Mood variation with belief predicates: Modal comparison in semantics and the common ground

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Abstract

A noteworthy problem for theories of mood is crosslinguistic and intralinguistic variation, and one of the most prominent challenges is the ability of epistemic/doxastic predicates like 'believe' to take subjunctive complements in Italian and other languages. This paper argues that the subjunctive is not a purely dependent element or mere bearer of presuppositions, but rather has intrinsic semantic content. Specifically, we propose that the subjunctive has a comparative meaning. It applies to two modal backgrounds, imposing a comparative relation on one and using the other to give the interpretation of that relation. Depending on the situation, the comparison can be lead to a preferential, directive, or evidential meaning. It is the evidential meaning we see in cases of subjunctive under 'believe' in Italian. We present experimental data showing the association of indicative and subjunctive in combination with 'believe' in Italian with distinct pragmatic profiles. Subjunctive is associated with contexts in which the complement proposition is at issue in the conversation and, as we show, it signals that the belief statement is to be taken as support for this proposition in the global context. We also explain the contrast with French, which does not allow subjunctive with 'believe', and extend the analysis to other predicates that show variation in Italian.

1 Introduction

Within the formal semantics tradition, research on verbal mood has been built on the assumption that the the presence of indicative or subjunctive morphology in a clause is to be explained by discovering the conditions under which these mood forms are selected, licensed, or triggered. Given this assumption and in light of the understanding which linguists have achieved concerning the semantics of propositional attitude predicates, the main approach to developing theories of verbal mood has been to seek analyses of the semantics of propositional attitude predicates, and then identify properties of those analyses which can be associated with the presence of indicative or subjunctive. This approach,

recently discussed in detail by Portner (2018a), has yielded much understanding, but there are features of the landscape of mood which it seems ill-suited to explain. Among the most noteworthy problems is the variation in mood choice both within and across languages. The goal of this paper is to motivate a new approach to one of these cases of variation, mood choice in the complements of belief predicates.

One of the most problematical cases of variation involves the complement of 'believe'. It is said that 'believe' selects indicative in most languages, as exemplified by French and Greek, but subjunctive in others, such as Italian and Portuguese. However, as we will see, the issue is equally one of intralinguistic variation; we will present experimental data showing the association of indicative and subjunctive in Italian with distinct pragmatic profiles. Subjunctive is associated with contexts in which the complement proposition is at issue in the conversation and, as we show, it signals that the belief statement is to be taken as support for this proposition in the global context. In contrast, indicative is associated with simple statements that the subject holds a belief. In a way, this relation is counterintuitive, relative to preanalytical assumptions about the function of subjunctive, in that the subjunctive can be used with 'believe' to signal greater commitment on the part of the speaker than the indicative. In the end, though, the data will be explained in a way which does not reverse the preanalytical assumptions.

The central idea of our analysis is that the subjunctive is not a purely dependent element or mere bearer of presuppositions, but rather has intrinsic semantic content. Specifically, we propose that the subjunctive has a comparative meaning. It applies to a background set of worlds, with a function similar to the modal base in Kratzer's (1981) system, and imposes a comparison on it. Depending on the situation, the comparison can be understood as contributing to a preferential, directive, or evidential meaning. It is the evidential meaning we see in cases of subjunctive under 'believe' in Italian. Another important feature of our analysis is that the comparative meaning of the subjunctive can be deployed locally, as when it combines with 'want', or globally, the case we see with 'believe'. This difference can be intuitively explained as follows: with 'want', the comparison imposed by the subjunctive relates relates one of two modal parameters given by the predicate to the other (the backgrounds here are buletic and doxastic), while with 'believe', it relates the one modal background given by the predicate (which is doxastic) to one given by the global context (the common ground).

We will apply our analysis of variation with 'believe' to a range of other predicates in Italian showing variation, including 'dream', 'say', and 'be certain'. A significant advantage of our approach is that it also allows a connection to the discourse function of root clauses in the subjunctive mood. As is well-known but rarely discussed, root subjunctives have meanings which can be broadly described as optative or directive (Portner 1997, 2018a; Giorgi and Pianesi 1997). We can also draw consequences for two other important puzzles, the semantics of the reportative subjunctive and the use of the indicative with 'hope'.

2 Empirical background

2.1 Cross and intra linguistic variation

Mood choice is a central issue in the semantic literatures, both formal and descriptive.[1] Across these works, a number of selection patterns have been identified. Giannakidou and Mari (2016a) summarize that the main selection patterns that we find in Greek and French are as follows.

- Verbs selecting indicative:

  (1) Indicative verbs in Greek
      - a. assertives: *leo* ('say'), *dhiavazo* ('read'), *isxirizome* ('claim')
      - b. fiction verbs: *onirevome* ('dream'), *fandazome* ('imagine')
      - c. epistemics, non-factive: *pistevo* ('believe'), *nomizo* ('think')
      - d. epistemic factive verbs: *ksero*, *gnorizo* ('know')

  (2) Indicative verbs in French
      - a. assertives: *dire* ('say')
      - b. fiction verbs: *rêver* ('dream'), *imaginer* ('imagine')
      - c. epistemics, non-factive: *croire* ('believe'), *penser* ('think')
      - d. epistemic factive verbs: *savoir* ('know')

- Verbs selecting subjunctive:

  (3) Subjunctive verbs in Greek
      - a. volitionals: *thelo* ('want')
      - b. directives: *dhiatazo* ('order'), *simvulevo* ('advise')
      - c. modal verbs: *prepi* ('must'), *bori* ('may')
      - d. permissives: *epitrepo* ('allow'); *apagorevo* ('forbid')

  (4) Subjunctive verbs in French
      - a. volitionals: *vouloir* ('want'),
      - b. directives: *ordonner* ('order'), *suggérer* ('suggest')
      - c. modal verbs: *il est nécessaire* ('must'), *il est possible* ('may').
      - d. permissives: *empêcher* ('forbid')

Across a variety of frameworks, these data have led to the elegant proposal that attitudes divide in two major groups: representational and preferential (the terminology is due to Bolinger 1974). Representational attitudes are analyzed as simple quantifiers over a set of accessible worlds, while preferential attitudes involve an ordering of worlds, an ordering source, or something similar (see e.g.

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[1] See Farkas 1985, Villalta 2008, Quer 2009, Portner and Rubinstein 2013; Smirnova 2012 for Bulgarian; Giannakidou 1999, 2015 for Greek; Marques 2004 for Brazilian and European Portuguese; Mari 2016a for Italian; Quer 1998, 2001 for Catalan and Spanish; Anand and Hacquard 2013 for French; Matthewson 2010 for St'át'imcets; see Portner 2018a for a comprehensive discussion.

Farkas 1985, Giorgi and Pianesi 1997, Giannakidou 1998, Villalta 2008, Anand and Hacquard 2013, Portner and Rubinstein 2013, Silk 2018). By considering the meaning of the attitude as a mood trigger, representational attitudes are argued to be indicative selectors, while preferential attitudes are considered subjunctive selectors. We can build on standard entries for 'believe' and 'want' (based on Portner 2018a):

(5) ⟦ *believe* ⟧ $= [\lambda p \lambda a \lambda w.$ for every $w' \in R_{dox}(a, w)$: w' in $p]$

(6) a. ⟦ *want* ⟧ $= [\lambda p \lambda a \lambda w.$ for every $w' \in BEST(R_{dox}(a, w), <_{desire}(a, w))$: $w' \in p]$

  b. ⟦ *want* ⟧ $= [\lambda p \lambda a \lambda w.$ for every $w' \in R_{dox}(a, w)$, every world in p maximally similar to w' is more desirable to a in w than every world maximally similar to w' in $\neg p]$

The two entries for 'want' represent a standard ordering semantics in (6-a) and a conditional semantics based on Heim (1992) in (6-b). The crucial thing to note is that they both involve comparison, and 'want' is therefore predicted to select subjunctive.

While subjunctive selection with preferential attitudes is extremely robust across languages (we call these the 'hard' subjunctive selectors), the pattern is less cross-linguistically stable with representational attitudes. Italian, Portuguese, Icelandic, German, and Bulgarian allow subjunctive with belief predicates (Giorgi and Pianesi 1997, Fabricius-Hansen and Saebø 2004, Schlenker 2005, Homer 2007, Smirnova 2012, Mari 2016a), and in fact, Italian allows mood shift with all indicative-selecting attitudes listed above, with the exception of 'know'.

(7) Mood alternation with 'believe'

  a. Gianni crede   che Maria sia   incinta.
      Gianni believes that Mary be.3sg.SUBJ pregnant.

  b. Gianni crede   che Maria è   incinta.
      Gianni believes that Mary be.3sg.IND pregnant.
      'Gianni believes that Mary is pregnant.'

(8) Mood alternation with 'say' predicates

  a. Gianni dice a tutti   the Maria è   malata.
      Gianni says to everyone that Mary be.3sg.IND ill.
      'Gianni tells everyone that Mary is ill.'

  b. Gianni dice che Maria sia   malata.
      Gianni says that Mary be.3sg.IND ill.
      'According to Gianni, Mary is ill.'

(9) Mood alternation with fiction predicates

  a. Gianni sogna   sempre che Maria lo   tradisce.
      Gianni dreams always that Mary him cheats-on.3sg.IND.
      'Gianni always dreams that Mary cheats on him.'

     b.   Gianni sogna   che Maria lo   tradisca   per
             Gianni dreams that Mary him cheats_on.3sg.SUBJ to
             poterla   lasciare.
             be allowed-her leave.
             'Gianni dreams that Mary cheats on him, to be allowed to leave her.'

In view of this variation, one tempting hypothesis is to postulate polysemy for all these verbs; yet, while it might be necessary to postulate polysemy in extraordinary cases in the theory of mood, we will propose an analysis where the variants above are predictable and meaningful. This will predict the fact that the indicative in (8-a) conveys only that the prejacent is the content of the reported saying, while with the subjunctive (8-b), the sentence acquires an evidential reportative interpretation. Although this difference could be encoded in the predicate as an ambiguity, it would clearly be more insightful to derive it from the semantics of mood, if possible.

The literature contains several ideas about the meaning difference between belief sentences with indicative or subjunctive in (7). After first discussing previous views, we will argue that these variants differ with respect to the discourse status of the complement proposition p. Specifically, we claim that the subjunctive conveys that p is at issue and that potential support is being offered for p in the conversation. Likewise, 'dream' in (9) is a proper fiction predicates when it selects the indicative, as in (9-a), but it conveys conjecture and hope when it embeds the subjunctive, (9-b) (as we have tried to convey with the English translations, cf. Mari 2016b).[2] In this paper, we will focus on explaining the variation with 'believe', and then extend our approach to 'say', 'imagine', and emotive factives.

2.2   Approaches to cross-linguistic variation

2.2.1   Multiplicity of mood triggers in the lexical entries of the predicates

To solve the puzzle of crosslinguistic and intralinguistic variation in mood choice, scholars have elaborated the semantics of the attitudes in a variety of manners. Two types of accounts have in particular been proposed to solve some of the puzzles of variation.

Multiple layers hypothesis   Farkas (1985) and Giannakidou and Mari (2016a) focus on variation in mood selection by emotive factives. In French, emotive factives select subjunctive, while in Greek and Romanian they select indicative.

(10)   Jean est content que Marie vienne.   (French)
        John is   happy   that Mary comes.3sg.SUBJ.
        'John is happy that Mary is coming.'

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[2]'Dream'+subjunctive can also mean 'pretend that', where the dream is with open eyes (Ciardelli p.c.).

In Farkas's and Giannakidou's theories, indicative is expected with factives, and so to explain the choice of subjunctive in French, they propose two layers of meaning: a factive layer and a preferential layer that expresses the "emotive" meaning. According to Giannakidou and Mari (2016a), the lexical entry for 'be happy' is the following:

(11)   Two layers hypothesis
         $\llbracket$ *be happy* $\rrbracket$ $= [\lambda p \lambda a \lambda s :$
         a.   Definedness condition: $w_s \in p$
         b.   Assertion: a is the attitude holder of s and every world $w \in R_{happy}(s)$, $SIM_w(p) <_s SIM_w(\neg p)]$

The preferential layer is argued to trigger subjunctive in number of languages. To achive cross-linguistic coverage, Farkas sketches to a ranked constraint analysis: some languages privilege subjunctive over indicative (French), while others privilege indicative over the subjunctive (Greek).

Multiple components hypothesis   Without positing two distinct layers at two different interpretative levels, Anand and Hacquard propose an analysis that disentangles a variety of meaning components. Their case study is *espérer* in French, which can license both indicative and subjunctive.

(12)   Marie espère qu'il   vienne/viendra.
         Mary hopes that-he comes.3sg.SUBJ/FUT.IND
         'Mary hopes that he will come.'

Anand and Hacquard's semantics for 'hope', as applied to (12), is presented informally in (13) (Anand and Hacquard 2013, p. 34):

(13)   Multiple components of 'hope'
         • *Uncertainty*: There is a non-trivial subset of Marie's belief worlds where he comes and a non-trivial subset where he does not.
         • *Doxastic*: There is a world compatible with Marie's beliefs where he comes.
         • *Preference*: His coming is more desirable to Marie than his not coming.

Though Anand and Hacquard (2013) do not propose a theory of mood selection, we can imagine how a theory like theirs could explain mood variation. The doxastic component could be seen as an indicative trigger and the preference component as a subjunctive trigger. In principle, then, 'hope' would take a complement in either mood.

While the multiple layers and multiple components approaches bring out important issues and make the correct predictions in certain cases, as the authors acknowledge, these types of approaches cannot solve a number of puzzles, including, notoriously, the cases of Italian in (8)-(9). In the next subsection, we discuss two interesting approaches to subjunctive with 'believe'.

2.2.2 Analyses based on weakness

Weakness of the embedding verb In order to account for the use of subjunctive with 'believe', several analyses propose that the subjunctive is chosen because it expresses a weak or uncertain belief (see Homer 2007 for Italian and Smirnova 2012 for Bulgarian). Homer states the condition as follows:

(14) Generalized Strength Condition: In Italian, the indicative is possible in a clause ϕ embedded under an epistemic predicate and expressing proposition p, if the speaker or the subject of the attitude assigns a maximal degree of belief to p.

(We can set aside for now the part of (14) related to the speaker; it connects to our own analysis in a way we will return to below.) Homer proposes a probabilistic semantics for epistemic predicates where 'a is certain that p' means that a assigns p probability 1, and 'a believes p' means that a assigns p a probability $> .5$. He then connects the subjunctive to the fact that 'believe' does not require a value of 1.

This approach, however, does not explain all of the data. As mentioned above, predicates such as *essere convinto* 'be convinced' and *essere certo* 'be certain' also allow the subjunctive in Italian:

(15) a. Gianni è convinto che Maria sia   incinta.
          Gianni is convinced that Mary be.3sg.SUBJ pregnant
          'Gianni is convinced that Mary is pregnant.'
      b. Ora che ho   letto le documentazioni sono certa   che
          Now that have.1sg read the documents   be.1sg certain that
          sia   stato lui.
          be.3sg.SUBJ been him
          'Now that I have read the documents, I am certain that he was (the murderer).'

Homer states that these predicates prefer the indicative, and while this is correct in certain contexts, he overgeneralizes in giving an analysis which predicts that these predicates select indicative in all contexts. Moreover, adverbs conveying certainty are compatible with the 'believe'+subjunctive, and this leads us to further doubt the idea that the subjunctive implies uncertainty in Italian.[3]

(16) Gianni crede   proprio   che Maria sia   incinta.
      Gianni believes absolutely that Mary be.3sg.SUBJ pregnant
      'Gianni really believes that Mary is pregnant.'

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[3]Note that the adverb *proprio* scopes below 'believe' in (i), where the speaker in uncertain about what Gianni fully believes:

(i) Forse Gianni crede   proprio   che Maria sia   incinta.
    Maybe John   believes absolutely that Mary be.3sg.SUBJ pregnant

'Maybe John really believes that Mary is pregnant.'

Trying to account for the fact that belief is strong in Italian and still can trigger subjunctive, Mari (2016a) locates weakness in an epistemic modal base, which is argued to be distinct from the doxastic modal base. According to Mari, 'believe' presupposes that the attitude holder does not know that p is true and asserts that he or she holds the opinion that p is true. 'Belief' is thus strong in the assertion (where all worlds compatible with the attitude holder's opinion are p worlds) and weak in the presupposition (because only some of the worlds in the attitude holder epistemic state are p worlds). The 'not knowing' presupposition, captured as a partitioned epistemic modal base, is a subjunctive trigger according to this analysis.

For completeness, here we outline Mari's formal proposal. Let E be an epstemic modal base, D a doxastic modal base, w the evaluation world and i the attitude holder in w.

(17) Two layers of belief
  a. $[\![\, i \, believe \, p \,]\!]^{\,E,i,D,w}$ is defined iff $\exists w' \in E(i,w)[\neg p(w')] \wedge \exists w'' \in E(i,w)[p(w'')]$
  b. If defined: $[\![\, i \, believe \, p \,]\!]^{\,E,i,D,w} = 1$ iff $\forall w' \in Best_{Dox}(w,i)[p(w''')]$.

$Best_{Dox}(w,i)$ is defined as a function that returns those worlds in the epistemic modal base E that best comply with i's beliefs in w.[4]

While Mari appeals to lack of knowledge and to non-homogeneity in the epistemic state, her discussion does not explain the relationship between knowledge and belief, and so it only restates the intuition that 'believe' is weak in some respect and strong in another. Our analysis bears some similarity to Mari's, but in our proposal the knowledge component is recast as an evidential meaning relating to the common ground.

Weakness of the subjunctive Smirnova (2012) also proposes that the subjunctive with 'believe' in Bulgarian expresses lack of certainty. In her analysis, uncertainty is described as a weakness presupposition:

(18) Weakness of subjunctive
  For any context c, modal base f, and ordering source g:
  a. $[\![\, SUBJ \, p \,]\!]^{\,c,f,g}$ is defined iff $\exists w' \in \bigcap f(a)(w)[w' \notin [\![\, p \,]\!]^{\,c,f,g}]$.
  b. When defined, $[\![\, SUBJ \, p \,]\!]^{\,c,f,g} = [\![\, p \,]\!]^{\,c,f,g}$

While it may be appropriate for Bulgarian, this analysis cannot explain the Italian facts we have outlined. In particular, it is incompatible with the subjunctive under 'be certain' and with adverbs of certainty.

A related approach to solving the puzzle of the Italian subjuncive would explain the meaningful variation in terms of competition between indicative and subjunctive (see Schlenker 2005). Suppose we propose that in each language, one

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[4]Note that this analysis of 'belief' is parallel to the analysis of epistemic modal MUST, as presupposing lack of knowledge and quantifying over the set of 'Best worlds', see Giannakidou and Mari to appear, 2016b

of the moods is unmarked, and the choice of the other conveys either certainty or uncertainty, as appropriate. In Italian, we would assume that the subjunctive is the default mood, and the choice of the indicative conveys certainty. Such a view would expect free variation in mood choice when reporting a belief which the subject holds certain. In a language like French, the markedness relation would be the reverse. Indicative would be the default, with the subjunctive used to convey uncertainty. Then, to explain the lack of variation in French, we would assume that 'be certain' and 'believe' never convey uncertainty in this language, and so the subjunctive is banned with these predicates in French.

This view has a variety of consequences that we are not ready to endorse. First, it predicts free variation in Italian with predicates conveying certainity. We will argue instead that the subjunctive always conveys a discourse level pragmatic meaning. Second, it would treat subjunctive in Italian and French as having not only different markedness status, but different meanings. Specifically, the subjunctive would have to incorporate a meaning of uncertainty only in French.

Finally, based on St'át'imcets data, Matthewson (2010) also proposes an analysis of the subjunctive as a weakener. Building on ideas from Portner (2007), she proposes that the subjunctive introduces a choice function over the domain of quantification of the attitude (i.e. the set of 'Best worlds', delivered by a modal base and an ordering source). In order to prevent the function from being the identity function, she stipulates that the domain of quantification comprises at least one world in which the prejacent is false; since the choice function selects a subset, it leads to weaker truth conditions. One can imagine applying Matthewson's analysis mood variation in Italian, leading to the prediction that 'believe' with subjunctive is weaker than 'believe' with indicative. However, we have argued that the subjunctive in combination with epistemic predicates is not reliably associated with weakness. Moreover, such an account would not explain the crosslinguistic differences within Romance, since it would lead one to expect major differences in the mood systems of Italian and French, rather than the limited variation we find.

We will provide a unified theory of the subjunctive crosslinguistically, without locating the variation between languages in the semantics of either the subjunctive or the attitude predicates.

2.3   Subjunctive and the common ground: judgment task

Our main idea is that, with 'believe' and the other cases of mood variation in Italian, the subjunctive indicates that the content of the complement clause is directly relevant to the common ground.[5]. It's not a weakening or other shift in the type of attitude expressed, but instead invokes a different relation among the contents of the subjunctive clause, the attitude verb, and the context. In the specific case of subjunctive under 'believe', the subjunctive conveys that the doxastic modal background DOX is to provide the basis for evaluating a

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[5]For the initial insights in this direction, see Mari 2015, 2017.

possible update of the common ground. In section 3, we will integrate this idea into a general analysis of mood where the subjunctive, across languages, has a consistent semantics.

Before going on to present our main arguments, we would like to make two preliminary observations. The first is that there is precedent for the idea that mood selection can depend on the relation to the common ground. Many theories of mood propose that factivity can be an indicative trigger (Giorgi and Pianesi 1997, Giannakidou 1998, Farkas 2003), and Farkas (2003) and Homer (2007) argue that the indicative is used in Italian when the speaker is committed to the truth of the complement proposition. Homer expresses this idea in the following congruence condition (this condition is incorporated into (14) above):

(19)   Congruence Condition: In Italian, the indicative is possible in a clause ϕ embedded under an epistemic predicate and expressing proposition p, if it is presupposed that the speaker assigns a maximal degree of belief to p.

Both of these ideas already amount to considering the status of p in the discourse context, rather than in the local attitude context, as possible triggers of the indicative. Our proposal takes a similar stance with regard to the subjunctive.

The second observation is that 'believe' is sometimes used to present p as a possible candidate to restrict the common ground. This can be seen from that fact that the complement of 'believe' can be directly targeted by denials, in contrast to the complements of preferential predicates.

(20)   I believe that this is the Pantheon.
        No, you are wrong, this is the Hotel des Invalides.

(21)   a.   I want for John to become a doctor.
              #No you are wrong, he will become a priest.
        b.   I prefer that John becomes a doctor.
              #No you are wrong, he becomes a priest.

We can describe this by saying that, at least in some instances, belief is a "public" attitude which can be used to put forward p as opposed to just describing the internal state of the attitudes holder. When it does so, it makes p available for ratification or denials by the other participants in the conversation.

In order to validate our intuitions about the difference between 'believe' with indicative vs subjunctive in Italian, we have performed a judgement task experiment. We presented 'believe' sentences in two types of context, 'intimate' contexts (which we also call 'subjective') and 'inquisitive' context (which we also call 'objective'). We will now describe these two types of contexts.

In intimate (subjective) contexts a belief statement addresses the nature of the personal commitments of the subject argument. We constructed belief sentences in which the complement contains a subjective predicate (Lasersohn 2005, Stephenson 2007) and thus most likely pertains to the private mental state of the attitude holder. The semantics of belief sentences in such contexts can be approximately captured by a standard Hintikkan semantics. We call the

reading favored in intimate contexts the BELIEF ONLY reading.

(22) is an example of an intimate context, with targets containing both indicative and subjunctive in the complement.

(22)   a.   **Intimate (subjective) context**
            A friend of yours asks you your opinion about the street where you both are. You reply:
     b.   Credo   che   sia   brutta.
            believe.1sg that be.subj ugly.
     c.   Credo   che   è   brutta.
            believe.1sg that be.indic ugly.

In inquisitive contexts, the truth value of p in the common ground is at issue. The belief sentence contains non-subjective predicates, and thus there is a fact of the matter about its truth that could be ratified in the common ground (for this reason, we also refer to inquisitive contexts as 'objective').[6] The reading favored in inquisitive contexts is labeled the DISCOURSE BELIEF reading. (23) is an example of an inquisitive context.

(23)   a.   **Inquisitive (objective) context**.
            A friend of yours asks you the name of the street where you both are. You reply:
     b.   Credo   che   sia   la   via   Boccaccio.
            believe.1sg that be.subj the Boccaccio street.
     c.   Credo   che   è   la   via   Boccaccio.
            believe.1sg that be.indic the Boccaccio street.

We performed a full judgment task experiment comparing the acceptability ratings of subjunctive and indicative complements in intimate (objective) and inquisitive (subjective) contexts.

Our study, presented in detail in Appendix A, shows that while there is no signficant difference in the acceptability ratings for the indicative in the intimate (subjective) and in the inquisitive (objective) contexts, with the subjunctive there is a statistically significant preference for the inqustive (objective) context. This conclusion has been reached on the basis of three different tests: the z-test of the mean, a two-samples Kolmogorov-Smirnov test and the z-test of the differences.

We conclude that the use of the subjunctive is related to truthfulness of p in the common ground, and we aim to make this precise in what follows. In contrast, the stability of the ratings of the indicative with belief verbs in objective and subjective contexts in an experimental setting does not prove that the indicative does not bear meaning when embedded under 'believe'. Rather, we might attribute the strong cross-contextual stability across contexts to a very strong normative pressure to avoid indicative with 'believe'.

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[6]Note that, even under objectivist approaches of predicates of personal taste, truthfulness of p cannot be ratified and faultless disagreement is always possible.

Connection to presuppositional theories. We mentioned above that several theories have proposed that a discourse-level presupposition can trigger the indicative (Giorgi and Pianesi 1997, Giannakidou 1998, Farkas 2003). Their intuitions about the data fit into our way of thinking, though we start from the assumption that it is the use of subjunctive with 'believe' that needs explanation, not the use of indicative. In general, we can describe presuppositional contexts as ones that support a belief-only reading, not a discourse belief reading. This point is clear in the case of true factivity, i.e. when the truth of the complement of 'believe' is presupposed in the discourse context. In such a situation, a discourse belief reading would not make sense, since the proposition is not at issue in the context.

Homer's (2007) analysis relates to ours in a slightly different way, because it is based not on truth, but on congruence, (19).[7] In a context where the speaker is presupposed to believe the complement of 'believe', but p itself is not presupposed (because the addressee does not accept it), matters are more subtle. Homer claims that such contexts prefer the indicative (Homer 2007, (49)):

(24) So   che noi due non siamo d'accordo. Io sono sicuro   che
      know.1st that we two neg are   agreed   I am   certain that
      Maria è   incinta, metre tu pensi non lo sia.   Anche Gianni
      Maria is.IND pregnant while you think neg it be.SUBJ also Gianni
      crede   che Maria ?sia/è   incinta.
      believes that Maria be.SUBJ/be.INDIC pregnant
      'I know that the two of us do not agree. I'm sure that Maria is pregnant,
      while you do not think so. Gianni too believes that Maria is pregnant.'

However, we disagree with Homer's interpretation of this judgement (which is presented as a weak preference in any case). In our view, this context is compatible with both a belief-only reading and a discourse belief reading. If the point of the utterance is just to report Gianni's belief (belief only reading), which agrees with the speaker's, indicative is preferred; if the point is to relate Gianni's belief to something at-issue in the context (discourse belief reading), the subjunctive is chosen. Our analysis will capture the difference in meaning in this case.

In any case, if we step back from these heavily theory-laden descriptions of subtle context-dependent effects, we can say that we broadly agree with these presuppositional proposals, in that we also think that the discourse status of the complement is important in explaining mood choice. As for subjunctive, our main idea is that it is unsettledness in the discourse that matters. The main advantage of our analysis is that we integrate this point into a general theory which assigns the same meaning to the subjunctive and indicative across languages and contexts, rather than separating out the cases with 'believe' and other epistemic predicates for special treatment. Crucially, in our theory the

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[7]See also Quer 2001 for a theory of subjunctive relying on consensus, in the specific case where a negation is used.

choice of mood does not merely reflect a background difference in the context, as the presuppositional analyses assume, but compositionally produces a difference in semantics.

Special contexts favoring the indicative There is one additional point which supports our view of the difference between indicative and subjunctive complements with 'believe'. Interestingly, the indicative is widely used in religious contexts, where speakers express their own personal view about faith. In (25), for instance, a prayer in which the speaker states his belief in each benefit of pain, the indicative is exclusively used under 'believe'. The first three elements of the prayer are in (25) (note the list of verbs in the indicative in the second bullet):[8]

(25)   Apostolato della sofferenza (Apostolate of suffering):

a.   Credo che il dolore **è** uno dei più grandi benefici che Dio possa concedere ad un'anima.
       I believe that pain is one of the greatest benefits that God might concede to a soul.

b.   Credo che il dolore **distacca**, **disillude**, **purifica**, **migliora**, anzi **conduce** l'anima alla più alta perfezione.
       I believe that pain detaches, disilluses, purifies, improves, and indeed guides the soul to the hghest perfection.

c.   Credo che Dio **è** vicino a quelli che soffrono per Lui.
       I believe that God is clode to those who suffer for him.

In our terms, we would state that indicative receives a belief-only reading in these texts, because the primary goal is to make her/his own state of mind known, rather than seeking to establish something as true in the context.

This feature of the meaning can be seen dramatically in (26), where the vocative indicates that the speaker is not engaged in a discussion, but is merely expressing a personal belief.[9]

(26)   Comunione Spirituale Gesù mio, io credo   che sei
       communion spiritual   Jesus my   I believe that be.2sg.INDIC
       realmente presente nel   Santissimo Sacramento.
       really   present in the holiest   sacrament
       'Spiritual Comunion My Jesus, I believe that you are truly present in the most holy sacrament.'

The use of the subjunctive would give the impression that the speaker is discussing something at issue in the common ground — a pragmatics incompatible with the concept of prayer. The difference between indicative and subjunctive cannot be described as certainty vs uncertainty, since the speaker feels certain of the matter in either case. The difference is in whether p is under discussion.

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[8]http://cvsmodena.altervista.org/pdf/apostolato_della_sofferenza.pdf
[9]Source: https://www.pinterest.fr/pin/785315253743596236/

The use of indicative with 'believe' in prayer contexts is often used to support the idea that it marks certainty. While we have shown clear evidence above that certain belief does not require indicative, the intuition that there is a connection between certainty and indicative in these cases in not wrong. We can explain it in terms of our theory as follows: prayers are solely about the speaker's state of mind, and this is what the indicative conveys. The ideal form of religious belief is unwavering faith, belief with no doubts. Thus, the indicative is often used in religious contexts when the speaker is understood not to suffer doubt. Conversely, when someone uses the subjunctive, they indicate that the truth or falsity of the belief is up for discussion in the conversation, and often when a person addresses a belief in conversation, it is because they are not certain of its truth. In the case of prayers, it would be especially inappropriate (as well as pointless) for the speaker to imply that the "prayed" belief sentence is part of a discussion in which the interlocutors jointly work towards the truth.

3 Analysis of mood variation in Italian

In this section, we present our analysis of mood choice in Italian and the variation between Italian and French with 'believe' and other epistemic predicates. We will proceed by first giving a semi-formal overview of the approach, then presenting it in a fully compositional form, and finally extending the proposal to other predicates which show variation in Italian.

3.1 Overview of the approach

Our basic idea about the semantics of the subjunctive is that it relates two modal backgrounds, the 'ordering' O and the 'target' T, making a comparison of worlds in T on the basis of O. A hard subjunctive-selector like 'want' provides two backgrounds, $\langle B_1, B_2 \rangle$, and the subjunctive identifies B_1 with O and B_2 with T. 'Believe' differs from 'want' in that it provides only a single modal background, B_1. The subjunctive identifies B_1 with O, but the verb does not provide a second background to function as T. In Italian but not French, a coercion rule identifies T with the common ground; as a result, 'believe' is ungrammatical with the subjunctive in French, and we derive a discourse belief meaning meaning in Italian (the truth conditions evaluate the worlds compatible with the common ground according to how well they fit with the attitude holder's beliefs). These ideas are summarized in Table 1, where '*' indicates that the combination fails for a semantic reason.

The indicative combines with a single modal background. It is incompatible with 'want' in all languages, because 'want' has a second background that cannot be used, and when it combines 'believe', it gives a Hintikkan semantics. The relations with indicative are summarized in Table 2.

	B_1	B_2	
'want'	Bul	DOX	
'want' + subjunctive	$O = Bul$	$T = DOX$	(Italian & French)
'believe'	DOX	$-$	
'believe' + subjunctive	$O = DOX$	$T = CG$	(Italian)
		$*$	(French)

Table 1: Overview of subjunctive

	B_1		
'want'	Bul	DOX	
'want' + indicative		$*$	(Italian & French)
'believe'	DOX	$-$	
'believe' + indicative	$T = DOX$		(Italian & French)

Table 2: Overview of indicative

3.2 SIM semantics for the subjunctive

We will formalize our ideas in terms of a version of the SIM semantics for desiderative and emotive predicates originally due to Stalnaker (1984) and Heim (1992). We build on Portner's recent proposal that the subjunctive involves a comparative operator CPR which takes two arguments, a proposition and a modal background, to produce a similarity-based ordering of worlds in that background (Portner 2018b):[10]

(27)   a.   Definition of SIM
       $SIM(p)(w) = v$: v is the world most similar to w such that $p(v) = 1$
     b.   Semantics for the subjunctive (to be revised)
       $[\![\ subj\ ]\!] = CPR = \lambda p \lambda B \ . \ \{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v \in B\}$

At this stage in our discussion, we can identify the the semantics of the subjunctive with CPR. (This point will be revised in our compositional implementation.) It's important for our purposes to note that CPR doesn't merely use a pre-existing ordering, but actively creates an ordering based on SIM (relative to B). The interpretation of this ordering (buletic in the case of 'want', evidential in the case of 'believe') enters the picture later in the derivation.

Given (27), the following entry for 'want' reproduces the standard Heimian semantics. $DOX(a,w)$ and $Bul(a,w)$ are premise sets, the set of a's beliefs in w and the set of a's desires in w. We write $w <_{Bul(a,w)} v$ when w is is preferred to v according to the pre-order of worlds induced by $Bul(a,w)$.

(28) $[\![\ want\ ]\!] = [\lambda r \lambda a \lambda w \ . \ r(\bigcap DOX(a,w)) \subseteq <_{Bul(a,w)}]$
     a. $[\![\ A\ wants\ [SUBJ\ S]\ ]\!] =$

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[10]For simplicity, we assume that there is always exactly one world most similar to w in which p is true. Villalta (2008) and Anand and Hacquard (2013) also proposes a semantics for the subjuctive based on the SIM semantics.

b. $[\![\,want\,]\!]\,(\lambda B\;.\;\{\langle SIM(p)(v),SIM(\neg p)(v)\rangle:v\in B\})(a)=$

c. $[\lambda r\lambda a\lambda w\;.\;r(\bigcap DOX(a,w))\subseteq<_{Bul(a,w)}]$
   $(\lambda B\;.\;\{\langle SIM(p)(v),SIM(\neg p)(v)\rangle:v\in B\})(a)=$

d. $[\lambda w\;.\;\{\langle SIM(p)(v),SIM(\neg p)(v)\rangle:$
   $\qquad\qquad v\in\bigcap DOX(a,w)\}\subseteq<_{Bul(a,w)}]=$

e. $[\lambda w\;.\;\text{for every world }v\in\bigcap DOX(a,w),$
   $\qquad\qquad SIM(p)(v)\;<_{Bul(a,w)}\;SIM(\neg p)(v)]$

In this derivation, the verb takes the subjunctive clause and applies it to the 'target' $DOX(a,w)$; CPR then creates the SIM pairs of a p-world and a $\neg p$-world based on the set $\bigcap DOX(a,w)$. The verb states that these SIM pairs can be interpreted in terms of the buletic ordering $<_{Bul(a,w)}$. The step from (28-d) to (28-e) simply restates the truth condition in a format where the preference ordering $<_{Bul(a,w)}$ is written in the normal way, with the compared worlds on either side of $<$, as in Heim's paper.

Note that the meaning assigned to 'want' involves two backgrounds, DOX and Bul. When it comes to 'believe' with a complement in the subjunctive, our proposal is that the verb only introduces a single background, and so the second background has to be identified in a different way.

3.3 Compositional derivation and crosslingustic variation

Our goal is now to give a compositional analysis which accounts for the difference between Italian, which allows the subjunctive under 'believe', and French, which does not. We treat the relation between the verb and its subjunctive or indicative complement clause in a non-standard way, where the verb is the argument of the complement CP. (This idea has precedents in Portner 1997 and Kratzer 2013.) The only semantic contribution of the matrix verb or adjective is a modal background or pair of modal backgrounds:

(29) a. $[\![\,believe\,]\!]\;=DOX$
      b. $[\![\,want\,]\!]\;=\langle Bul,DOX\rangle$
      c. $[\![\,certain/convinced\,]\!]\;=CERT$
      d. $[\![\,say\,]\!]\;=RCG$ (for 'reported common ground')
      e. $[\![\,dream\,]\!]\;=DRM$
      f. $[\![\,suprise\,]\!]\;=\langle Unexpect,\lambda x\lambda w.CG\rangle$

We will show how each of these meanings fits into the framework below, starting with 'believe' and 'want'. By giving the verbs such simple meanings, we will be able to avoid the polysemy present in other analyses of mood variation. Specifically, 'believe' contributes DOX in all languages and contexts, and the difference between cases where it combines with indicative or subjunctive rests in the moods themselves.

Next we give the meanings for the indicative and subjunctive morphemes. Notice that the indicative in (30-a) has one modal background argument, T, while the subjunctive in (30-b) has two, O and T:

(30)   a. $[\![\,indic\,]\!] = \lambda p\lambda T\lambda x\lambda w[T(x,w)\subseteq p]$
       b. $[\![\,subj\,]\!] = \lambda p\lambda O\lambda T\lambda x\lambda w[CPR(p)(\bigcap T(x,w)\subseteq<_{O(x,w)})]$

(30) incorporates the relation between the target T and the interpretation of the SIM ordering O which is attributed to a verb like 'want' in Heim's analysis and the discussion in Section 3.1. In other words, the mood morphemes' meanings have been lifted to do what previously had been the verbs' jobs.

   We can illustrate how these entries work with examples.

(31)   'Believe' plus indicative (French)

       a. $[\![$ Jean croit que Marie est enceinte $]\!] =$
       b. $[\![\,indic(Marie.enceinte)(croire)(Jean)\,]\!] =$
       c. $[\![\,indic(Marie.enceinte)\,]\!](DOX)(j)$
       d. $\lambda w[DOX(j,w)\subseteq\{v : $ Marie is pregnant in $v\}]$

This derivation yields the standard Hintikkan semantics for belief. The only unusual aspect of the derivation is the reversal of the function-argument relation between verb and complement.

(32)   'Want' plus subjunctive

       a. $[\![$ Gianni vuole che Maria si sposi $]\!] =$
       b. $[\![\,subj(Maria.sposarsi)(volere)(Gianni)\,]\!] =$
       c. $[\![\,subj(Maria.sposarsi)\,]\!](\langle Bul, DOX\rangle)(g) =$
       d. $\lambda w[CPR(p)(\bigcap DOX(g,w))\subseteq<_{Bul(g,w)}] =$
       e. $\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v\in\bigcap DOX(g,w)\}\subseteq<_{Bul(g,w)}]$

Here we achieve the standard Heimian semantics for desire. In this case, the verb provides two backgrounds, one buletic and one doxastic. The subjunctive is designed to take two modal backgrounds to yield the correct meaning.

(33)   'Believe' plus subjunctive (Italian)

       a. $[\![$ Gianni crede che Maria sia incinta $]\!] =$
       b. $[\![\,subj(Maria.incinta)(credere)(Gianni)\,]\!] =$
       c. $\lambda T\lambda w[CPR(p)(\bigcap T(x,w))\subseteq<_{DOX(g,w)}] =$
       d. $\lambda T\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v\in\bigcap T(g,w)\}\subseteq<_{DOX(g,w)}]$

This derivation is the core of our proposal. The subjunctive complement combines with a verb that provides only a single modal background, which is doxastic. The speaker's beliefs represent the interpretation of a SIM ordering of worlds in the target set $T(g,w)$, but T is not provided by the verb. We propose that a pragmatic process applicable in Italian replaces $T(g,w)$ with the common ground. This process, discussed further below, yields the following denotation:

(34)   a. $\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v\in\bigcap CG\}\subseteq DOX(m,w)]$
       b.   The ordering of worlds in the context set according to Gianni's beliefs ranks worlds in which Maria is pregnant higher than worlds in which she is not.

More precisely, (33) true in w iff, for each world v in the context set, if Maria is pregnant in v, it better fits Gianni's beliefs in w than the most similar world in which she is not, and if she is not pregnant in v, it worse fits Gianni's beliefs in w than the most similar world in which she is.

An assertion with the type of semantics in (34-b) is expected to have a distinct pragmatics, since it involves quantification over the context set. We have observed that an assertion of 'believe' with subjunctive typically amounts to proposing that p become common ground. This feature of meaning is especially clear with a first person subject, where the semantics just outlined relates the speaker's own beliefs to the space of possibilities compatible with the common ground.

(35)   a.   Credo   che Maria sia   incinta.
            believe.1sg that Mary be.3sg.SUBJ pregnant.
       b.   The ordering of worlds in the context set according to the speaker's beliefs ranks worlds in which Maria is pregnant higher than worlds in which she is not.

The special pragmatics of such examples can be explained in terms of the semantics we propose. In the case of (35-a), we have the semantics (35-b). In many contexts, because the speaker should have reasons for her beliefs, this naturally implicates that worlds in which Mary is not pregnant should be demoted from the common ground. Even if they are not removed from the common ground entirely, they should be treated as less likely, so long as the speaker's information is deemed to have evidential value.

Our analysis reduces the difference in mood selection between Italian and French to a single rule outside of the core compositional system. This is an important advantage over all previous theories, which attribute the difference either to the verbs' lexical semantics (without any other reason to assume that 'believe' means different things in the two languages), or to the mood morphemes (which makes it hard to explain how similar their mood selection properties are across all other contexts).

- Proposal: Italian but not French can use the common ground as a default background in propositional attitude sentences.

We give this rule explicitly in (36):[11]

(36)   Common ground as default background:
       When a root sentence S is of type $\langle\langle es, \langle st, t\rangle\rangle, st\rangle$,

_____

[11]It woud be interesting to pursue a dynamic (or more broadly, performative) analysis of the function of subjunctive in these cases. The idea would be that, when subjunctive fills in its missing argument with CG, it is reinterpreted so as to actively update the evidential information in the context with p, rather than producing a proposition which is true iff the attitude holder's beliefs support p. Such a view could be connected to evidentials as well as to the use of subjunctives as root clauses, where they tend to have a directive or optative meaning. However, pursuing this intuition would require a significant study of recent work on evidential semantics, such as Murray (2014) and Murray and Starr (2016), as well as new techniques for analyzing mood. We hope to develop this idea in future work.

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- $CG + S = CG \cap [\![\, S \,]\!](\lambda x \lambda w.CG)$

This rule implements a type of accomodation or coercion which fixes a type-mismatch for contextual update; since 'believe'+subjunctive produces a denotation which still requires a conversational background in order to be of the right type for assertion, the common ground is used as a default.[12]

3.4 Predicates of certainty

As seen in (15), predicates of certainty can also take the subjunctive. Recall the example with 'convinced', repeated here:

(37)   Gianni è convinto   che Maria sia   incinta.
        Gianni is convinced that Mary be.3sg.SUBJ pregnant
        'Gianni is convinced that Mary is pregnant.'

We assume that 'convinced' here refers to a single background, $CERT$, with the following definition:

(38) $[\![\, convinced \,]\!] = CERT = \lambda x \lambda w \{p \in DOX(x,w) : p$ is not below any other proposition in $DOX(x,w)$ in the strength with which x holds p in $w\}$

This says that 'convinced' means 'believes to the highest degree', which is certainly a simplification; see Barker and Taranto (2003), Taranto (2006), Krawczyk (2012), Klecha (2014), and Portner and Rubinstein (2016) for important discussion relevant to 'certain'. All that's essential for the purpose of explaining its mood selection in our framework is the assumption that 'convinced' introduce a single modal background.

Given that it refers to a single modal background, 'convinced' is correctly predicted to allow indicative across languages. When it can take subjunctive, as in Italian, it behaves like 'believe':

(39)   'Certain' plus subjunctive (Italian)
        a. $[\![$ Gianni è convinto che Maria sia incinta $]\!] =$
        b. $[\![\, subj(Maria.incinta)(convinto)(Gianni) \,]\!] =$
        c. $\lambda T \lambda w[CPR(p)(\bigcap T(x,w)) \subseteq <_{CERT(g,w)}] =$
        d. $\lambda T \lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v \in \bigcap T(g,w)\} \subseteq <_{CERT(g,w)}]$
        e. Apply rule (36):
            $\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v \in \bigcap CG\} \subseteq <_{CERT(g,w)}]$

The result of applying rule (36) is (39-e), which says that (37) is true iff Gianni's certain beliefs rank worlds in the context set in which Maria is pregnant higher than the most similar worlds in which she is not pregnant, and worlds in the context set in which Maria is not pregnant lower that the most similar worlds

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[12]Since the common ground is a set of propositions, but the subjunctive expects a conversational background (a function from an individual and a world to a set of propositions), we have to incorporate $\lambda x \lambda w CG$ rather than simply CG.

in which she is. Pragmatically, an assertion of this naturally amounts to an endorsement of adding 'Maria is pregnant' to the common ground — and all the more so if *Gianni* is replaced by the first person subject.

The following attested example (with 'certain' rather thant 'convinced') further illustrates our point: the speaker puts forward a hypothesis for why she has been dumped by her boyfriend. She asserts that her certain beliefs, i.e. $CERT$, order worlds in which it is because of her obesity above worlds in which that is not the reason, and this may be taken as an indication that that she thinks this hypothesis should be accepted as common ground.[13]

(40)   Il   mio ragazzo   mi ha tradito   due mesi   fa   e   sono
       the my boyfriend me has dumped two months ago and be.1sg.INDIC
       sicura   che sia.   da   attribuire   tutto alla   mia obesità.
       certain that be.3sg.SUBJ from attribute.inf all   to-the my obesity
       'My boyfriend dumped me two months ago, and I am certain that this
       is to be attributed to my obesity

3.5 'Say' and 'dream'

With the data repeated below, we showed that 'say' and 'dream' allow both indicative and subjunctive in Italian:

(41)   a.   Gianni dice a tutti   the Maria è   malata.
            Gianni says to everyone that Mary be.3sg.IND ill.
            'Gianni tells everyone that Mary is ill.'
       b.   Gianni dice che Maria sia   malata.
            Gianni says that Mary be.3sg.SUBJ ill.
            'According to Gianni, Mary is ill.'

(42)   a.   Gianni sogna   sempre che Maria lo   tradisce.
            Gianni dreams always that Mary him cheats-on.3sg.IND.
            'Gianni always dreams that Mary cheats on him.'
       b.   Gianni sogna   che Maria lo   tradisca   per
            Gianni dreams that Mary him cheats-on.3sg.SUBJ to
            poterla   lasciare.
            be allowed-her leave.
            'Gianni dreams that Mary cheats on him, to be allowed to leave
            her.'

The compositional anaysis of these cases is the same as with 'believe'. The verbs refer to a single modal background, RPG and DRM respectively, which can unproblematically be taken as argument by an indicative CP. When these verbs combine with the subjunctive, their modal background saturates the O argument, and the T argument is filled in by Rule (36). Thus, (41-b) means that, across the context set, worlds in which Mary is ill better match what Gianni

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[13]Source: `https://it.answers.yahoo.com/question/`, accessed May 2017.

said than otherwise similar worlds, and conversely for worlds in which Mary is not ill. An assertion of this proposition evaluates the common ground on the basis of what Gianni said, and so it naturally is taken as a move leading towards it becoming common ground that Maria is ill (and even more so if the subject is changed to first person), though it is in fact weaker than a simple assertion that she is. The meaning is similar in its pragmatics to a reportative-evidential statement.

It is reasonable to assume that for each world in the context set in which Maria is ill, the most similar world in which she is not ill is also in the context set, and conversely for each world in the context set in which she is not ill, that the most similar world in which she is ill is also in the context set. It is convenient to have a notation for the situation when this holds:

(43) SIM-inclusion: $SIMIN(p, S)$ holds iff

$$domain(\{\langle SIM_w(p), SIM_w(\neg p)\rangle : w \in S\}) \cup$$
$$range(\{\langle SIM_w(p), SIM_w(\neg p)\rangle : w \in S\}) \qquad \subseteq S$$

We speculate that in the configuration *x say that subj(S)*, the proposition p denoted by S always meets the condition $SIMIN(p, CG)$. This states that the truth or falsity of p is fully open in CG in the sense that the participants agree that, on the assumption that p holds in the actual world, the supposition that it doesn't hold stays within the common ground (and conversely on the assumption that p doesn't hold, the supposition that it does stays within the common ground). It is in this type of context that an evidential statement like (41-b) would be appropriate. In any case, if we can assume that $SIMIN(p, CG)$ holds, the meaning we assign to (41-b) is equivalent to the proposition that all of the worlds in the common ground in which what Gianni said is true are worlds in which Maria is ill.

In the case of 'dream'+subjunctive, the connection between the common ground and lexical modal background is more subtle. Our translation of (42-b) indicates that it could be used in a situation where it is at issue in the conversation whether Gianni is allowed to leave Maria. The truth conditions we assign to this example are that Gianni's dream better describes each world in which Maria cheats on him than it does the otherwise most similar world in which she does not (and conversely). Why would someone mention a dream which ranks worlds in the context set in this way? In this case, 'dream' takes on a shade of meaning similar to 'wish', since we all know the experience of nuturing daydreams which show us what we desire, as well as the experience of repressing daydreams which show us what we fear. The sentence, in essence, means that Gianni's happy dreams better describe common ground worlds in which Maria cheats on him, than they do worlds in which she doesn't. If we want Gianni to be happy, an assertion of this content suggests that we too should prefer worlds in which Maria cheats on Gianni.

3.6 Factivity and probability

To conclude this section, we will give the analysis of emotive factives (which behave the same in Italian and French), and then make note of how probability predicates fit into the system.

In the entry for 'surprise' in (29-f), we have two modal backgrounds, as with 'want'. This explains why it takes subjunctive. However, note that one of the two is the common ground, not a "private" background such as DOX or Bul.[14] The factivity of 'surprise' provides additional motivation for this feature of its meaning: we need to be able to state in the lexical entry that the common ground entails the truth of the complement proposition.

Given the fact that we treat the predicate's meaning as simply a sequence of backgrounds, it is not straightforward to encode the factive presupposition. 'Surprise' does not have direct access to the proposition p denoted by the constituent under the mood morpheme, and as a result factivity will have to be imposed not when the verb is composed with its complement, but at a point where where both p and CG are available. In our current analysis, this is at the level of the mood morpheme, so we would need a factive subjunctive, as in the following:

(44) $[\![\, subj^{[+fact]} \,]\!] =$
$\lambda p \lambda O \lambda T \lambda x \lambda w \; : \bigcap T(x,w) \subseteq p \,.\, [CPR(p)(\bigcap T(x,w)) \subseteq <_{O(x,w)}]$

In (44), the presupposition is incorporated as a domain restriction $\bigcap T(x,w) \subseteq p$, where $T(x,w)$ is the target which will be identified with the common ground. However, as far as we know, there is no precedent for analyzing factivity at the level of mood, and so this treatment is somewhat stipulative. There is, however, evidence that factivity is introduced at the level of the complementizer (Kratzer 2006, Schueler 2016), and so this analysis gives us motivation to decompose the meaning currently attributed to mood into a part contributed by mood itself, and a part contributed by the complementizer.

(45)   a. $[\![\, indic \,]\!] = \lambda p.p$
        b. $[\![\, subj \,]\!] = \lambda p.CPR(p)$

(46)   a. $[\![\, C_{indic} \,]\!] = \lambda p \lambda T \lambda x \lambda w [\bigcap T(x,w) \subseteq p]$
        b. $[\![\, C_{subj} \,]\!] = \lambda r \lambda O \lambda T \lambda x \lambda w [r(\bigcap T(x,w)) \subseteq <_{O(x,w)}]$

The indicative complementizer must always go with the indicative mood morpheme, and similarly for the subjunctive complementizer and mood morpheme. This could be treated as syntactic selection, but it can also be attributed to the semantic types. C_{indic} takes a simple proposition as its argument, while C_{subj} takes a function from backgrounds to sets of SIM-pairs. These are the corresponding types of their mood-marked arguments.

The indicative and subjunctive complementizers both have factive versions:

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[14]Technically, it is the constant function from an individual and a world to CG, to maintain consistency of types. In a language where emotive factives take the indicative, we would suggest that CG is provided by a default rule in the manner of (36)

(47)   a. $[\![C_{indic}^{[+fact]}]\!] = \lambda p \lambda T \lambda x \lambda w : w \in p . \bigcap T(x,w) \subseteq p$
       b. $[\![C_{subj}^{[+fact]}]\!] = \lambda r \lambda O \lambda T \lambda x \lambda w : w \in domain(r(\bigcap T(x,w)) .$
$$r(\bigcap T(x,w)) \subseteq <_{O(x,w)}$$

Within (47-b), the domain of the CPR function is $domain(r(\bigcap T(x,w))$; given the definition of CPR in terms of $SIM(p)$, it is a set of p worlds. Therefore, the presupposition $w \in domain(r(\bigcap T(x,w))$ states that the evaluation world is a p world.

With this treatment of factivity in the background, we can illustrate the compositional derivation of an example with 'surprise':

(48)   'Surprise' plus subjunctive
       a. $[\![$ Jean est surpris que Marie vienne $]\!] =$
       b. $[\![C_{subj}^{[+fact]}(subj(Marie.comes))(surprised)(Jean)]\!] =$
       c. $\lambda w : w \in domain(CPR(p)(\bigcap[\lambda x \lambda w.CG](x,w)) .$
             $CPR(p)(\bigcap[\lambda x \lambda w.CG](x,w))) \subseteq <_{Unexpect(j,w)} =$
       d. $\lambda w : w \in domain(CPR(p)(\bigcap CG) .$
             $CPR(p)(\bigcap CG) \subseteq <_{Unexpect(j,w)} =$
       e. $\lambda w : w \in domain(CPR(p)(CG)) .$
             $\{\langle SIM(p)(v), SIM(\neg p)(v) \rangle : v \in \bigcap CG\} \subseteq <_{Unexpect(j,w)}$

An advantage of using the SIM-based semantics for factive and anti-factive predicates is that it automatically handles the comparison between common ground worlds and worlds outside of the common ground. In (48-e), p is true in each common ground world v (Marie comes in each of these worlds), and so $SIM(p)(v)$ always $= v$. However, the compared world $SIM(\neg p)(v)$ lies outside the common ground. It is the world as similar as possible to common ground world v given that Marie doesn't come. The SIM semantics also explains the counterfactual inferences associated with emotives. For example, (49) implicates that I would have been sad if she had not come (under the assumption that in the closest $\neg p$ world to v, I have the same preferences as I have in v).

(49)   I am happy that she came.

It's also interesting to consider probability predicates in this framework. We begin with 'probable'. Suppose we assume that it provides two modal backgrounds like 'want' and 'surprise'. The first, labeled $Prob$ below, yields a probability ordering between worlds $<_{Prob(i,w)}$.[15] We assume that the second is the common ground, as with 'surprise', and that the speaker is an implicit argument (represented by i) which fixes the basis for the probability judgment:

(50) $[\![probable]\!] = \langle Prob, \lambda x \lambda w.CG \rangle$

(51)   'Probable' plus subjunctive
       a. $[\![$ Il est probable que Marie vienne $]\!] =$

---

[15]It would also be possible to adopt an analysis where the probability relation between worlds is given directly, and not in terms of an ordering source.

b. $[\![\, subj(Marie.comes)(probable)(i)\,]\!]\ =$

c. $\lambda w[CPR(p)(\bigcap CG) \subseteq <_{Prob(i,w)}]\ =$

d. $\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v \in \bigcap CG\} \subseteq <_{Prob(i,w)}]$

The output (52-d) is quite similar to the semantics for 'believe'+subjunctive in (34-b). In essence, we treat 'believe' with the subjunctive as a subjective (dox-astic) probability judgment about the common ground. Though the outcomes are the same, the derivations with 'believe' (33) and 'probable' (51) are different because the CG parameter is introduced in different ways: by accommodation rule, in the former case, versus the embedding predicate's lexical entry, in the latter. Also, note that under reasonable assumptions (51) entails that p is more probable than $\neg p$ overall: it states that each p world is more probable than the most similar $\neg p$ world. Thus, on the assumption that $SIMIN(p, CG)$, the total probability of the p worlds in the common ground must be greater than the total probability of the $\neg p$ worlds.

In the event one prefers to disconnect the probability judgment from the speaker, it is also be possible to give a type-flexible entry for the subjunctive which allows this to be the case. The idea would be that when 'probable' takes a background $Prob$ which is only a function from worlds to sets of proposi-tions (not a function from individual-world pairs to propositions), it applies the background to a world argument only:

(52)   'Probable' lacking a speaker argument

    a. $[\![\, \text{Il est probable que Marie vienne}\,]\!]\ =$

    b. $[\![\, subj(Marie.comes)(probable)\,]\!]\ =$

    c. $\lambda w[CPR(p)(\bigcap CG) \subseteq <_{Prob(w)}]\ =$

    d. $\lambda w[\{\langle SIM(p)(v), SIM(\neg p)(v)\rangle : v \in \bigcap CG\} \subseteq <_{Prob(w)}]$

The derivation in (52) is appropriate for representing the "objective" meaning of 'probable' (see Lyons 1977, Kratzer 1981, Nuyts 2001, Portner 2009 for detailed discussion of objective vs subjective readings of probability operators and epis-temic modals). It states that, across the mutually agreed-up space of worlds, the context set, a probability relation which is not linked to the speaker ranks worlds where Mary comes above worlds where she doesn't. This contrasts with (51), where the probability relation is specifically linked to the speaker, and so might involve beliefs or evidence not shared by the addressee.

Overall, then, our framework suggests two possibilities for the probability term 'probable'. We can assign an objective meaning, the one given in (52), and a reading similar to 'believe'+subjunctive, (51). Portner and Rubinstein (2013) have also pointed out that 'probable' can occasionally take the indicative in French when it has an highly "objective" meaning. We would analyze this is as a case similar to 'believe'+indicative in Italian. When used this way, $[\![\, probable\,]\!]$ $= Prob$. Then (53) simply relates the complement proposition 'that we have a more or less pure case of ϵ' to this single modal background, as opposed to stating that the evidence supports its truth relative to the background information in the common ground (example from Portner and Rubsinstein, p. 469).

(53)   Il est probable que nous avons   là   un état plus ou moins
       it is   probable that we   have.INDIC there a   case more or less
       pur   de ϵ.
       pure of ϵ
       (Dominique Barthélemy, *Critique Textuelle de l'Ancien Testament*, 1992)

4   Discussion and future directions

Mood shift with 'believe' and other predicates in Italian is semantically relevant, and we have provided an analysis in which the meaning differences emerge from the mood itself, and not in an ambiguity in the matrix predicate. Our analysis builds on previous approaches to verbal mood which associate the subjunctive with comparative meanings, and the indicative with simpler non-comparative ones. We assign the comparative meaning directly to the subjunctive, and this allows us to treat all attitude verbs as simply referring to a one- or two-member sequence of modal backgrounds. We propose that mood shift occurs in Italian because it makes use of a coercion rule which allows the common ground to saturate a conversational background which is not provided within the sentence when the subjunctive combines with 'believe' and the other predicates which show the same variation. Moreover, we explain the contrast with languages that do not allow mood shift, such as French, with a simple difference in whether the coercion rule is available in a given language.

Our proposal has consequences for pragmatic and philosophical questions concerning the relation between belief and assertion. In our analysis, belief sentences can have two distinct meanings. On the belief-only reading, a sentence only describes the private mental state of the attitude holder. This meaning is modeled well by the standard Hintikkan semantics and we expect such sentences to be assertable when the speaker has reasonable confidence that the attitude holder's mental state is as described. On the discourse belief reading, a sentence describes the relation between the attitude holder's mental state and the common ground, and when the matrix verb is 'believe', this relation is naturally understood as evidential. Moreover, when the subject is first person, it can naturally be understood as a weakening of the assertion that would be made by asserting the content of the (indicative) complement clause alone, since the hearer can in principle accept the assertion that the speaker's beliefs prefer p worlds to $\neg p$ worlds, without accepting p into the common ground.

Though our analysis has focused on Italian, we assume that other languages have ways of making the same distinction between belief-only and discourse belief readings. In English, the postposed *I think* conveys the discourse belief meaning:

(54)   Mary is pregnant, I think.

We speculate that the semantics of this structure involves the CPR operator and a functional structure similar to that of the Italian 'believe'+subjunctive.

Interestingly, Giorgi and Pianesi (1997) state that 'know' and 'say' only take the indicative in normal subject-complement order, but allow subjunctive when the complement is preposed (example Giorgi and Pianesi 1997, p. 226):

(55)   a.   Che Giuseppe è/sia   sciocco, Mario lo sa.
                that Giuseppe be.IND/be.SUBJ silly   Mario it knows
       b.   Che Giuseppe è/sia   partito, Mario l'ha   detto.
                that Giuseppe be.IND/be.SUBJ left   Mario it-has said

(While we have pointed out that 'say' does allow subjunctive in normal verb-complement order, we agree that dislocation makes the subjunctive more natural in many cases.) Moreover, Giorgi and Pianesi point out that preposing requires a connection between the complement and the common ground, suggesting that it might be useful to extend our analysis of 'believe' to 'know', with the goal of somehow explaining why 'know' does not allow the subjunctive unless the complement is dislocated.[16]

Our approach also may have consequences for other outstanding problems in the theory of verbal mood.

- The reportative subjunctive in German, Icelandic and other languages has typically been treated as conveying a meaning or requiring a triggering condition different from more typical subjunctives (example from Giorgi and Pianesi 1997, p. 199; see also Fabricius-Hansen and Saebø 2004).

  (56)   Hans sagte, daß Paul einen Brief geschrieben hat/habe.
            Hans says   that Paul a   letter written   has.IND/has.SUBJ

  We might connect this to the option of the subjunctive with preposing in Italian illustrated in (55). Given the significant differences in syntax between the languages, it might be plausible that the same type of dislocation is allowing the subjunctive in both cases, but is manifest with different word orders (preposing in Italian, sentence final position in German).

- The use of subjunctive in root clauses to express directive or optative meanings has been occasionally discussed in the semantics literature (example Giorgi and Pianesi 1997, p. 195; see also Portner 1997).

  (57)   (Che) Mario parta!
           that   Mario leaves.SUBJ

  It is difficult to connect these uses to theories of mood choice based on selection by a higher predicate without postulating a significant amount of phonologically unexpressed structure. However, in our analysis a root subjunctive would denote a function whose first two arguments are a pair

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[16]Citing Manzini (1994), Giorgi and Pianesi briefly note that stress on the matrix verb can allow the subjunctive.

of modal backgrounds. Dynamic theories of the imperative, such as Portner (2004), Charlow (2011), and Starr (2013), have proposed that the discourse context contains an ordering component in addition to the common ground.[17] For example, in Portner's framework, imperatives affect the addressee's to-do list, a set of properties which defines an ordering over the worlds in the context set which represents how the addressee is committed to act.

We suggest that a root subjunctive integrates into the discourse context by taking the to-do list (or something like it) and the common ground as arguments. This is a natural extension of our proposal that the subjunctive under 'believe' takes the common ground as one of its arguments, and moreover is suggestive of the right meaning 'p worlds are better-ranked by the to-do list than otherwise similar $\neg p$ worlds (and conversely)'. There are, however, significant issues to work out in terms of the pragmatics, and so we cannot address root subjunctives further here.

- One of the most notorious problems in the theory of verbal mood is why 'hope' takes indicative in many languages, including Italian and French. Our theory suggests two possiblities. One is that 'hope' differs from 'want' crucially in referring to a single modal background, as proposed by Portner (1997) and Schlenker (2005). The problem with such analyses is that they have never explained in detail why the subtle meaning difference between the verbs should be represented in precisely this way, but to meet this challenge we would speculate that there is a process which merges two modal backgrounds $\langle Bul, DOX \rangle$ into one when certain conditions are met.[18]

The second possiblity is that 'hope' has two modal backgrounds but employs a syntax that allows it to derive a meaning with the CPR operator without the subjunctive. It is obviously the case that not every language expresses the difference between belief-only readings and discourse belief readings with verbal mood, and this implies that there must be some way of introducing a second modal background apart from mood morphemes. Moreover, the fact that 'hope' allows the same postposing as (54) is suggestive of a different syntax, at least as an option.

(58)   Mary is pregnant, I hope/*want.

Perhaps the best thing we can say about our analysis in connection with 'hope' is that it opens up new ways of thinking about the puzzle.

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[17]These authors also assume that the context contains a question set of the kind introduced by Roberts (2012), but it is not relevant here.

[18]Another recent approach, represented by Portner and Rubinstein (2013) and Silk (2018), associates the indicative with commitment towards the embedding predicate's modal background(s). We note that the compositional system given here can easily implement this type of analysis, given that the mood-marked clause takes the background(s) and subject as arguments.

Acknowledgements

Appendix A   Statistical study

Our goal is to study whether there is a significant preference for the subjunctive (or indicative) in either the objective (inquisitive) or the subjective (intimate) contexts. We expect the indicative to be equally preferred in both contexts and the subjunctive to be preferred in objective contexts. The analyses corroborate the hypothesis.

A.1   Methodology

We study the distributions of acceptance of two classes of sentences (with embedded indicative / subjunctive) in two different contexts (subjective / objective):

- objective context, embedded indicative mood (hereafter, class 'OI');

- objective context, embedded subjunctive mood (class 'OS');

- subjective context, embedded indicative mood (hereafter, class 'SI');

- subjective context, embedded subjunctive mood (class 'SS');

The use of subjunctive vs indicative with epistemic attitudes is a topic under close scrutiny in the academic curriculum of Italian speakers, and there is a strong normative pressure for using the subjunctive, the indicative being banned as 'wrong' by the teachers beginning in primary school. Speakers are highly aware of these rules, which are actively discussed in textbooks. For this reason, we have decided to avoid (i) submitting a rating system that would be comparable to academic grades, and (ii) we have maximized the independence of the ratings by not submitting all types of items to each speaker.

There is a pool of 16 target sentences in total, 4 sentences of each class described above. We have also used 16 fillers, to maximize distraction. We perform a statistical study over a population of 122 Italian speakers (18-29 yrs: 6%, 30-49 yrs: 54%; 50 yrs and older: 40% - f: 53%, m: 47%). Each speaker was assigned 4 sentences, drawn uniformly at random among the 16 sentences; as a result a given speaker might have to judge several sentences of the same class; in other words, not all speakers were assigned sentences of the four different classes.

Each speaker was given the possibility of judging the acceptability of each one of his/her four sentences on a scale between 0 and 100, with a cursor of accuracy unit 1; each sentence was therefore assigned an integer between 0 and 100. This large scale was chosen to approximate *continuous* probability distributions of acceptances of the sentences. The interest of this type of scale is twofold: first, it models judgments of a finer granularity than a simple ordinal scale. Second, it provides a proper mathematical basis for the tests used below, based on two-samples comparisons of cumulative distribution functions, which are better defined and more accurate for continuous distributions than discrete ones with a few values.

A.2   Pre-treatment of the data and results

Several speakers did not reply, or ended the survey before completion. In total we obtain a data set of 418 data points, i.e. 418 value judgments between 0 and 100, assigned to the various sentences among the 16 target sentences. They are divided into 4 data sub-sets:

- 123 data points corresponding to class OI-ratings;

- 80 data points of SI-ratings;

- 100 data points of OS-ratings;

- 115 data points of SS-ratings.

The main characteristics of these four data-subsets are given in Table 3 and their distributions are provided in Figures 1 and 2.

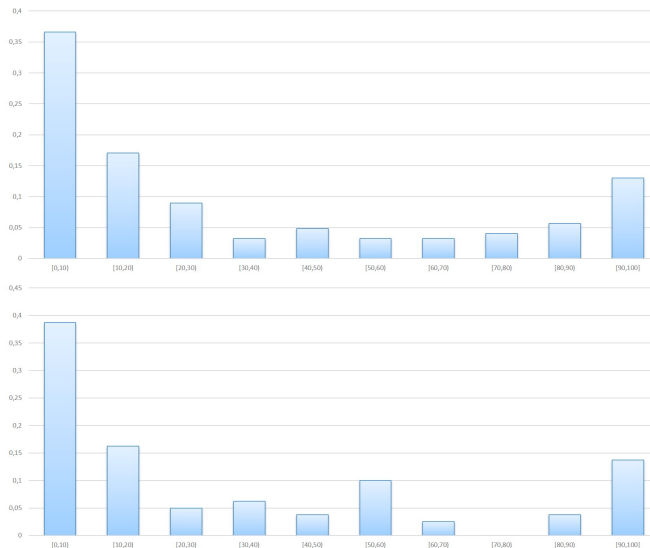|	OI-rating	SI-rating	OS-rating	SS-rating
Sample size	123	80	100	115
Empirical mean	32.9431	31.4750	82.3700	60.4783
Unbiased empirical variance	1208,9886	1447,9092	514,4779	1266,8937

Table 3: The data set

Figure 1: Distribution of OI-ratings (top) and SI-ratings (bottom).

A.3 Analysis

To more easily describe our analysis and our results, let us introduce a piece of formal notation. We define the following underlying random variables,

$$
\begin{cases}
X_{\text{OI}} & = \text{rating given by a speaker chosen uniformly at random to a } OI\text{-sentence;} \\
& = \text{``}OI\text{-rating''} \\
X_{\text{SI}} & = \text{``}SI\text{-rating''} \\
X_{\text{OS}} & = \text{``}OS\text{-rating''} \\
X_{\text{SS}} & = \text{``}SS\text{-rating''}
\end{cases}
$$

in other words the data-subset of OI (resp. SI, OS, SS)-ratings provide a sample of realizations of the random variable (r.v., for short) X_{OI}. Using the above-described data-set, our objective was to qualitatively compare the distributions of X_{OI} and X_{SI} on the one hand, and the distributions of X_{OS} and X_{SS} on the other. We have performed three types of statistical analyses.
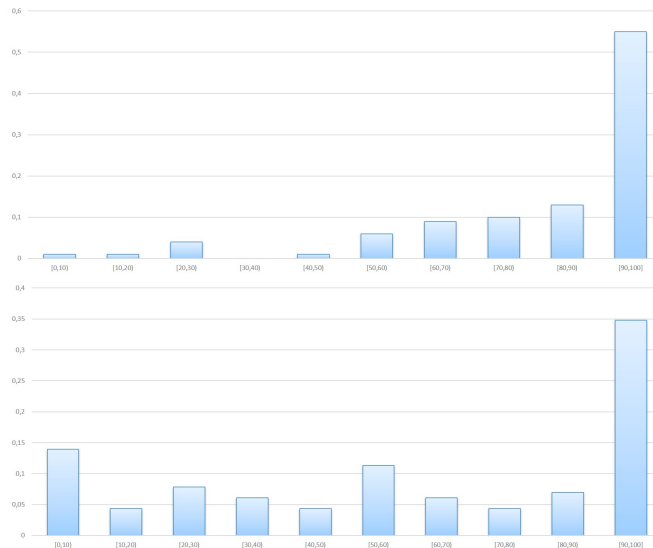
Figure 2: Distribution of OS-ratings (top) and SS-ratings (bottom).

A.3.1 z-test of the mean

We first test the equality of the expected values of OI-ratings and SI-ratings on the one hand, and OS-ratings and SS-ratings on the other, i.e. we test whether $\mathbb{E}[X_{\mathrm{OI}}] = \mathbb{E}[X_{\mathrm{SI}}]$ on the one hand, and $\mathbb{E}[X_{\mathrm{OS}}] = \mathbb{E}[X_{\mathrm{SS}}]$ on the other. Supported by the relatively large size of the data subsets, we perform each time, a z-test of equality of the means.

Indicative mood. As Table 3 indicates, the empirical mean $\bar{X}_{\mathrm{OI}}$ of X_{SI} is very close to the empirical mean $\bar{X}_{\mathrm{OI}}$ of X_{OI}. To test the statistical relevance of this tendency, we perform the following two-sided test:

$$(\mathbf{H_0}) : \mathbb{E}[X_{\mathrm{OI}}] = \mathbb{E}[X_{\mathrm{SI}}] \quad \text{vs} \quad (\mathbf{H_1}) : \mathbb{E}[X_{\mathrm{SI}}] \neq \mathbb{E}[X_{\mathrm{OI}}].$$

The corresponding z-score equals -0.2778, and the p-value thus equals 0.7812. So we do not reject H_0 at any significance level less than $0, 0.7812$. We conclude that $\mathbb{E}[X_{\mathrm{OI}}]$ and $\mathbb{E}[\bar{X}_{\mathrm{SI}}]$ are not substantially different, in other words the average OI-rating is not significantly different from the average SI-rating.

Subjunctive mood. Following again Table 3, the empirical mean $\bar{X}_{\mathrm{OS}}$ of OS ratings is substantially larger than the empirical mean $\bar{X}_{\mathrm{SS}}$ of SS-ratings. We perform the following one-sided z-test:

$$(\mathbf{H_0}) : \mathbb{E}[X_{\mathrm{OS}}] = \mathbb{E}[X_{\mathrm{SS}}] \quad \text{vs} \quad (\mathbf{H_1}) : \mathbb{E}[X_{\mathrm{OS}}] > \mathbb{E}[X_{\mathrm{SS}}].$$

We obtain a z-score of 4.2456, and the corresponding p-value is 0.00002. We thus reject H_0 at any significance level more than 0.00002, so we conclude that the average OS-rating is significantly larger than the average SS-rating.

	OI-**rating** vs SI-**rating**	OS-**rating** vs SS-**rating**
z-**score**	-0.2778	4.2456
p-**value**	0.7812	0.00002
Conclusion at significance level 5%	Do not reject H_0	Reject H_0
Conclusion at significance level 1%	Do not reject H_0	Reject H_0

Table 4: Two-sided (left) and One-sided (right) z-tests of the means

The results of these two z-tests are summarized in table 4.

A.3.2 Comparison of the cdf's

Recall that the cumulative distribution function (cdf) of a given r.v. X is defined as the real valued function F_X mapping any real number x onto the following element of $[0, 1]$,

$$F_X(x) = \mathbb{P}[X \leq x]$$
$$= \text{Probability that the r.v. } X \text{ takes a value less or equal to } x.$$

Also, the *empirical* cdf of a data set $x_1, ... x_n$ of size n consisting of n realizations of a r.v. X is defined as the function F_X^e mapping any real number x onto

$$F_X^e(x) = \frac{\text{Card}\{x_i \,;\, x_i \leq x\}}{n}$$
$$= \text{Proportion of samples points less or equal to } x \text{ in the data set.}$$

The empirical cdf's of $F_{X_{\text{OI}}}^e$ of X_{OI} and $F_{X_{\text{SI}}}^e$ of X_{SI} (respectively $F_{X_{\text{OS}}}^e$ and $F_{X_{\text{SS}}}^e$) are represented in Figure 3. For a thorough comparison of the distributions of X_{OI} and X_{SI} on the one hand, and X_{OS} and X_{SS} on the other, we compared their respective cdf's, as is described below.

Indicative mood First, as we reached the conclusion that there is no significant difference between the expected values of X_{OI} and X_{SI}, we investigated the goodness-of-fit between the whole *distributions* of these r.v.'s, by conducting the following two-sided two-samples Kolmogorov-Smirnov test:

$$(\mathbf{H_0}) : F_{X_{\text{OI}}} = F_{X_{\text{SI}}} \quad vs \quad (\mathbf{H_1}) : F_{X_{\text{OI}}} \neq F_{X_{\text{SI}}}.$$

The ks-score, given by

$$\sup_{x \in [0, 100]} \left| F_{X_{\text{OI}}}^e(x) - F_{X_{\text{SI}}}^e(x) \right|,$$

equals 0.0683 for our data set. Therefore, as the critical value for a significance level $\alpha = 0.05$ is $D_{123,80,0.95} = 0.1951$, we do not reject H_0, and cannot conclude that there is a significant difference between $F_{X_{\text{OI}}} = F_{X_{\text{SI}}}$ and thereby, between the distributions of X_{OI} and X_{SI} over $[0, 100]$. These results are summarized in Table 5.
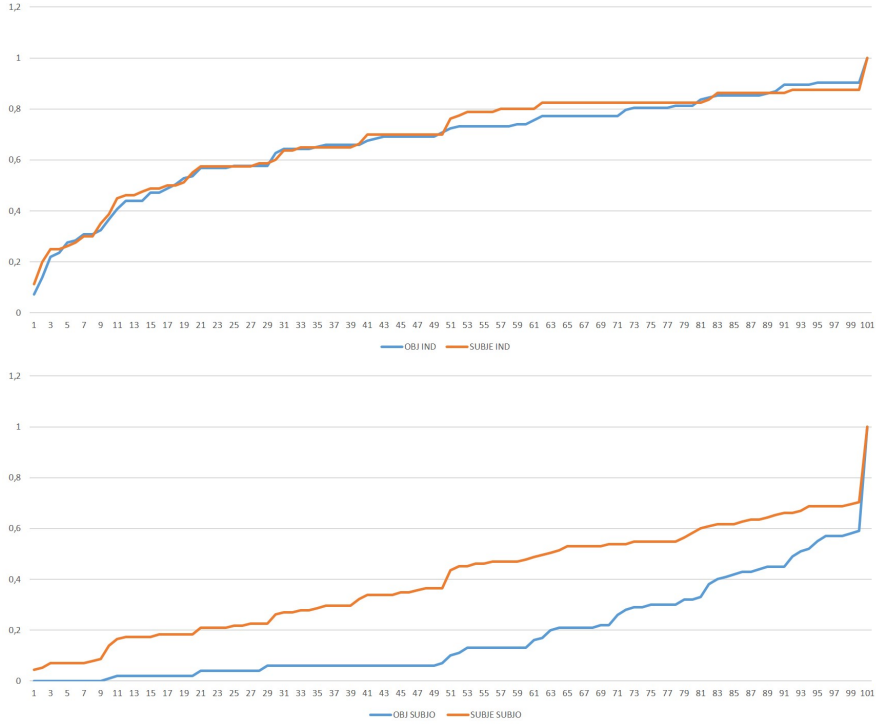
Figure 3: Cumulative distribution functions of the OI-ratings and SI-ratings (left) and of the OS-ratings and SS-ratings (right).

Subjunctive mood For two functions f and g mapping R onto $[0, 1]$, we write $f \prec g$ if $f(x) < g(x)$ for any $x \in R$. We then say that the r.v. Y *stochastically dominates* the r.v. X (or Y is larger than X for the *strong ordering*), if $F_Y \prec F_X$.

To strengthen the conclusions delivered by the above z-test of means, showing that the average SS-rating is significantly larger than the average OS rating, we tested the stronger statement that the former stochastically dominates the latter. We thus perform the following one-sided two-samples Kolmogorov-Smirnov test:

$$(\mathbf{H_0}) : F_{X_{\text{os}}} = F_{X_{\text{ss}}} \quad \text{vs} \quad (\mathbf{H_1}) : F_{X_{\text{os}}} \prec F_{X_{\text{ss}}}.$$

In this case the one-sided ks-score, given by

$$\sup_{x \in [0,100]} \left(F^e_{X_{\text{ss}}}(x) - F^e_{X_{\text{os}}}(x) \right)$$

equals 0.3483, whereas the critical value for $\alpha = 0.05$ is $D_{100,115,0,95} = 0.1857$. Thus we do reject H_0 at level 0.05. As $D_{100,115,0,99} = 0.2225$, we also do so at significance level $\alpha = 0.01$. We thus conclude to a significant difference between

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	Two-sided Test
ks-**score**	0.0683
Critical value for $\alpha = 1\%$	0.2338
Conclusion for $\alpha = 1\%$	Do not reject H_0
Critical value for $\alpha = 5\%$	0.1951
Conclusion for $\alpha = 5\%$	Do not reject H_0

Table 5: Kolmogorov-Smirnov test of cdf's: OI-ratings *vs* SI-ratings

	One-sided Test
ks-**score**	0.3483
Critical value for $\alpha = 5\%$	0.1857
Conclusion for $\alpha = 5\%$	Reject H_0
Critical value for $\alpha = 1\%$	0.2225
Conclusion for $\alpha = 1\%$	Reject H_0

Table 6: Kolmogorov-Smirnov test of the cdf's: OS-ratings *vs* SS-ratings

the cdf's of X_{OS} and X_{SS}, the former stochastically dominating the latter. These results are summarized in Table 6.

A.3.3 z-test of the differences

Lastly, to emphasize the tendencies that have emerged above, and to take into account individual speaker variation, we conducted a test of the preference of a given individual between OI and SI (resp., OS and SS) sentences. For this, we constructed two data sub-sets as follows:

- For the indicative moods, we kept track of all speakers who rated at least one OI-sentence and one SI-sentence, for a total population of 48 speakers,

- For the indicative moods, we kept track of all speakers who rated at least one OS-sentence and one SS-sentence, for a total population of 49 speakers.

For each speaker in these data sub-sets, we computed the average rating for each type of sentence. These rating are designated the 'OI-rating' (resp., 'SI-rating', 'OS-rating' and 'SS-rating') of the corresponding speaker. Then, we define:

- The 'I-difference' (denoted by Y_{I}) of a speaker who rated at least one OI-sentence and one SI-sentence is the difference OI-rating $- SI$-rating;

- The 'S-difference' (denoted by Y_{S}) of a speaker who rated at least one OS-sentence and one SS-sentence is the difference OS-rating $- SS$-rating.

	OI-rating $- SI$ rating	OS-rating $- SS$-rating
Sample size	48	49
Empirical mean	2.0104	14.6803
Unbiased empirical variance	1374.4816	757.7324

Table 7: The data sets of I-differences (left) and S-differences (right)

We aim at comparing OI and SI-ratings on the one hand, OS- and SS-ratings on the other, by investigating whether the r.v.'s Y_{I} and Y_{s} have a null expected value or not. Observe that this is not the same statistical test as Subsection A.3.1, first, because the population is not the same (we consider the sub-population of speakers who rated both a OI and a SI-sentence, or both a OS and a SS-sentence); second, because we consider a data set of *couples* (OI and SI-ratings, or OS and SS-ratings) corresponding to the speakers, instead of two data sets of single ratings. The main characteristics of the data sets are summarized in table 7.

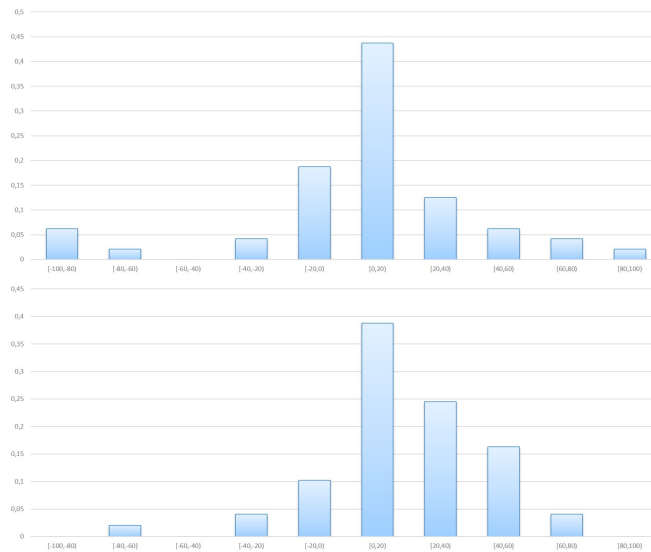The distributions of I-differences and S-differences are represented in Figure 4.

Figure 4: Distribution of I-differences (top) and S-differences (bottom)

Indicative mood. As Table 7 and Figure 4 indicate, the average I-difference (i.e. the average difference between a OI-rating and a SI-rating) for a given speaker seems close to 0, i.e. the r.v. Y_{I} seems centered. To investigateg the significance

	OI-rating $-$ SI-rating	OS-rating $-$ SS-rating
z-**score**	0.3757	3.7331
p-**value**	0.7071	0.0002
Conclusion at significance level 5%	Do not reject H_0	Reject H_0
Conclusion at significance level 1%	Do not reject H_0	Reject H_0

Table 8: Two-sided (left) and one-sided (right) z-tests of nullity of the means

of this observation, we perform the following one-sample, two-sided z-test:

$$(\mathbf{H_0}) : \mathbb{E}\left[Y_\mathrm{I}\right] = 0 \quad \text{vs} \quad (\mathbf{H_1}) : \mathbb{E}\left[Y_\mathrm{I}\right] \neq 0.$$

The corresponding z-score equals 0.3757, and the p-value thus equals 0.7071. So we do not reject H_0 at any significance level less than 0.7071. We conclude that $\mathbb{E}\left[Y_\mathrm{I}\right] = 0$, i.e. a given speaker gives in average the same rating to an OI-sentence and to an SI-sentence provided he/she is given the occasion to rate both.

Subjunctive mood. Following Table 7 and Figure 4, the average S-difference seem positive. To statistically check this observation we conduct the following one-sample, one-sided z-test:

$$(\mathbf{H_0}) : \mathbb{E}\left[Y_\mathrm{s}\right] = 0 \quad \text{vs} \quad (\mathbf{H_1}) : \mathbb{E}\left[Y_\mathrm{s}\right] > 0.$$

We obtain a z-score of 3.7331, and the corresponding p-value is 0.0002. We thus reject H_0 at any significance level more than 0.0002, so we conclude that $\mathbb{E}\left[Y_\mathrm{s}\right] > 0$, i.e. a given speaker gives on average a substantially higher rating to an OS-sentence over an SS-sentence, provided he/she is given the occasion to rate both.

The results of these two z-tests are summarized in Table 8.

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