka 2017). In other words, negative polar questions are one of the ways in which natural languages encode (negative or positive) speaker bias.

Following the work by Giannakidou and Mari (2017, 2018, 2019, 2021), we understand the term bias to apply to epistemic preferences that possibly arise, not only in questions, but in all non-veridical environments in the sense of Giannakidou (1997;

and subsequent work). Under such a view, speaker bias is relevant also for modalized assertions, where it is triggered by the presence of modal verbs and epistemic adverbs; see (4a) and (4b), respectively.[1]

(4) a. *Prepi* na tros pola ghlika.[2]
must SUBJ eat.2SG many sweets
'You must eat a lot of candy.'
b. *Malon* tros pola ghlika.
probably eat.2SG many sweets
'You probably eat a lot of candy.'

When uttering either (4a) or (4b), the speaker does not know that the addressee eats a lot of candy. Crucially, though, they consider this possibility as more likely than the polar alternative corresponding to *The addressee doesn't eat a lot of candy*; the speaker is in this sense positively biased (Giannakidou and Mari 2017).

In the present study we focus on a third linguistic device used in Greek to convey speaker bias, namely non-negative *min* exemplified by the pair in (5).

(5) a. Fovame *min* tros pola ghlika.
fear.1SG MIN eat.2SG many sweets
'I fear you maybe eat a lot of candy.'
b. *Min* tros pola ghlika?
MIN eat.2SG many sweets
'Do you maybe eat a lot of candy?'

While Greek *min* normally spells out a sentential negation marker (Holton et al. 1997), it is interpreted non-negatively when found under the scope of certain non-veridical operators (Makri 2013; Chatzopoulou 2018). Previous research has identified non-negative *min* as a modal element that conveys that the speaker has no bias or is positively biased with respect to the proposition embedded under a fear-predicate—e.g., the proposition corresponding to *The addressee eats a lot of candy* in (5a) (Makri 2013). Independent research (Giannakidou and Mari 2019) has argued that non-negative *min* has a weakening effect in questions such as (5b); venturing a parallel formulation, *min* is considered as a negative bias marker. Given the existence of such contradictory claims, we decided to further investigate *min*. In this study, we present for the first time to our knowledge experimental evidence that non-negative *min* is interpreted uniformly as conveying that the speaker is neither fully ignorant nor negatively biased, but positively biased regarding the expressed proposition p.

The rest of the paper is organized as follows. In Sect. 2 we build on the existing literature in order to describe the status of *min* in Greek grammar, its distribution and use. In the third section, we present in detail the experimental study we carried out to determine the interpretation of *min* on an empirical basis. Based on the results of this study, we proceed to propose a novel formal analysis of *min* as a positively

[1] See Liu et al. (2021) for a study of bias in conditionals.

[2] It is only the epistemic, not the deontic, reading of *prepi* that is relevant to our discussion. See Giannakidou and Mari (2021) for a discussion of deontic *prepi*.

biased epistemic modal in the modality framework developed by Giannakidou and Mari (2017, 2018, 2019, 2021) in Sect. 4. Section 5 concludes the paper.

2 Greek non-negative *min*

The Greek word *min* is most often described as a negative marker that arises in non-veridical environments (Giannakidou 1998; Chatzopoulou 2018). In (6) below, *min* appears in the scope of the non-veridical subjunctive operator *na*.[3] Note that, since Greek is a Strict Negative Concord language (Giannakidou 1997, 1998; Zeijlstra 2004), the negative *min* in (6) can license Negative Concord Items (NCIs), like the emphatic *TIPOTA* 'nothing.'

(6) Ipa na *min* fas TIPOTA.[4]
said.1SG SUBJ NEG_2 eat.2SG nothing
'I told you not to eat anything.'

Interestingly, linguistic research (Makri 2013; Roussou 2015; Chatzopoulou 2018; Giannakidou and Mari 2019) has brought attention to instances of *min* where no negative interpretation is obtained. Specifically, as anticipated in (5), when *min* appears in the complement of a fear-denoting predicate (7) or in initial position of a root (8a) or embedded (8b) polar question, it is not interpreted as a negative marker. Like its negative counterpart, non-negative *min* needs to be licensed by a non-veridical operator (i.e., the fear-predicate or the question operator).[5] However, it cannot license the NCI *TIPOTA*.[6]

[3] In fact, traditional grammars of Greek (Holton et al. 1997) define *min* as the subjunctive negation, which however proves to be a theoretically complicated or empirically inaccurate claim.

[4] We gloss negative occurrences of *min* as NEG_2, to distinguish it from *dhen* which is glossed as NEG_1, and non-negative occurrences of *min* as MIN, to distinguish it from NEG_2. Throughout the paper, we translate non-negative *min* in English as *maybe*. This is a convention that helps demonstrate merely the epistemic modal interpretative import of *min*; its exact interpretation is reflected in the results of the experimental study and is made explicit in Sect. 4.

[5] We further report here the understated use of non-negative *min* in conditionals. We thank Konstantina Olioumtsevits for bringing this data point to our attention.

(i) *Min* po kati, amesos na griniaksis!
MIN say.1SG.PERF something immediately SUBJ whine.2SG
'If I say something, you will immediately start whining!'

This use is not discussed any further in the paper because it was not included in our experimental study. What is important to our discussion is that, in this case too, *min* is licensed by a non-veridical operator, namely the conditional.

[6] We note that, although the emphatic *TIPOTA* is out in (7) and (8), the corresponding Negative Polarity Item (NPI) non-emphatic *tipota* 'anything' is possible. Crucially, though, the NPI *tipota* is not licensed by *min* but by the non-veridical operator that also licenses *min*.

(i) Fovame *min* troi tipota.
fear.1SG MIN eat.3SG anything
'I fear he is maybe eating something.'

(7) Fovame *min* troi ghlika/ *TIPOTA.
fear.1SG MIN eat.3SG sweets nothing
'I fear he maybe eats candy.'

(8) a. *Min* troi ghlika/ *TIPOTA?
MIN eat.3SG sweets nothing
'Does he maybe eat candy?'
b. Kita *min* troi ghlika/ *TIPOTA.
look.IMP.2SG MIN eat.3SG sweets nothing
'Check if he maybe eats candy.'

Moreover, this non-negative *min* can co-occur with the Greek indicative negative marker *dhen* (Holton et al. 1997) without giving rise to a double negation reading, as shown in (9); in that case *TIPOTA* is licensed by the presence of negative *dhen*.

(9) Fovame *min dhen* troi arketa ghlika/ TIPOTA.[7]
fear.1SG MIN NEG_1 eat.3SG enough sweets nothing
'I fear maybe he doesn't eat enough candy/anything.'

What has been so far presented merely allows us to describe non-negative occurrences of *min* as different from the negative ones. However, the exact interpretation of non-negative *min* has remained unspecified up to this point. This is what we are getting into next.

Makri (2013), while studying *min* in complement position of Greek fear-predicates, makes an observation that is key to determining its interpretation. She notices that *min* is incompatible with epistemic modals, such as the adverb *malon* 'probably' in (10a). This is not the case with *oti* 'that'-complements of predicates of fear, the only clausal structural alternatives to fear-complementation available in Greek, which are perfectly compatible with *malon* (10b).

(10) a. Fovame *min* (#malon) troi pola ghlika.
fear.1SG MIN probably eat.3SG many sweets
'I fear he maybe eats a lot of candy.'
b. Fovame oti malon troi pola ghlika.
fear.1SG that probably eat.3SG many sweets
'I fear that he maybe eats a lot of candy.'

The complementary distribution of *min* with an epistemic modal adverb like *malon* is taken as an indication that non-negative *min*, too, has an epistemic interpretative import. Makri (2013) proceeds to make the concrete claim that *min* in fear-predicate

(ii) *Min* troi tipota?
MIN eat.3SG anything
'Is he maybe eating anything?'

[7] We note that a similar structure is found in Hebrew. In the example from Francez (to appear) that follows, *še-lo* is considered as semantically parallel to a modal complementizer.

(i) paxadeti *še-lo* lo yiša'er klum.
feared.1SG that.NEG NEG remain nothing
'I was scared that there would be nothing left.' (Francez to appear: 23, ex. (41))

complement position conveys either the lack of speaker bias or the presence of positive speaker bias. For our example (10a) it could be said that the speaker believes that the expressed proposition p (i.e., *He eats a lot of candy*) and its polar propositional alternative $\neg p$ (i.e., *He doesn't eat a lot of candy*) are equally probable, or that p is more likely than $\neg p$.[8]

Interestingly, what appears to be an opposing claim has been made in relation to *min* in polar questions. Giannakidou and Mari (2019) suggest that *min* has a weakening effect in questions, in the sense that (11a) below would be uttered by a speaker less certain about the answer to be expected (if expecting an answer at all) than the speaker uttering the *min*-free question in (11b).

(11) a. *Min* troi pola ghlika?
MIN eat.3SG many sweets
'Does he, by any chance, eat a lot of candy?'
b. Troi pola ghlika?
eat.3SG many sweets
'Does he eat a lot of candy?'

Summing up, the existing linguistic literature has motivated empirically a distinction between negative and non-negative *min*, which for the purposes of the present study are considered to represent separate lexical entries.[9] While both negative and non-negative *min* need to be licensed by a non-veridical operator, the former is interpreted as a negative marker and the latter is interpreted as an epistemic modal. There is an ongoing debate as to the exact epistemic contribution of non-negative *min*, with all three possibilities—namely lack of bias, positive bias, and negative bias—having been put forth. In the present paper we attempt to settle the debate by offering experimental evidence on the topic. The experimental study we carried out is described in the upcoming section.

3 The experimental study

In order to gather conclusive evidence regarding the interpretation of non-negative *min*, we designed and carried out a study consisting of three experiments. Recall that the insight offered by previous researchers was contradictory, with the epistemic contribution of *min* ranging from positive to negative bias. Therefore, it was methodologically advisable that we made a choice and formulated a working hypothesis. We based our choice on one theoretical consideration and one empirical intuition. As regards the former, we chose the most economical analytical alternative according to

[8] To be precise, Makri (2013) argues that *oti*-complements (10b) show what we have called positive speaker bias, while *min*-complements (10a) show either lack of bias or positive bias. This being the case, the speaker's choice of *min* over *oti* is predicted to trigger an implicature of absence of speaker bias (Makri 2013: 64).

[9] We remain agnostic as to the (historical) connection between negative and non-negative *min*. We refer the interested reader to Chatzopoulou (2018), for the idea that non-negative *min* emerged via grammaticalization and reanalysis of the negative one, and Roussou (2015), for speculations around the possibility that it is negative *min* that is derived from the non-negative one.

which *min* is interpreted uniformly in the complement of fear-predicates and in questions. Following the latter, we opted for the positive bias interpretation of *min*. Our hypothesis is explicitly stated in (12):

(12) Non-negative *min* is always interpreted as a positively biased epistemic modal.

In what follows, we present in detail the experiments carried out to test this hypothesis one by one.

3.1 Experiment 1

Our first experiment was based on an acceptability judgement task. Experiment 1 aimed to test for a linguistic reflex of the hypothesis in (12). Specifically, if non-negative *min* conveys bias, it is predicted to reject the realization of polar propositional alternatives $\{p, \neg p\}$. The incompatibility of bias with the presence of alternatives is known in relation to questions already since Pope (1976). We believed it would extend to the complements of fear-predicates if our hypothesis about the interpretation of *min* is correct. The specific subhypothesis that was targeted by Experiment 1 is presented in (12i) below.

(12) i. The presence of non-negative *min* in polar questions and complements of fear-predicates is incompatible with the overt realization of polar propositional alternatives.

In an attempt to confirm (12i), the presence vs. absence of *min*, in root polar questions and fear-verb subordinate clauses, was tested against the presence of polar propositional opposites within the same utterance. Participants were shown a set of sentences in isolation and asked to rate the naturalness of each sentence. The study was administered via Alchemer.

Participants. A total of 63 native speakers of Greek (18 males, 45 females; mean age 29.40 years, SD = 7.97) voluntarily took part in Experiment 1. The participants were recruited via Facebook and other social media platforms.

Materials. For Experiment 1, we used a set of 16 critical items, all of which had the abstract form *p or not p*. Half of them (8 items) were construed as questions and the other half (8 items) had the form of fear-predicate embedded assertions. Within each sentence type, another division was made: half of the items (4 items) included *min*, while *min* was absent from the rest (4 items). The interaction of sentence type with the presence vs. absence of *min* created four distinct types of items, which are exemplified below (see the Appendix in Supplementary Materials for the whole set of items).

(13) Question with *min*
Min irthe o Petros i dhen irthe?
MIN came.3SG the Petros or NEG_1 came.3SG
'Did Petros maybe come or not?'

(14) Question without *min*

Aghorasan kenurghio spiti i dhen aghorasan?
bought.3PL new house or NEG_1 bought.3PL
'Did they buy a new house or not?'

(15) Fear-verb complement with *min*

Fovame *min* xalase ti sodhia to xalazi i dhen ti xalase.
fear.1SG MIN destroyed.3SG the crops the hail or NEG_1 it destroyed.3SG
'I fear the hail maybe destroyed the crops or not.'

(16) Fear-verb complement without *min*

Fovate oti i odhighise to Audi o mikros i dhen to odhighise
fear.3SG that or drove.3SG the Audi the small or NEG_1 it drove.3SG
'He fears that the boy either drove the Audi or not.'

It must be noted that the fear-predicate complement items differed from questions in three respects. First, in the former but not the latter, the disjunction of polar propositional alternatives was embedded. Second, in the case of fear-verb complements *min* was not contrasted with its absence but with the complementizer *oti* (e.g., (15) vs. (16)). Third, specifically for fear-predicate complements without *min* (16), the double exclusive disjunction *i . . . i* 'either. . . or' was used. With this decision we tried to rescue the co-occurrence of *oti*—which conveys high certainty (Roussou 2010)—with the *p or not p* disjunction, which was expected to give rise to meaningless or contradictory readings; that is, in a sentence such as (16), the speaker cannot be highly certain of the truth of two complementary propositions.

The predictions derived from subhypothesis (12i) were that (i) questions without *min* would be rated significantly higher than questions with *min*; (ii) there would be no significant difference with respect to naturalness between questions with *min* and fear-predicate complements with *min*, since *min* is supposed to have the same meaning independently of the non-veridical syntactic environment it occurs in; and (iii) fear-predicate complements without *min*—but introduced by *oti*—would be rated significantly higher than their equivalents with *min*.

Experiment 1 further included a set of 16 control items that had the abstract form *p or q* and aimed at making sure that any obtained effect in the case of critical items had to do with the co-occurrence of *min* with polar propositional opposites, and not merely the structural complexity brought about by the presence of propositional alternatives. Half of the controls had the form of root questions (17), and the other half were construed as embedded assertions (18). Note that, as with critical items, the propositional disjunction was unembedded in the case of questions and embedded in the case of assertions.

(17) Tha parete kreas i tha parete psari?
will take.2PL meat or will take.2PL fish
'Are you having meat or fish?'

(18) Apofasise oti i tha taksidepsi stin Asia i tha taksidepsi stin
decided.3SG that or will travel.3SG at.the Asia or will travel.3SG at.the
Evropi.
Europe

'She decided that she will either travel to Asia or to Europe.'

The set of items was completed with 16 fillers, 8 questions and 8 embedded assertions with *min*, that either did not involve more than one proposition or introduced the polar alternative in a separate utterance, as illustrated in (19) below.

(19) *Min* ine erotevmenos o Nikos?... I dhen ine?
MIN is in.love the Nikos or NEG_1 is
'Is Nikos maybe in love?...Or he isn't?'

Given that the filler items did not feature alternative propositions, at least not within the same utterance, they were irrelevant to the specific subhypothesis (12i) addressed by the experiment.

Participants were given the following instructions: "In what follows you will be presented with a set of sentences. Every sentence is followed by a scale from 0 to 100. We ask you to use this scale to show how natural, in your opinion, each of these sentences is (0 = totally unnatural, 100 = absolutely natural)."

All participants rated the total of items, producing 48 ratings each (16 critical items + 16 control items + 16 filler items). Excluding fillers, a sum of 2,016 responses (63 participants × 32 ratings) were statistically analyzed.

Procedure. Participants completed Experiment 1 using their own computer or smart device. First, they were asked to read the instructions and fill in a brief questionnaire regarding their sociolinguistic background (see the Appendix in Supplementary Materials). Once the questionnaire was completed, the main task started, which consisted in reading a sentence and evaluating its naturalness.

The order of the items was randomized. Each item consisted of a sentence and a rating scale. Below we give an example of what participants saw in their screen, to which we add the English translation.

(20) Min kimithike to pedhi i dhen kimithike?
MIN slept.3SG the kid or NEG_1 slept.3SG
'Did the kid maybe sleep or not?'

katholu fisiki — apolita fisiki
'totally unnatural' — 'absolutely natural'

The median duration of the experiment was 9′ 52″.

Results. The results related to the control items of Experiment 1 are shown in Fig. 1. The graph provides the mean acceptability rating for the two Sentence Type values, which appear in the *x* axis: questions and assertions. All in all, the results show that participants had no serious problems accepting disjunction over propositional alternatives (mean acceptability higher than 69% for both sentence types), although such disjunction was dispreferred in assertions.[10]

[10]This asymmetry can be taken to reflect (i) the fact that questions, in contrast with assertions, are related to alternatives by default (Hamblin 1973; Groenendijk and Stokhof 1997); and (ii) the relatively higher structural complexity of the embedded propositional disjunction items. Recall that the question vs. asser-

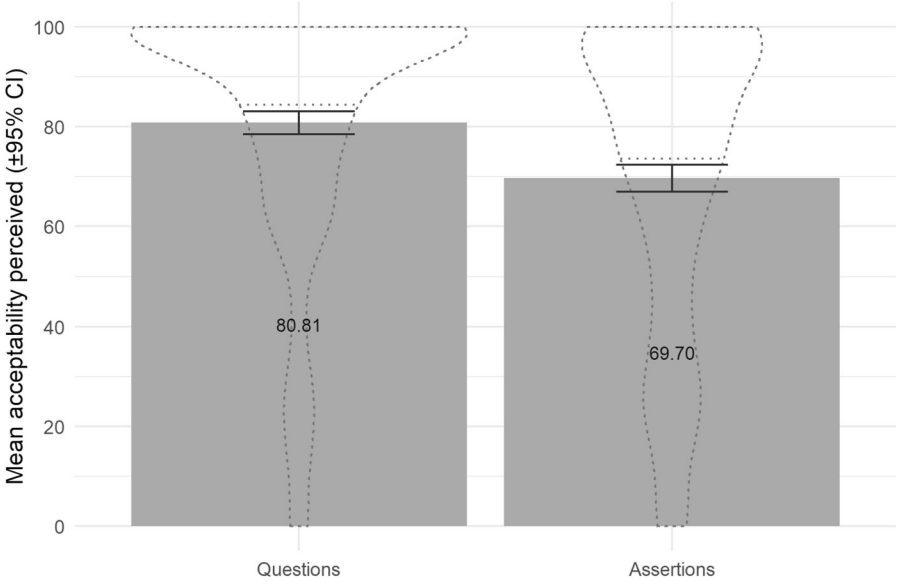

Fig. 1 Results of Experiment 1—Controls

A beta mixed-effects model was run with acceptability as the dependent variable. To fulfill the requirements of a model based on a beta regression, the response values were first divided by 100 (to obtain a 0–1 distribution), and then the two ends were replaced by very close values (0.0000001 for 0, and 0.9999999 for 1). Sentence Type (question, assertion) was the fixed factor. A random slope for Sentence Type by Subject, and a random intercept for Item were included in the model.

Sentence Type was found to be significant, $\chi^2(1) = 17.314$, $p < .001$, indicating that questions were globally rated as more acceptable than assertions ($d = 0.571$, $p < .001$).

As regards the critical items, the results of Experiment 1 are shown in Fig. 2, as a function of Sentence Type (question, fear-verb assertion) and the *Min* condition (with *min*, without *min*). The two values of Sentence Type appear in the x axis, while the *min*-related values are depicted as different tones of grey. The figure provides the mean acceptability rating for the four categories of items created via the interaction of Sentence Type and the *Min* condition. It shows that questions without *min* were rated as far more acceptable that their equivalents with *min*. On the contrary, fear-verb assertions received very low ratings, regardless of the presence or absence of *min*. Finally, there seems to be no difference in acceptability between questions with *min* and fear-verb assertions with *min*.

A beta mixed-effects model was run with acceptability as the dependent variable. Sentence Type (question, fear-verb assertion), the *Min* condition (with *min*, without *min*), and their paired interaction were the fixed factors. A random slope for Sentence

tion distinction coincided with the one between embedded and unembedded disjunction of alternatives in the items tested.

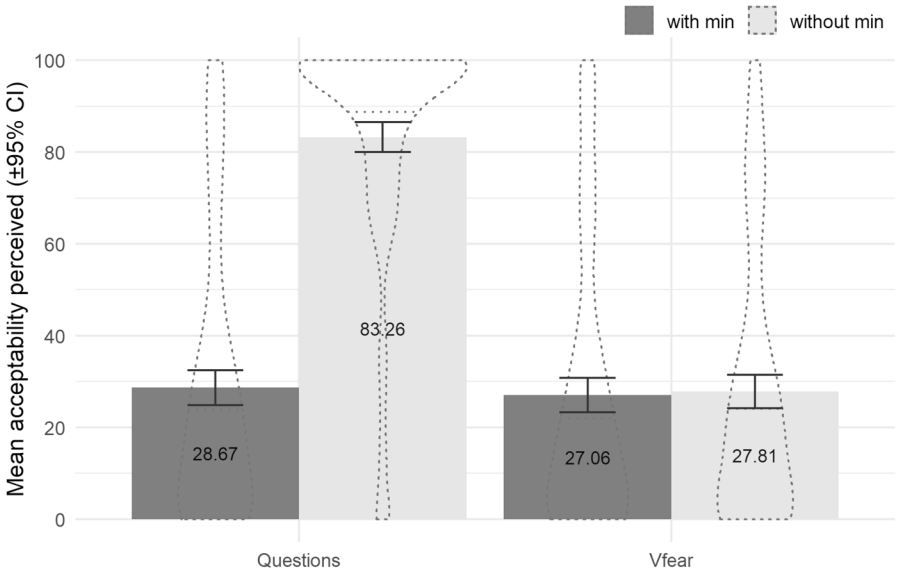

Fig. 2 Results of Experiment 1—Criticals: Sentence Type × *Min* condition

Type × *Min* condition by Subject, and a random intercept for Item were included in the model.

A significant effect was found for the three fixed factors, though the results of the two main effects are just a consequence of the ones obtained from their interaction. The main effect of Sentence Type, $\chi^2(1) = 25.378$, $p < .001$, indicated that questions were globally rated as more acceptable than fear-verb assertions ($d = 1.276$, $p < .001$), and the main effect of the *Min* condition, $\chi^2(1) = 20.324$, $p < .001$, indicated that the absence of *min* led to higher acceptability ($d = 1.208$, $p < .001$). However, the results of the interaction Sentence Type × *Min* condition, $\chi^2(1) = 105.152$, $p < .001$, lead to a more specific scenario, i.e., questions without *min* received higher acceptability rates than the other three structures. First, questions received higher acceptability rates than fear-verb assertions in the structures without *min* ($d = 2.476$, $p < .001$), but not in those with *min* ($d = 0.077$, $p = .667$). Second, whereas the absence of *min* in questions led to higher acceptability ($d = 2.407$, $p < .001$), it had no significant effect in fear-verb assertions ($d = 0.008$, $p = .948$).

Discussion. Experiment 1 confirmed two out of the three predictions derived from subhypothesis (12i): questions without *min* were rated significantly higher than their counterparts with *min*, and no significant difference was found in the acceptability of questions with *min* and fear-predicate complements with *min*. Our third prediction though, namely that fear-predicate complements with *min* would receive ratings significantly lower than those of fear-predicate complements without *min*, was not borne out. We take these results to confirm subhypothesis (12i): non-negative *min* is incompatible with the overt realization of polar propositional alternatives. However, fear-predicate complements are not an appropriate linguistic environment to test this

incompatibility since the presence of alternatives is problematic in all instances of fear-predicate complementation.

Specifically, we can think of at least three possible reasons why *oti*-complements of fear-predicates were rated as low as their *min*-counterparts. First, both types of fear-predicate complementation involved embedded disjunction and, therefore, they were more complex structurally than the question items. The idea that complexity might correlate with lower ratings is corroborated by the results of the control sentences, where assertions were again rated significantly lower than questions (see also fn. 10). Second, it has been claimed that *oti* is a complementizer that conveys relatively high certainty regarding the expressed proposition (Roussou 2010). If the disjunctions under *oti* were interpreted as inclusive, the sentences may have been rejected as non-sensical because a speaker cannot be certain about a proposition and its polar opposite at the same time.[11] Finally, under a doxastic analysis of fear-predicates (Anand and Hacquard 2013), it is possible that the embedding predicate itself encodes some kind of bias, thus rendering the presence of propositional alternatives in its complement odd or infelicitous.

3.2 Experiment 2

While Experiment 1 tested the incompatibility of *min* with overt polar propositional alternatives, Experiment 2 aimed at tapping on the exact epistemic effect of non-negative *min*, by means of an interpretation task. Recall that *min* occurs in non-veridical environments where the speaker considers both the expressed proposition p and its polar alternative $\neg p$ as possible, namely polar questions and fear-predicate complements. We thought that, if *min* encodes positive speaker bias (12), it should be produced by speakers who are not completely ignorant in the sense of Farkas (2020)—that is clueless regarding p or $\neg p$—but are at least moderately confident regarding the possibility that p is true. Speaking in terms of the theoretical literature on modality, the proposition that appears after *min* is predicted to be true in the best possible worlds, the worlds that are closest to what the speaker knows, believes, or expects (Kratzer 1989; Portner 2009; Giannakidou and Mari 2017). For the purposes of the present study, we dub speaker's confidence regarding the potential truth of a proposition p as *certainty*. Our subhypothesis (12ii), that was addressed by Experiment 2, is formulated explicitly below.

(12) ii. Non-negative *min* in polar questions and complements of fear-predicates conveys medium speaker certainty regarding a proposition p.

In order to test (12ii), the presence vs. absence of *min*, in both questions and fear-predicate complements, was tested against speaker's certainty. In Experiment 2—as in Experiment 1—participants were faced with a set of sentences in isolation. This time they were asked to rate how certain the speaker was with respect to the proposition expressed. This study was administered via Alchemer, too.

[11] See Gajewski (2009) and Del Pinal (2019) on the relationship between logical triviality and reduced acceptability.

Participants. A total of 65 participants (19 males, 45 females, 1 other; mean age 32.72 years, SD = 9.93) voluntarily took part in Experiment 2. They were all native speakers of Greek. The participants were recruited via Facebook and other social media platforms.

Materials. A set of 20 critical items was used for Experiment 2. The design was parallel to the one of Experiment 1: half of the items (10 items) had the form of a polar question, and the other half (10 items) were fear-verb embedded declaratives. Each sentence type was further divided into an equal number of constructions with *min* (5 items) and constructions without *min* (5 items). The four types of items created by the interaction of sentence type and *min*-presence/absence are exemplified below (for the full list of items, see the Appendix in Supplementary Materials).

(21) *Min* xalase to plindirio?
MIN broke.3SG the washing.machine
'Did the washing machine maybe break?'

(22) Apolithike o Lazaros?
got.fired.3SG the Lazaros
'Did Lazaros get fired?'

(23) Fovame *min* irthan i kenuryi yitones.
fear.1SG MIN came.3PL the new neighbors
'I fear the new neighbors maybe came.'

(24) Fovame oti teliose to ghala.
fear.1SG that finished the milk
'I fear that we are out of milk.'

All items were followed by a question of the type "How certain is the speaker that *p*?" with *p* taking the form of the expressed proposition in each case. Note that, again, question items differed from fear-predicate complement items in that in the former *min* contrasted with its absence, while in the latter it contrasted with *oti*.

The main prediction derived from our subhypothesis (12ii) was that (i) *min* would convey medium speaker certainty, in both questions and fear-verb embedded declaratives. Looking into the literature on questions, we further expected that (ii) questions without *min* would convey lower certainty than their equivalents with *min*, as the former are associated with fully ignorant speakers (Farkas 2020). Following the literature on *oti* (Roussou 2010; Makri 2013), we predicted that (iii) *oti*-complements would be interpreted as conveying higher speaker certainty than their *min*-equivalents, due to the high certainty interpretation of the former.

Experiment 2 included further a set of 20 control items, in order to make sure that participants understood the concept of speaker certainty as gradient. The control items had the form of embedded or unembedded assertions that employed either *doubt*-type (25) or *know*-type (26) epistemic adverbials or predicates; the former were expected to convey medium certainty while the latter were expected to be rated

as of high certainty, thus setting a baseline for effectively testing the subhypothesis in (12ii). Below we give two examples from the item list.[12]

(25) *Isos* na ipotimises tis dhinatotites su.
maybe SUBJ underestimated.2SG the potential yours
'Maybe you underestimated your potential.'

(26) Ime *sighuros* oti plirosa to enikio.
am sure that paid.1SG the rent
'I am sure that I paid the rent.'

We gave the following instructions to participants: "In what follows a set of sentences will be presented to you. Every sentence is followed by a scale from 0 to 100. We ask you to use that scale to show how certain the speaker seems to be with respect to the content of each sentence (0 = not certain at all, 100 = absolutely certain)."

Participants rated the total of items, thus producing 40 ratings each (20 critical items + 20 control items). A sum of 2,600 responses (65 participants × 40 ratings) were statistically analyzed.

Procedure. The procedure followed for Experiment 2 was similar to the one described for Experiment 1. First participants had to fill in the sociolinguistic questionnaire that was used also for the first experiment (see the Appendix in Supplementary Materials). Then the main task started. The sole difference was that, in this case, each item consisted of a sentence, a question regarding the speaker's certainty with respect to the content of this sentence, and a rating scale. An example of what participants saw in their screens is given below, including the English translation.

(27) Min vulose o neroxitis?
MIN clogged the sink
'Is the sink maybe clogged?'

Poso veveos ine o omilitis oti o neroxitis vulose?
'How certain is the speaker that the sink is clogged?'

katholu veveos ——●—— apolita veveos
'not certain at all' 'absolutely certain'

The median duration of the experiment was 9′ 38″.

Results. Figure 3 shows the results obtained from the control items of Experiment 2, as a function of Category (predicate, adverb) and Confidence (*doubt*-type, *know*-type). The two Category values are represented in the *x* axis, while the values related to Confidence are depicted as different shades of grey. The figure provides the mean perceived certainty rating for the four distinct Category and Confidence combinations. It shows that participants did perceive speaker certainty as gradient, attributing

[12] We did not include filler items in Experiment 2, in order to make the task as short as possible. We decided we could afford the omission of fillers given that the presence of interrogative and declarative sentences, in simple or subordination structures, created enough variation to keep our research question untransparent to the participants.

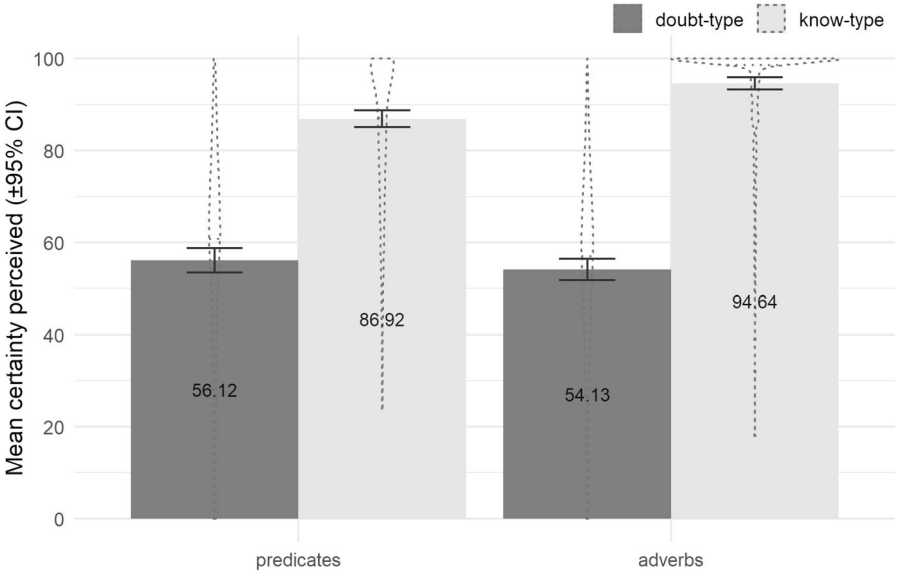

Fig. 3 Results of Experiment 2—Controls

medium certainty to *doubt*-type items and high certainty to *know*-type items, with Category apparently playing no role.

A beta mixed-effects model was run with perceived certainty as the dependent variable. Category (predicate, adverb), Confidence (*doubt*-type, *know*-type), and their paired interaction were the fixed factors. A random slope for Confidence by Subject, and a random intercept for Item were included in the model.

Confidence was the only effect found to be significant, $\chi^2(1) = 95.536$, $p < .001$, indicating that *know*-type items were globally perceived with a higher degree of certainty than *doubt*-type ones ($d = 1.092$, $p < .001$). Category was not found to be significant, $\chi^2(1) = 1.756$, $p = .185$, and neither was the paired interaction, $\chi^2(1) = 2.238$, $p = .135$, although pairwise contrasts indicated that adverbs were globally perceived with a higher degree of certainty than predicates in the *know*-type condition ($d = 0.275$, $p = .046$).

Moving on to the critical items, the results, as a function of Sentence Type (question, fear-verb subordinate clause) and the *Min* condition (with *min*, without *min*), are shown in Fig. 4. The two values related to Sentence Type appear in the x axis and the two values of the *Min* condition are represented as different tones of grey. The figure provides the mean perceived certainty rating for the four types of items created by the interaction of Sentence Type and the *Min* condition. It shows that questions with *min* were rated as showing higher speaker certainty than questions without *min*. It also shows that the situation is the reverse for fear complements: fear-verb sentences with *min* convey lower certainty than their counterparts without *min*. Finally, the graph shows that *min* conveys medium speaker certainty regarding the expressed proposition, in both questions and fear-verb sentences.

A beta mixed-effects model was run with the perceived certainty as the dependent variable. Sentence Type (questions, fear-verb embedded assertions), *Min* condition

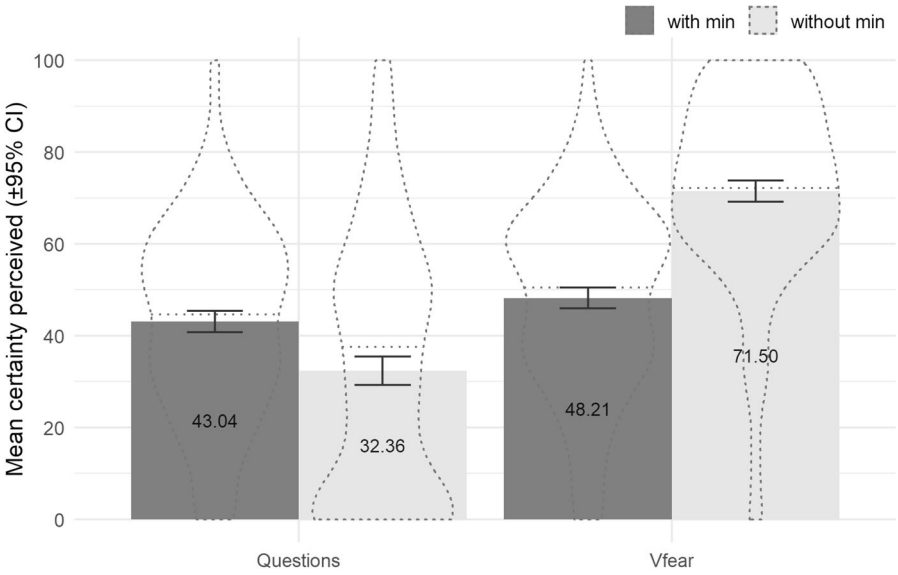

Fig. 4 Results of Experiment 2—Criticals: Sentence Type × *Min* condition

(with *min*, without *min*), and their paired interaction were the fixed factors. A random slope for Sentence Type × *Min* condition by Subject, and a random intercept for Item were included in the model.

A significant effect was found for Sentence Type and for the paired interaction. The main effect of Sentence Type, $\chi^2(1) = 16.536$, $p < .001$, indicates that fear-verb assertions were globally perceived with a higher degree of certainty than questions ($d = 0.415$, $p < .001$). The main effect of the *Min* condition was not found to be significant, $\chi^2(1) = 0.323$, $p = .570$. The results of the interaction Sentence Type × *Min* condition, $\chi^2(1) = 12.666$, $p < .001$, can be read in two complementary ways. First, fear-verb assertions received significantly higher certainty rates than questions in the items without *min* ($d = 0.767$, $p < .001$), but not in those with *min* ($d = 0.064$, $p = .634$). Second, whereas the presence of *min* in questions led to higher certainty rates ($d = 0.308$, $p = .028$), it was the absence of *min* that led to higher certainty rates in fear-verb assertions ($d = 0.395$, $p = .004$).

Discussion. Experiment 2 confirmed our main prediction that *min* would convey medium speaker certainty both in questions and in fear-predicate complements; no significant difference was found regarding the certainty of the speaker with respect to the expressed proposition between the two sentence types in the *min*-condition (Fig. 4). Interestingly, the two secondary predictions derived from the interaction between our subhypothesis (12ii) and the literature on questions and *oti* were also confirmed: Questions with *min* were found to convey higher speaker certainty than their *min*-free equivalents, and fear-complements with *min* were rated as showing lower certainty than their *oti*-counterparts. In other words, fear-complements with *oti* were interpreted as showing high speaker certainty, fear-complements with *min*

and questions with *min* as showing medium certainty, and questions without *min* as showing low certainty.

By confirming subhypothesis (12ii), Experiment 2 provided additional support to our main hypothesis (12). Interestingly, though, part of its findings contrasted directly with a claim made in the literature regarding the meaning of *min*. Specifically, while Giannakidou and Mari (2019) argue that it has a weakening effect in questions, our findings suggest the opposite: questions with *min* appear to be stronger, as regards speaker certainty, than their counterparts without *min*. With this stark contrast in mind, we decided to carry out a complementary experiment focusing entirely on the interpretation of *min* in polar questions. This third experiment should further corroborate the positive bias epistemic effect of *min*, allowing us to safely extend to questions an intuition first expressed by Makri (2013) in relation to fear-predicate complements.

3.3 Experiment 3

Experiment 3 aimed at obtaining additional evidence on the interpretation of non-negative *min* by means of a forced-choice task. This time we tested the core of our hypothesis in (12) directly; limiting the task to polar questions, we investigated explicitly the relation between the presence of *min* and bias. The relevant part of the hypothesis is repeated below for ease of reference.

(28) Non-negative *min* in polar questions is interpreted as a positively biased epistemic modal.

In order to address (28), three types of Greek polar questions (positive, negative, and questions with *min*) were tested against the three possible biases (positive, negative, or no bias). In this third experiment, participants were asked to choose out of the three options available the one that was most compatible with the meaning of each sentence. Like Experiments 1 and 2, Experiment 3 was administered via Alchemer.

Participants. Experiment 3 was voluntarily completed by a total of 437 participants. We excluded one non-native speaker of Greek and, additionally, 15 participants that did not properly fulfill the requirements for their data to be considered as valid, since they did not give at least one "no bias" response among the 24 answers that they had to provide. Therefore, here we report the outputs of 421 native speakers of Greek (31 males, 388 females, 2 others; mean age 31.45 years, SD = 7.02). These participants were also recruited via Facebook and other social media platforms.

Materials. Experiment 3 featured a set of 18 critical items divided equally into three groups: 6 positive polar questions + 6 negative polar questions + 6 questions with *min*. Each group is exemplified by (29), (30) and (31), respectively (see the Appendix in Supplementary Materials for the complete list of items).

(29) Positive question
Ipiate uiski sto parti?
drank.2PL whiskey at.the party
'Did you drink whiskey at the party?'

(30) Negative question
Dhen pirame tiri ya avrio?
NEG$_1$ took.1PL cheese for tomorrow
'Didn't we buy cheese for tomorrow?'

(31) Question with *min*
Min pighate se akriva maghazya?
MIN went.2PL at expensive shops
'Did you maybe go to expensive shops?'

Every question was followed by three options, corresponding to positive bias, negative bias, and lack of bias. Our hypothesis in (28) predicted that questions with *min* would be systematically linked to the positive bias option. Crucially, the type of bias potentially associated with positive and negative questions was not related to our specific research question, which focused exclusively on the interpretation of polar questions with *min*.

In order to prevent an artificial effect of associating each sentence type with one of the three available options, we complemented the set of materials with 6 sentences that had the form of *mipos*-questions. An example is given below.

(32) Question with *mipos*
Mipos akusate taxidhromo?
maybe heard.2PL mailman
'Did you maybe hear a mailman?'

The instructions given to participants were the following: "In what follows you will be presented with a set of sentences. Each sentence is followed by another explanatory sentence with three possible versions. We ask you to choose the version that, in your opinion, describes each situation in the best possible way."

Participants rated the total of items, each producing 24 responses (6 positive questions + 6 negative questions + 6 questions with *min* + 6 *mipos*-questions). A total of 10,104 responses (421 participants × 24 ratings) were statistically analyzed.

Procedure. The procedure followed for Experiment 3 was similar to the one described for the previous two experiments and the same sociolinguistic questionnaire was used (see the Appendix in Supplementary Materials). This time the main task involved reading a sentence and then three alternative follow-ups. Participants were requested to choose the follow-up that was most fitting, based on the preceding sentence.

Both the order of the items and the order in which the three follow-ups were presented within the items were randomized. Each item consisted of a question and three alternative statements regarding this question. In (33) we provide an example of what participants were presented with, along with the English translation.

(33) Min xriazeste tileorasi?
MIN need.2PL TV
'Do you maybe need a TV?'

O omilitis nomizi oti: 'The speaker thinks that:'
(a) xriazonde tileorasi. 'they need a TV.'
(b) dhen xriazonde tileorasi. 'they don't need a TV.'
(c) i xriazonde tileorasi i oxi. 'either they need a TV or not.'

The median duration of the experiment was 7′ 57″.

Results. Figure 5 shows the results to Experiment 3 as a function of Question Type (negative, positive, *mipos*, *min*) and Bias (negative bias, no-bias, positive bias). The different Question Type values appear in the *x* axis, while the values of Bias are shown as different tones of grey. The graph provides the percentage of negative bias, no-bias, and positive bias options chosen for each type of question. Negative questions favored a reading attributing a negative bias to the speaker, and positive questions were found to correlate with the absence of bias. As for the other two, while *mipos*-questions favored either a positive bias or a no-bias interpretation, *min*-questions were strongly associated with the positive bias option.

A zero-inflated Poisson mixed-effects model was run with the number of each chosen bias as the dependent variable, with Bias, Question Type, and their paired interaction as fixed factors. A random intercept for Subject was included in the model.

All fixed factors were found to be significant. The main effect of Bias, $\chi^2(2) = 133.296$, $p < .001$, indicated a global preference for declaring a bias such that no-bias ($n = 4{,}306$) > positive bias ($n = 4{,}088$) > negative bias ($n = 1{,}710$) (all $p < .001$). The main effect of Question Type, $\chi^2(3) = 25{,}881$, $p < .001$, is related to the results of the paired interaction and suggests that the two least preferred bias options in

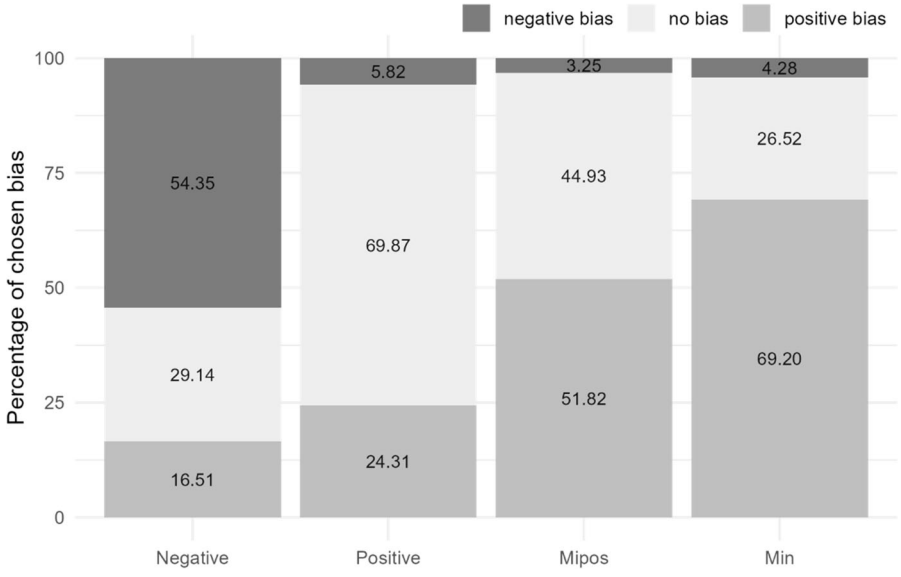

Fig. 5 Results of Experiment 3: Question Type × Bias

the case of negative questions (namely, no-bias and positive bias) were chosen with higher frequency than the least preferred bias types in the cases of positive, *min*, and *mipos*-questions (in all three cases at $p < .001$), with no significant difference between the latter. In other words, negative questions present higher variation in bias ascription than the other three types of questions. This can also be interpreted as suggesting that negative questions have a less clear bias preference than the rest.

The results of the paired interaction Bias × Question Type, $\chi^2(6) = 1768.053$, $p < .001$, can be discussed in two complementary ways: which bias is more often ascribed to each question type or which question type encodes most frequently each bias. On the one hand, negative questions show a preference such that negative bias > no-bias > positive bias (all $p < .001$), positive questions show a preference such that no-bias > positive bias > negative bias (all $p < .001$), and both *min* and *mipos*-questions show a preference such that positive bias > no bias > negative bias (all $p < .001$, except for positive bias vs. no-bias for *mipos*-questions, in which $p = .003$). On the other hand, negative bias is more generally conveyed via negative questions (all $p < .001$), with no difference between *min*-questions and either positive or *mipos*-questions ($p = .106$; $p = .347$). A preference for positive questions over *mipos*-questions was found regarding the expression of negative bias ($p < .001$). A no-bias response was more frequently chosen for positive and *mipos*-questions compared to the other two question types (all $p < .001$), with no difference between negative and *min*-questions ($p = .477$); lastly, the positive bias encoding tendency can be represented via the following rank: *min*-questions > *mipos*-questions > positive questions > negative questions (all $p < .001$).

Discussion. Experiment 3 showed that speakers tend to associate positive polar questions with the lack of bias (pace Giannakidou 2013; Farkas 2020). As for negative polar questions, they were mostly linked to the negative bias option; presented without a context, they were apparently most often interpreted as involving propositional negation (see Sect. 1). Note, however, that negative questions were the ones with the least clear bias ascription preference, a result possibly reflecting their ambiguity.

But let us focus on *min*-questions, which was the only question type about which our hypothesis made a prediction. In accordance with the hypothesis in (28), *min*-questions were indeed systematically associated with the positive speaker bias option, providing additional support to our interpretation of the results to Experiments 1 and 2. It is crucial, though, that we get into a more detailed discussion of the *min*-related column in Fig. 5. As reported, the obtained preference for the positive bias option in questions with *min* was statistically significant. Nevertheless, there were also cases where participants chose the negative bias or the no-bias option. While the percentage corresponding to the former (4.28%) is so small that can be neglected as residual, the 26.52% of no-bias answers calls for a comment in the least.

A first idea that comes to mind is to extend Makri's (2013) claim on the interpretation of *min* in fear-predicate complements to polar questions. If *min* can convey either the lack of bias or the presence of positive speaker bias, then one can easily account for the obtained results. A worry that arises very shortly, though, is that, under this view, *min*-questions are predicted to be interpretatively equivalent to positive

polar questions, at least in some of their uses, and thus *min* can be interpretation-wise vacant. Although theoretically possible, this result is conceptually unattractive.

However, the main reason why we abandon the line of thought presented above is not theoretical but empirical. Recall that *min* is only licensed in the scope of a non-veridical operator, that is an operator that conveys that the speaker considers both the expressed proposition p and its polar alternative $\neg p$ as possible, a speaker that has no bias. If *min* can convey the lack of bias itself, why does it need to occur under an operator that guarantees exactly that? Taking this into account, we conclude that non-negative *min* is always interpreted as a positively biased epistemic modal: It takes a proposition p as its complement and conveys that all the possible worlds that are closest to what the speaker knows, believes, or expects are worlds where p is true. We take the no-bias answers obtained in the *min*-condition of Experiment 3 as reflecting not the interpretation of *min* itself but the non-veridicality, the lack of bias, introduced by its licensor, i.e., the question operator. This is further supported by the fact that the no-bias option was chosen in 29.14% of cases in the negative question condition as well.[13]

3.4 Summary

Putting together the results of all three experiments that formed part of our study, we can draw the following generalizations: (i) non-negative *min* is incompatible with the overt realization of polar propositional alternatives within the same utterance, (ii) it conveys medium certainty with respect to a proposition p on the part of the speaker, and (iii) it encodes positive speaker bias in the context of polar questions. These three generalizations constitute empirical arguments in favor of our main hypothesis (12), according to which *non-negative min is always interpreted as a positively biased epistemic modal*. In other words, it conveys that, of all the possible worlds, the worlds that are closest to what the speaker knows, believes, or expects are worlds where the expressed proposition p is true. This hypothesis is fleshed out as a formal proposal on the interpretation of non-negative *min* in the following section.

4 The meaning of non-negative *min*: Epistemic modality and positive bias

In order to formally define non-negative *min* as a positively biased epistemic modal, we need to look into what it means for an item to be an *epistemic modal* and what it means for an item to be *biased*. Following Giannakidou and Mari (2017), epistemic modals are objectively non-veridical, because they do not entail the truth of a proposition p, and also subjectively non-veridical, because they do not even entail that the speaker believes that p is true. This leaves us with a situation where the set of possible worlds compatible with what the speaker knows, believes, or expects—what

[13] Although unrelated to our specific research question, a comment on *mipos* is due. The results of Experiment 3 suggest that it can be ambiguous between a no-bias and a positive bias reading, matching tightly Makri's (2013) description of *min*. We note that *mipos* has a different distribution from *min* and refer the interested reader to Roussou (2015).

is technically called the speaker's modal base—contains worlds where the expressed proposition p is true as well as worlds where its polar alternative $\neg p$ is true. This situation is the interpretational reflex of non-veridicality and the precondition for the interpretation of epistemic modals.

Biased epistemic modals have an additional property. Being objectively and subjectively non-veridical, they entail neither the truth of p in the actual world nor the speaker's belief that p is true. Crucially, though, they entail the truth of p in the *Best* worlds (Giannakidou and Mari 2017), that is, in the set of worlds that are closest to the speaker's actual knowledge, beliefs and expectations. The entailment of p in *Best* worlds is theoretically captured by the introduction of an ordering source (Kratzer 1981; and subsequent work), a function that orders the worlds that make up the speaker's modal base from best to worst and derives *Best*. The interpretational reflex of the presence of an ordering source is the epistemic effect of bias, that was derived from the results of our three experiments.

Having isolated and defined the meaning components that are relevant for the analysis of non-negative *min* as a biased epistemic modal, we can now proceed to formalize our proposal. Building on Giannakidou and Mari (2017), we set M_s to stand for the modal base relativized to a judge or speaker s (Lasersohn 2005; Stephenson 2007).

(34) $M_s = \lambda w'.w'$ is compatible with what is known by the speaker s in w_0.

We further assume an ordering source g over worlds w compatible with what is known by the speaker s in w. For our present purposes, we adapt Kratzer's (1981) and Portner's (2009) definition in the following terms:

(35) Ordering source $g(w^{Ms})$
For any set of propositions X and any worlds $w, w' \in M_s$: $w \leq_X w'$ iff for all $p \in X$ if $w' \in p$ then $w \in p$

In words, $\leq_X$ stands for the order generated by a set of propositions X. The world w is at least as good as world w' with respect to the ordering source in X if, and only if, for every proposition p that belongs to X, if p is true in w', then it is also true in w (see also Kratzer 1991). In (35) w is more highly ranked or ranked the same as w'—better worlds appear towards the left.

Based on the ordering source g, we define the set of *Best* worlds as follows:

(36) $\text{Best}_{g(w^{Ms})(X)} : \{w' \in M_s : \forall p \in X(w' \in p)\}$

In words, *Best* is the output of the ordering function that identifies the set of worlds w' in the epistemic modal base of the speaker such that for every proposition p that belongs to X, p is true in w'.

With these formal tools in place, we can formally define non-negative *min* as shown below:

(37) $[\![min]\!]^{Ms,g(w)} = \lambda p_{\langle s,t\rangle}.\forall w' \in \text{Best}_{g(w^{Ms})} : p(w')$

In words, non-negative *min* is interpreted with respect to the epistemic modal base of the speaker and an ordering function. It selects for a proposition p and, for all

possible worlds w' that are part of the *Best* worlds in the speaker's M_s, it ensures that p is true in w'. It is exactly this, namely the ordering of worlds such that p worlds are *Best*, i.e., epistemically preferred by the speaker over $\neg p$ worlds, that ultimately triggers the inference of what we have been referring to as the positive bias epistemic effect of *min*; the speaker is understood to believe that p is more likely than $\neg p$. *Min* is the item responsible for the introduction of the ordering function over worlds, or—put differently—it is the Spell-Out of the ordering function itself. As regards non-veridicality, it must be syntactically instantiated independently of *min*. We agree with Giannakidou and Mari (2017) that non-veridicality is a precondition (a presupposition) of all modals, but in the specific case of *min* it is syntactically disembodied from the modal.

The interpretation of the *min p* part of the structures that formed part of our experimental items is shown in (38), directly derived from (37).

(38) $[\![min\ p]\!]^{M_s, g(w)} = 1$ iff $\forall w' \in \text{Best}_{g(w^{M_s})} : p(w')$

The next step is to compose the meaning of *min* sentences with their non-veridical licensors. First, we consider the case of polar yes/no questions, which request an answer that specifies whether the proposition expressed by the sentence holds or does not hold. For the purposes at hand, we adapt Krifka's (2011) modeling of polar questions.

(39) $[\![\text{Q}]\!] = \lambda w \lambda f_{\text{Q}} \in \{\lambda p.p, \lambda p.\neg p\}[f_{\text{Q}}(p_w)]$

Let us next consider the meaning of *min p* under the scope of a polarity question (our example (5b), repeated here for convenience as (40a)).

(40) a. *Min* tros pola ghlika?
MIN eat.2SG many sweets
'Maybe you eat a lot of candy?'

b. $[\![\text{Q } min\ tros\ pola\ ghlika]\!]^{Ms}(w_0)$
$= \lambda w[\lambda f_{\text{Q}} \in \{\lambda p.p, \lambda p.\neg p\}[f_{\text{Q}}(\text{min tros}_w \text{ pola ghlika}]^{Ms}(w_0)]$

In words, the question operator introduces both p worlds and $\neg p$ worlds, thus satisfying the non-veridicality precondition for the interpretation of *min*. Then, *min* orders these worlds in such a way that p worlds are *Best* worlds.

We now move on to consider the meaning of *min p* under the scope of the fear predicate *fovame*. Notice that this predicate entails non-veridicality in the sense that, when applied to a proposition p, it is not logically valid to infer the truth of p. That is, as we have just seen in the case of polar questions, its meaning is also associated with a function with respect to which both p and $\neg p$ are possible.[14]

(41) $[\![\text{fovame}]\!] = \lambda w \lambda f_{\text{FEAR}} \in \{\lambda p.p, \lambda p.\neg p\}[f_{\text{FEAR}}(p_w)]$

[14]Following the main insight in Anand and Hacquard (2013), fear verbs have a doxastic component, that allows for doxastic alternatives, and an emotive component, that orders these alternatives from most to least undesirable. The results of our experiments provide evidence that Greek non-negative *min* interacts with the doxastic component. Therefore, the emotive part of the meaning of fear predicates is left at the side of our analysis. See Tahar (2021) for the view that non-negative *non* in the complement of French *craindre* 'fear' interacts with the emotive component of the meaning of this verb.

If we now apply this meaning to our example (5a), repeated here for convenience as (42a), we obtain (42b).

(42) a. Fovame *min* tros pola ghlika.
fear.1SG MIN eat.2SG many sweets
'I fear you maybe eat a lot of candy.'

b. $[\![$fovame *min tros pola ghlika* (x)$]\!]^{Ms}(w_0)$
$= \lambda w[\lambda f_{\text{FEAR}} \in \{\lambda p.p, \lambda p.\neg p\}[f_{\text{FEAR}}(\text{min tros}_w \text{ pola ghlika})^{Ms}$
(x)$(w_0)]$

In words, the fear predicate (in a way parallel to the question operator) introduces both p worlds and $\neg p$ worlds, thus satisfying the non-veridicality precondition for the interpretation of *min*. Then, *min* orders these worlds in such a way that p worlds are *Best* worlds.

At this point, a clarification is in order. Throughout this paper, we have used p to refer to the realized proposition and $\neg p$ to refer to the complementary proposition. The polarity of the realized proposition, positive or negative, is irrelevant to our discussion and *min* is blind to it. *Min* conveys positive bias in the sense that worlds where the expressed proposition p are true are always preferred (*Best*) over worlds where $\neg p$ is true. Crucially, though, p can correspond either to a proposition of positive polarity q or a proposition of negative polarity $\neg q$. The latter case is exemplified by (9), repeated below as (43).

(43) Fovame *min dhen* troi arketa ghlika/ TIPOTA.
fear.1SG MIN NEG_1 eat.3SG enough sweets nothing
'I fear maybe he doesn't eat enough candy/anything.'

Our analysis of non-negative *min* as an epistemic modal that takes a proposition of either positive or negative polarity as its complement correctly predicts that *min* can co-occur with the negative marker *dhen*. Note that in the case of (43) *Best* worlds will include exclusively worlds where the realized proposition p corresponding to *He is not eating enough candy* is true. Simply put, non-negative *min* always takes scope over propositional negation, as reflected in syntax.[15]

We have so far analyzed the meaning of *min p* in the context of both polar questions and fear predicates, which was found to convey medium certainty in Experiment

[15] As regards syntax, we follow the standard assumption that *dhen* is merged in the head of NegP. In our view, non-negative *min* is merged in the head of Judgement Phrase (Krifka 2020, 2021), which encodes epistemic modality and evidentiality, and therefore the two can freely co-occur (see Tsiakmakis and Espinal 2022).

The comment above begs the question of why non-negative *min* cannot co-occur with the negative one, which like *dhen* is postulated to merge in Neg^0. Recall that both types of *min* need to be licensed by a non-veridical operator. Crucially, however, the subset of non-veridical operators that license negative *min* (e.g., volitional predicates, subjunctive *na*, imperative speech act operators) does not intersect with the subset of non-veridical operators that license the non-negative one. This is demonstrated by the fact that the negative marker that appears in fear-predicates (i) and polar questions (ii), i.e., in the contexts that license non-negative *min*, is spelled out as *dhen* even in the absence of non-negative *min*.

(i) Fovame oti *dhen*/ **min* efaghan manitaria.
fear.1SG that NEG_1 NEG_2 ate.3PL mushrooms
'I fear that they didn't eat mushrooms.'

2 but uncontroversial positive bias in questions in Experiment 3. We are interested in addressing the results without *min*. Going back to Fig. 4, questions without *min* are shown to convey lower speaker certainty than their equivalents with *min* because the former are considered as instantiating the default form to express speaker's ignorance. Recall that this result is further corroborated by the no-bias preference associated with positive questions in Experiment 3 (Fig. 5). Figure 4 further shows that the mean perceived certainty increases in fear-complement sentences without *min*. We interpret this result as linked to the meaning of *oti*. Consider sentence (24), repeated here as (44a), and its meaning in (44b). *Oti* introduces an embedded assertion by which the speaker is CERTAIN$_{\langle d,\langle s,t\rangle\rangle}$ to a specific degree of the truth of p: the speaker believes that p holds relativized to salient degree of certainty.[16]

(44) a. Fovame *oti* teliose to ghala.
fear.1SG that finished the milk
'I fear that we are out of milk.'

b. $[\![\text{fovame } \textit{oti teliose to ghala } (\text{x})]\!]^{Ms}(w_0)$
$=\lambda w[\lambda f_{\text{FEAR}} \in \{\lambda p.p, \lambda p.\neg p\}[f_{\text{FEAR}}(\text{oti teliose}_w \text{ to ghala}]^{Ms}(\text{x})(w_0)]$

In words, the fear predicate introduces p worlds and $\neg p$ worlds in this case too. That is, the context is objectively non-veridical. However, it then composes with *oti*, which conveys that the speaker is certain about p to a salient degree. Our analysis attributes the interpretative asymmetry between *min* and *oti* fear-complements shown in Experiment 2 to the fact that *min*, being a modal, is objectively and subjectively non-veridical, whereas *oti* is subjectively veridical; it entails that the speaker believes p (see Giannakidou and Mari 2017).

An anonymous reviewer observes that the analysis of non-negative *min* as a positively biased epistemic modal, in the way formalized above, brings it very close to the Greek universal epistemic modal *prepi* 'must.'[17] Giannakidou and Mari (2017) analyze *prepi* as a biased epistemic modal which comes with the precondition that the speaker's modal base includes both p worlds and $\neg p$ worlds, and requires that all *Best* worlds are p worlds. We totally share the intuition regarding the interpretational similarity between the two modal elements. When we compare their distribution though, a very interesting picture arises.

Specifically, we have multiply stated that non-negative *min* can only appear if licensed by a non-veridical operator (i.e., the question operator or the fear-predicate). *Prepi*, on the other hand, does not seem to need any non-veridical licensor; if anything, *prepi* seems to be a non-veridical licensor itself.

(45) a. **Min* efaye pola ghlika.
MIN ate.3SG many sweets

(ii) *Dhen*/ **min* efaghan manitaria?
NEG$_1$ NEG$_2$ ate.3PL mushrooms
'Didn't they eat mushrooms?'

[16] For details on the degree component, see Kennedy and McNally (2005); Castroviejo (2021); among others.

[17] Also, the Greek epistemic future marker *tha*; see Giannakidou and Mari (2017).

b. *Prepi* na efaye pola ghlika.[18]
must SUBJ ate.3SG many sweets
'He must have eaten a lot of candy.'

Even more intriguing is the fact that *prepi* cannot appear in those environments where *min* occurs.

(46) a. *Min* efaye pola ghlika?
MIN ate.3SG many sweets
'Did he maybe eat a lot of candy?'
b. **Prepi* na efaye pola ghlika?
must SUBJ ate.3SG many sweets

(47) a. Fovame *min* efaye pola ghlika.
fear-1SG MIN ate.3SG many sweets
'I fear he maybe ate a lot of candy.'
b. *Fovame oti *prepi* na efaye pola ghlika.
fear-1SG that must SUBJ ate.3SG many sweets

If *min* and *prepi* have the same interpretation but complementary distribution, then it may well be that the former behaves as a polar variant of the latter. In other words, *prepi* is spelled out as *min* when found in the scope of a non-veridical operator.

Pushing the comparison deeper, both *min* and *prepi* are modal and, therefore, they are interpreted on the condition that the speaker's modal base is non-veridical. Crucially, the non-veridicality condition of *min* is satisfied syntactically, whereas the one of *prepi* is satisfied simply by the epistemic state of the speaker. This asymmetry may have important consequences for future work in the way the semantics of modals in relation to the semantics of non-veridical licensors and non-veridical licensees need to be understood and formalized.

5 Conclusions

The present study set out to determine the meaning of Greek non-negative *min*, which occurs in complement position of predicates of fear or in initial position of root or embedded polar questions. An experimental study consisting of three experiments confirmed that non-negative *min* is incompatible with the overt realization of polar alternative propositions $\{p, \neg p\}$ within the same utterance, it conveys medium speaker certainty with respect to the expressed proposition p, and it shows a bias in favor of p on the part of the speaker. These findings support the hypothesis that *min* is a positively biased epistemic modal: it conveys that all possible worlds that are closest to what the speaker knows, believes, or expects, are worlds where the expressed proposition p is true. Under this view, *min* can be argued to be interpreted as other biased epistemic modals, like *prepi* 'must.' In fact, *min* seems to behave as the polar variant of these modals since it always requires formal licensing by an external non-veridical operator.

[18] Modal verbs in Greek take subjunctive complements.

In this paper we focused solely on the interpretation of non-negative *min*. When we try to see how it relates to the general linguistics literature, *min* seems to be an exemplary instantiation of what has been considered as *expletive negation* (Jespersen 1917; Vendryès 1950; Espinal 1992; Horn 2010; among many others). Here we have provided a solid basis for future investigation of the underexplored relationship between allegedly expletive negation and epistemic modality. See Choi and Lee (2017) and Tsiakmakis and Espinal (2022) for (cross-linguistic) extensions.

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Materials Availability The material used in the experiments has been submitted as Supplementary Material.

Declarations

Competing Interests The authors have no conflicts of interest to declare that are relevant to the content of this article. Availability of data and material.

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