



# Bilingual Children's Use of the 'Maximize Presupposition' Principle

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**RESEARCH**

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## Abstract

This article reports the results of an experimental study that examines the influence of bilingualism on the acquisition and use of the *Maximize Presupposition* principle in the context of speakers' choices among propositional attitude predicates (equivalent to) *know* and *think*. We compared the performance of monolingual Slovenian- and Italian-speaking school children to that of age-matched early bilingual children speaking both languages. Our findings suggest that while all children demonstrate adherence to *Maximize Presupposition* in an adult-like manner, bilingualism may enhance performance in pragmatic tasks that bear on this principle, and therefore constitutes a potential advantage in the relevant area.

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## 1 Introduction

A topic of growing interest in recent literature in theoretical and experimental pragmatics deals with speakers' knowledge and real time computation of different types of pragmatic inferences over and above the compositional meaning of the sentence. Pragmatic inferential processes related to conversational implicatures, including scalar implicatures, are currently the focus of extensive theoretical and experimental research. Some recent work (Heim 1991; Sauerland 2008; Schlenker 2012; Lauer 2016; among others) scrutinizes presuppositions and other kinds of inferences from the perspective of pragmatics. In line with this more recent approach, the present study provides an experimental perspective on the acquisition and use of a less studied pragmatic principle Maximize Presupposition (MP). Specifically, we examine the influence of bilingualism on the learners' choice within the pair of propositional attitude predicates *<know, think>* guided by that principle. To that end, using a felicity judgment task, we compared MP-related performance of monolingual Slovenian and Italian-speaking school children to that of age-matched Slovenian-Italian early bilingual children in three different age groups, as regards the appropriate choice of predicate within that pair. The rationale underlying our interest in the bilingual performance was to investigate the extent to which the commonly hypothesized enhanced ability of bilinguals pertaining to evaluating of (linguistic) alternatives and inhibition of irrelevant ones (cf. Bialystok 2010 among others), can be deployed for the purpose of manipulating semantically equivalent alternatives in the context of MP. This question is important both in the theoretical sense, strengthening the recently emerging consensus that the concept of competition plays an important role also in the domain of pragmatic knowledge, as well as for a better understanding of respective psychological mechanisms, especially those concerning executive functions that may be operative when that knowledge is put to use. We also examined how factors of increased structural complexity such as negation affect the overall performance on the MP-related conditions in this language. The present study exploits the parallel between mechanisms responsible for computing MP-related inferences and scalar implicatures, another type of pragmatic inference that, in contrast to the former, received much more attention in the current pragmatic literature (see below). Our results suggest that a) MP is highly respected in all tested age and language groups; and b) bilingualism significantly affects performance in a MP-driven pragmatic task. The results also provide support for the hypothesized parallel between the two types of pragmatic inferences.

## 2 Maximize Presupposition and the *<know, believe>* pair

Broadly, presuppositions are triggered by an expression or a lexical item (sometimes referred to as a *presupposition trigger*), but are not part of the truth-conditions of the utterance. A sentence such as *John has stopped smoking* has the assertive content 'John does not smoke' and the presupposition that John used to smoke. Presuppositions are also triggered in constructions involving verbs of propositional attitudes such as *know* and *regret* (see Hintikka 1969 for a precursor for standard theories of propositional attitude verbs). These verbs embed propositions to which the referent of the subject of the main clause holds a specific attitude. Focusing on the pair *<know, believe/think>*, (1) and (2) differ in that, for (2) to hold, it must be the case that Mary went to the theatre on Saturday, while this is not necessary for (1):<sup>1</sup>

- (1) Peter believes/thinks that Mary went to the theatre on Saturday.
- (2) Peter knows that Mary went to the theatre on Saturday.

The embedded proposition is entailed by (2), but not by (1). Its content—that Mary went to the theatre on Saturday—has to be true for (2) to be felicitous. The difference between *know* and *believe/think* is presuppositional, as the truth of the embedded proposition projects through negation:

- (3) Peter does not know that Mary went to the theatre on Saturday.

Just like (2), (3) has an inference that Mary went to the theatre on Saturday. We treat the veridical inference triggered by *know* as a presupposition. We assume that a presupposition is triggered

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<sup>1</sup> We put aside here some more intricate aspects of meaning of *know* in relation to *believe/think* discussed in the philosophical literature, e.g. in the context of the so called Gettier problem (cf. Alai 2011).

from *know* as soon as a speaker retrieves its lexical meaning, i.e. there is no intermediate stage in meaning construal in which the factive entailment holds but no presupposition is generated (see also fn. 6). In other words, *know* has a presupposition of factivity that *believe* or *think* do not have.

According to the semantic approach to presuppositions in the Frege-Strawson tradition, one sentence presupposes another iff whenever the first is true or false, the second is true (cf. Kiparsky & Kiparsky 1970; Karttunen 1977). An alternative, pragmatic approach to presuppositions goes back to Stalnaker (1977) and recently defended in Abbott (2000), Simons (2003), Schlenker (2008), among others. In the pragmatic approach, a presupposition associated with a sentence is a condition that a speaker would normally expect to hold in the common ground when that sentence is uttered in the participants' discourse. The choice between the semantic and pragmatic approaches to presuppositions is still a matter of debate in the current semantic and pragmatic literature, and is beyond the scope of the present work. For our present purposes, we will adopt the basic tenets of the pragmatic approach à la Stalnaker and others while acknowledging also that some presuppositional properties arising in pragmatics may be related to particular lexical items (see, e.g. Abusch 2002; 2009 for examples of such mixed approach including the notion of 'soft' triggers).<sup>2</sup>

The pragmatic principle MP states that in the evaluation of semantically equivalent alternatives whose presuppositional requirements are satisfied in a given context, the speaker chooses the one that presupposes most (Heim 1991; Schlenker 2005). We will also assume, with Percus (2006), a strengthened condition of contextual equivalence among alternatives which restricts them to those having the same at-issue component, i.e. for all worlds in the common ground, alternatives must be equivalent in these worlds. Within the pair <*know*, *believe*>, exemplified in (1) and (2), the principle favors the *know*-alternative in contexts in which the factive presupposition is satisfied. When the factive presupposition is not satisfied the speaker is expected to choose the *believe*/*think*-alternative instead in accord with knowledge about felicitous use of *know*. Heim (1991) proposes that the mechanism regulating choices like this (Heim's actual examples involved the pair <*the*, *a*>) is similar to that involved in the domain of scalar implicatures (cf. Sauerland 2008). Scalar implicatures, triggered by specific lexical items, arise as pragmatic inferences, in which the choice of a weaker alternative rather than a stronger one in a set of alternatives based on asymmetric entailment leads to the negation of the stronger one. Thus (4) implicates that not both individuals will come, because the stronger alternative under consideration *Paul and Jim will come* has not been chosen:

(4) Paul or Jim will come.

It is important to stress that (4) would be true if both came, as well as if only one of them came (i.e. the *and*-alternative entails the *or*-alternative, an inclusive meaning of *or*). However, the fact that the speaker could have used *and* and chose to use *or* instead suggests that she meant that not both would come (an exclusive meaning of *or*). In other words, the reasoning on which the pragmatic inference is based rests on both the availability of an alternative term and on the principle that speakers maximize the information they convey, something that Grice's (1989) Maxim of Quantity (roughly, *say as much as, but not more than is necessary*) and more contemporary variants have tried to capture. The general consequence is that it would be inappropriate (or *infelicitous*) to produce an utterance such as (4) in a case where the speaker knows that both Paul and Jim will come. Similarly, under Heim's/Sauerland's proposed parallel, it would be inappropriate to produce a *think*-utterance such as (2) in a context in which it is taken for granted that the embedded clause (*Mary's going to the theatre on Saturday*) is true. The choice of the *think*-alternative in this context triggers an *implicated presupposition* (in Sauerland's 2008 terminology) leading to an anti-factivity inference. In other words, just as triggers of implicatures, triggers of implicated presuppositions are subject

<sup>2</sup> The semantic approach to presuppositions may in fact be compatible with the pragmatic approach, as pointed out by Stalnaker and others, though not necessarily vice versa (Beaver & Geurts 2014). For instance, given that a definite description semantically presupposes the existence of a suitable referent, then speakers using definites will pragmatically presuppose the existence of such a referent. It is therefore conceivable that presuppositional properties of lexical triggers such as the pair *know* and *think*, as well as scalar implicatures, as discussed below, are relevant under the pragmatic approach as well.

to appropriate or inappropriate uses.<sup>3</sup> It is also worth noting that some more recent accounts in formal pragmatics propose to treat implicated presuppositions and scalar implicatures in the same theoretical framework, a consideration that might lead one to expect further similarities between the two phenomena with respect to acquisition and/or developmental aspect (cf. Magri 2009; Anvari 2018). Crucially, acquisition of scalar implicatures, similarly to implicated presuppositions, requires a language user's knowledge of competing alternatives and an ability to resolve competition.

### 3 Experimental literature relevant to implicated presuppositions

The issue of choosing among competing linguistic alternatives has recently come in focus not only among formal pragmatics experts, but also in the context of the rapidly developing field of experimental pragmatics. The bulk of the current experimental studies is devoted to investigating behavioral markers and potential processing cost underlying derivation of a specific type of pragmatic inferences, namely, scalar implicatures (see, e.g. Noveck 2018 for a recent overview). The experimental literature on deriving implicated presuppositions in general, and in the context of MP in particular, is growing, albeit still rather limited.

#### 3.1 Anti-uniqueness presupposition of 'every'

Using a felicity judgment task, Yatsushiro (2008a; b) experimentally investigated German children's acquisition of the anti-uniqueness presupposition of *jeder* 'every'. Yatsushiro grounds her hypotheses in the developmental literature on scalar implicatures which suggests that younger children produce much less pragmatic interpretations, with a clear developmental curve (Noveck 2001; Chierchia et al. 2001; Gualmini et al. 2001; Papafragou & Musolino 2003; Guasti et al. 2005; Pouscoulous et al. 2007; Huang & Snedeker 2009; Tieu et al. 2014; Singh et al. 2016; among others). Participants (four age groups from 6 to 9 years) were presented with three target conditions: a scalar implicatures using *einige* (*some*); a test of the lexical presupposition (existence) of *jeder*; a test of the implicated presupposition (anti-uniqueness) of *jeder*. The items used a visual context for two sentences presented by two dolls. The participants had to reward the doll that said better what happens in the picture. As an example, in the implicated presupposition condition, a picture of a single girl playing football was shown, while the sentences were as follows:

(5) Das Mädchen hier spielt Fussball.  
 The girl here plays soccer  
 'The girl here is playing soccer.'

(6) Jedes Mädchen hier spielt Fussball.  
 Every girl here plays soccer  
 'Every girl here is playing soccer'

Yatsushiro found a difference between the 6-year-old and the 7-year-old groups, with the younger children giving less pragmatic answers in the scalar and implicated presupposition conditions. She interpreted this as support for the hypothesis that the acquisition of both types of inferences have similar developmental trajectories. Based on that, Yatsushiro proposed that a) lexical presuppositions are acquired earlier than implicated presuppositions, and b) implicated presuppositions follow the developmental path of scalar implicatures.

#### 3.2 Acquisition of the pair <know, think>

Dudley et al. (2015) present a comprehensive systematization of the kinds of developmental studies which investigate the acquisition of *know* and places them in three groups: i) negation tasks which distinguish the non-factive *think* from the factive *know* because only the latter

<sup>3</sup> In the literature on formal semantics and pragmatics, the pairs of alternatives whose relevance to MP has been previously argued for include <*the, a*> (Heim 1991; Sauerland 2008); <*know, think/believe*> (Chemla 2008; Sauerland 2008), <*the, every*> (Sauerland 2008; Yatsushiro 2008a, 2008b), <*both, every*> (Chemla 2007; Sauerland 2008), singular vs. plural morphology (Sauerland et al 2005; Sauerland 2008; Legendre et al 2010, Pearson et al 2010) and 1<sup>st</sup> and 2<sup>nd</sup> person participant morphology vs. 3<sup>rd</sup> person non-participant morphology (Heim 1991; Legendre et al 2010).

but not the former allow the factive presupposition to project through negation (cf. Harris 1975; Hopmann & Maratsos 1978; Scoville & Gordon 1980; Léger 2007; among others); ii) metalinguistic tasks in which participants are asked to decide whether a character knows a proposition or believes it (Macnamara et al. 1976; Abbeduto & Rosenberg 1985; among others) and iii) relative strength tasks (cf. Moore & Davidge 1989; Moore et al. 1989; Falmagne et al. 1994; among others). Many of these studies suggest that younger children do not have an adult-like representation of *know*. In contrast, Dudley et al. (2015) argue that even children as young as 3 years of age can have an understanding of the presuppositional property of *know*. While none of the above-mentioned studies directly addressed acquisition of implicated presuppositions, some of the previous results can be re-interpreted in the light of MP. This is the case for Moore & Davidge's (1989) study, where children (aged 3–6 and divided into four age groups) were asked to find a candy hidden in one of two differently colored boxes, following the hints given by two bears. One of the bears would use *think* ('I think it's in the red box'), and the other would use *know* ('I know it's in the blue box'). In order to choose the bear that 'knows' rather than the bear that 'thinks', children would not only have to have mastered factivity relative to *know*, they would also have to compute the inference of anti-factivity (the implicated presupposition) with respect to *think*, as expected on the basis of the literature on implicated presuppositions reviewed above (e.g. Sauerland 2008). The results showed that 3-year-olds scored significantly lower than all other age groups, suggesting that the implicated presupposition is not drawn before 4 years of age. These results were confirmed by a later study (Moore et al. 1989).

### 3.3 MP: a possible developmental path

Stateva & Stepanov (2021) investigate whether the acquisition of MP-related inferences is subject to a developmental trajectory. It is argued that successful passing a Theory of Mind (ToM) test (cf. Wimmer & Perner 1983, Baron-Cohen et al. 1985; Wellman et al. 2001; Liu et al. 2008; among others) and acquisition of *know* as a factive verb (or, rather, its lexical presupposition of factivity; cf. Moore & Davidge 1989 but also Schulz 2003) are two prerequisites for an adult-like knowledge of applying MP to the *<know, think>* pair. The authors conducted an experiment that included two parallel tasks. One task probed children's knowledge of Theory of Mind, and the other, a felicity judgment task, knowledge of lexical presupposition of factivity, as well as sensitivity to MP, in two groups of Slovenian pre-school and early school children, specifically, 5- and 7-year olds. The choice of this age group was determined by the finding that the bulk of the acquisition of scalar implicatures, a parallel type of pragmatic inferences, takes place in children between 4 and 8 years of age, with some exceptions (Feeney et al., 2004; Guasti et al., 2005; Katsos & Bishop 2011; Foppolo et al. 2012; Skordos & Papafragou 2014; among others). Only the results of the children who successfully passed the ToM task were analyzed in the felicity judgment task. Children in this experiment performed similarly on the condition testing lexical presupposition of factivity and condition testing the knowledge of MP within each age group, with success rates in felicitous responses increasing accordingly with age (age did not interact with condition). While 7-year old children in this study performed practically at ceiling on lexical presupposition and slightly less so on the MP condition, performance of the 5-year olds on both conditions was only 70–76% successful. The less than ceiling result in the 5-year-old group suggests that the lexical presupposition property of the Slovenian verb *vedeti* ('know') was not fully acquired within this age group. The generally high accuracy (>90%) of performance on the MP-related condition in 7-year-olds suggested that at this age, children have adult-like knowledge about MP. These results reinforced the earlier conclusion that knowledge of MP is contingent on the lexically-grounded knowledge of the presuppositional contrast between the *know* and *think*-type predicates, which is expected to come along with acquisition of the predicates themselves and be in place at that age.

### 3.4 The role of bilingualism in deriving MP-related inferences

An issue that we believe deserves separate attention in light of children's computation of pragmatic inferences attributed to MP concerns the potential role of bilingualism in this process. In order to appreciate this special role, let us clearly articulate what 'knowledge of MP' implies for our purposes. We assume that it encompasses the following competences and abilities:



- i. knowledge about asserted meaning,
- ii. knowledge about presupposed meaning,
- iii. general ability to recognize a competition between relevant (linguistic and non-linguistic) alternatives and ability to access these alternatives,
- iv. ability to resolve the competition.

While the first two competences can be directly linked to linguistic knowledge, the abilities to recognize and to resolve a competition, as in iii) and iv), are relevant in general cognitive domains. Competition resolution, understood as inhibition of competing information, is widely argued to be part of executive control processes (Baddeley 1986, Posner & Petersen 1990, Miyake et al. 2000). With respect to bilingualism, studies in lexical access reveal that interlocations activate translational equivalents in the bilingual mind and those in the non-target language are inhibited, thus suggesting that inhibition, being an executive function, is positively influenced by bilingualism (Green 1998; Costa et al. 1999; Abutalebi & Green 2007; Costa et al. 2008; Ivanova & Costa 2008; Guo et al. 2011; Misra et al 2012). That bilingualism contributes to an enhanced inhibition function of the Executive Control system was also a conclusion of a number of experimental studies on perceptual conflict tasks, e.g. Stroop or Simon tasks, which require inhibition of irrelevant information. Other results confirm a bilingual cognitive advantage in the domain of Executive Control abilities (e.g. Bialystok 1999; 2010; 2011; Bialystok et al. 2009; Antoniou et al. 2016), although the effect tends to be selective, depending on many factors such as type of bilingualism, type of task etc., rather than being across-the-board (see Adesope et al. 2010; Valian 2015; Calvo et al. 2016 for detailed reviews). Importantly, most experimental work suggests that such cognitive advantages are associated with children, including pre-verbal ones (cf. Kovács & Mehler 2009a; b; Brito & Barr 2012), as well as older populations experiencing deficits in the cognitive reserve (a resource resulting from intelligence, education, life-time acquired knowledge; cf. Stern 2009) generally related to varieties of brain damage, but not often with speakers in their cognitive primes, i.e. (young) adults (cf. Bialystok et al. 2005; 2008; Salvatierra & Rosselli 2011). The relevance of these studies to our interest in MP follows from the assumption that adherence to MP depends on competition resolution and consequently an enhanced inhibitory function, most pronounced in children. To the extent these findings pertain to choosing among competing alternatives, they substantiate an inquiry about the role of bilingualism in processing inferences due to MP assuming competition resolution as a relevant mechanism, in particular, exploring a reasonable hypothesis that enhanced abilities related to inhibition (and possibly executive functioning) could give bilingual children an advantage in adherence to MP.<sup>4</sup>

Although, to our knowledge, no previous research directly addressed the influence of bilingualism on processing MP-related inferences, a limited number of studies compared the development of pragmatic abilities of early bilingual and monolingual children, in particular, in the domain of scalar implicatures. The state of the art provides two divergent claims, although the second one is heavily prevailing:

1. Early bilinguals slightly outperform monolingually developing children in the production of implicatures. The advantage could be attributed to non-linguistic abilities linked to bilingualism (Siegal et al. 2007; 2009; 2010).
2. There is no robust evidence that suggests a multilingual advantage in the comprehension of scalar implicatures (Antoniou et al. 2013; Syrett et al 2017; Antoniou & Katsos 2017; Dupuy, Stateva et al. 2019).

The results of Antoniou et al.'s (2013) study can be subjected to scrutiny given that they compare multilingually growing children to children speaking two dialects of Greek and in that sense the study does not really evaluate bilingualism as a factor in comprehending scalar implicatures. No such obvious objections can be raised against the findings of Dupuy, Stateva et al. (2019) and Antoniou & Katsos (2017). These works show a numerical advantage of the bilingual participants in the comprehension of scalar implicatures, which, however, does not reach significance. Finally, some studies attempted to establish a correlation between enhanced performance on executive abilities tasks and a higher rate of implicature comprehension

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<sup>4</sup> Since the first step necessary to adhere to MP is to know the meaning of the competing terms, one may also expect that early bilinguals may encounter more difficulties than their age-matched monolingual peers because of the inhibitory effect in the lexical domain, as discussed above. We thank an anonymous reviewer for this important caveat.

but the results again do not reach significance (cf. Siegal et al. 2007; 2009; 2010). To sum up, bilingualism may be reasonably placed as a major factor potentially affecting children's computation of MP-related inferences. This, together with the general question as to how these inferences are computed in real time (see above), opens an interesting venue for further exploration.

## 4 The present study

The present study is an experimental exploration into the derivation of pragmatic inferences pertaining to presuppositions in the context of bilingualism. Given that deriving inferences in line with MP bears on evaluation of truth-conditionally equal propositional alternatives, we ask whether this process may be positively affected by bilingualism, the latter being typically associated with an enhanced cognitive capacity of inhibiting irrelevant alternatives in language production as well as comprehension (see above). We focus on adherence to MP in the context of the <know, think> pair and investigate performance of bilingual elementary-school-aged children's processing of pragmatic inferences that arise due to MP when choosing between the respective alternative utterances involving propositional attitude predicates *know* and *think*, and compare it with that of their monolingual peers. To this end, we tested preschool and elementary school-level monolingual and bilingual children, as well as adult controls, in an experiment involving a felicity-judgment task. Specifically, we compared MP-related performance of monolingual Slovenian and Italian children as well as Slovenian-Italian early bilingual children in three different age groups, as regards the appropriate choice within the pair <know, think>. On the basis of the results obtained in this study, we will argue that a) MP is highly respected in all age and language groups; and b) bilingualism significantly affects performance in a MP-driven pragmatic task.

### 4.1 Participants

We recruited sixty-three monolingual Slovenian, fifty-nine monolingual Italian and sixty-four bilingual Slovenian-Italian child participants (total N = 186), assigned to three age groups, namely nine-, eleven- and thirteen-year-olds. Our decision about the age of the target group of this study was based on several guiding criteria: i) a reliable lexical knowledge of the <know, think> pair, especially the presuppositional properties of *know*, in both languages in the case of bilingual participants; ii) a sufficient vocabulary to understand complex sentences with embedded complements, as well as sufficient writing abilities to pass the language proficiency test, in the case of bilinguals (see Section 4.2.1), and iii) maximizing the probability of an adult-like acquisition of scalar implicatures. Regarding i) and ii), a number of studies of language proficiency of bilingually growing children show that they lag behind their monolingual peers in lexical acquisition (cf. Bialystok et al. 2010) as well as complex grammatical variables (Oller & Eilers 2002; Nicoladis et al. 2007; Paradis 2010). Bialystok et al. (2010) reports data from the administration of the Peabody Picture Vocabulary Test (Dunn & Dunn 1997) to 1738 children between 3 and 10 years of age divided into 8 age groups. In each of these groups the bilinguals demonstrated a significantly lower score of receptive vocabulary in English. Similar results from studies on a smaller scale have been reported in Siegal et al. (2007) and Antoniou & Katsos (2017), among others. Regarding iii), some developmental studies on the comprehension of scalar implicatures show that even 9-year-old children still produce less pragmatically strengthened interpretations than adults (cf. Noveck 2001). The interval between 9 and 13 years of age thus offers a promising opportunity to reliably track children's performance in MP-related tasks in the context of bilingual language development.

Children were selected on the basis of an extensive questionnaire filled out by their parents in addition to a signed parent consent form (the questionnaire had a different form for monolingual and bilingual participants concerning their language background). Monolingual participants were recruited from five elementary schools in the region of Nova Gorica, Slovenia, two elementary schools in the region of Gorizia and Udine and two summer camps in Gorizia and Udine, Italy, respectively. Bilingual children were recruited from four elementary schools serving the bilingual communities in the Gorizia region (Italy), the cities of Izola, Piran, and Koper and the Music school in Nova Gorica (Slovenia). We targeted early bilinguals who were introduced to either Slovenian or Italian at birth and AoA (age of acquisition) of the second language of the pair was not greater than 3. The monolingual and bilingual groups of

children were matched by age and socio-economic status. We also checked that each group of monolingual children contained only children who were not exposed to any other language outside of the standard school curriculum.

In addition, 20 adult native speakers of Italian and 22 adult native speakers of Slovenian (total  $N = 42$ ) participated in the experiment serving as controls.

## 4.2 Design and materials

### 4.2.1 C-test

To estimate the linguistic proficiency of our bilingual participants, in addition to the language questionnaire, c-tests were administered to both monolingual and bilingual groups.<sup>5</sup> In our study, we constructed c-tests based on two short texts extracted from children books that were approved for the respective ages, not included in school reading lists, and written either in Slovenian or in Italian. The texts were balanced by targeted age (9-, 11- or 13-year old), size, and the word type/token ratio (about 73%). The number of gaps for 9-, 11- and 13-year olds was equally balanced across the texts and was 40, 50 and 50, respectively. The deleted word parts were substituted with mini-windows that were all of the same size, where the participants could write in their responses.

### 4.2.2 The main experiment

The main experimental design assesses children's sensitivity to lexical presupposition of factivity (LP) by testing their knowledge of the factivity of *vedeti* or *pensare* ('know'), and at the same time their sensitivity to MP, in a within-subjects design. The type of visual and story-telling material we created for this task was similar in spirit to material usually used in ToM tasks (cf. MP: a possible developmental path) because it manipulates false and true beliefs of the attitude holder, with one important modification: ours was a felicity judgment task in the target conditions of which participants are expected to choose between two truth-conditionally equivalent assertions, one of which is more felicitous than the other which related to the background story. Every item in our experimental material includes a sequence of 4 images, each of which accompanied by a sentence, that together tell a short story involving two main characters. There were three conditions in the stimuli and 8 story items per condition. Condition LP ('lexical presupposition') examines children's representation of *know* as a factive verb and tests for a respective lexical presupposition. It describes an event in which Character 2 moves the relevant object to a new location but the test sentence makes reference to the initial location in which Character 1 has put the object. A sample item from the Condition LP is given in [Figure 1](#).

Granny has baked a cake.

She puts it on the table.

Granny goes to look for grandfather.

Nathan puts the cake on the window.

Where did Granny put the cake?

On the table  On the window

Where is the cake now?

On the table  On the window

Help Nathan to choose the sentence that better describes the situation at the end!

Granny thinks that the cake is on the table.

Granny knows that the cake is on the table.

**Figure 1** Sample story for Condition LP (actual stimuli are in Slovenian or Italian).

<sup>5</sup> A typical c-test is a cloze test based on a short text in which the second half of every second word is truncated (the first two and the last two sentences are left intact). The participants are asked to reconstruct the missing word parts. For instance, a sentence like *Eva and her husband had just returned from a shopping trip* would be presented to the participants as *Eva a\_\_\_\_ her hus\_\_\_\_ had ju\_\_\_\_ returned fr\_\_\_\_ a shopping tr\_\_\_\_*. The ratio of correctly reconstructed words to the total words is taken to be a measure of general language proficiency. C-tests are mainly used for estimating the vocabulary size, but also sometimes seen in the literature as an integrative measure of linguistic knowledge in the written modality including morphology and syntax as well (Eckes & Grotjahn 2006; Karimi 2011).



In this condition, the pair contains an example like (7) whose presupposition is not satisfied in the context and a minimally different sentence (8) which is both felicitous and true.

- (7) Babica ve, da je torta na mizi.  
 Granny knows that is cake on table  
 ‘Granny knows that the cake is on the table.’
- (8) Babica misli, da je torta na mizi.  
 Granny thinks that is cake on table  
 ‘Granny thinks that the cake is on the table.’

This pair is irrelevant to MP since the constraint requires that only alternatives that are both true and felicitous in a given context are compared. In the case (7) the complement is not true, therefore the alternative should not be chosen. Choosing alternative (8) indicates that children are sensitive to the lexical presupposition associated with *know*.

The second condition, Condition MP, was intended to probe into knowledge of MP. In the respective story, Character 2 does not move the relevant object from its initial position. *Figure 2* illustrates a sample item for this condition.

A sample target pair of Condition MP sentences is illustrated in (9)–(10):

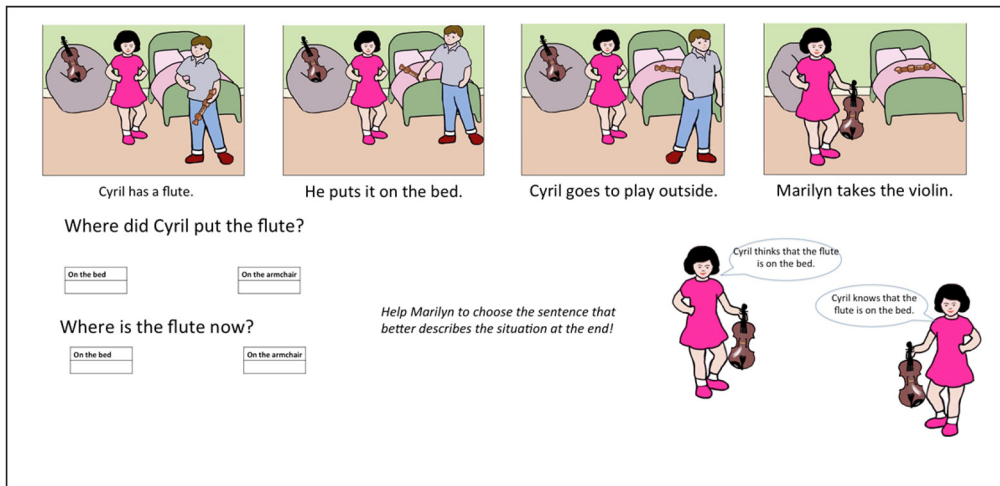
- (9) Ciril misli, da je flavta na postelji.  
 Cyril thinks that is flute on bed  
 ‘Cyril thinks that the flute is on the bed.’
- (10) Ciril ve, da je flavta na postelji.  
 Cyril knows that is flute on bed  
 ‘Cyril knows that the flute is on the bed.’

In view of MP, (9) and (10) are potential alternatives because they are truth-conditionally equivalent and differ by presupposed content. In contexts that satisfy the presupposition triggered by *know* in (10) the competition between (9) and (10) is resolved in the felicitous use of (10). In other words, MP predicts (10) to be preferred in this context since only that sentence presupposes the truth of its complement. The *think*-alternative in such contexts is true if Cyril holds a belief that the embedded proposition holds (viz. that that the flute is on the bed) but it is infelicitous given that the *know*-alternative is presuppositionally stronger. In contexts that do not support the presupposition of (10), the latter is infelicitous. On the other hand, under MP, the interpretation of (9) in such contexts is strengthened by adding an implicated presupposition that the presupposition of its alternative is not satisfied.<sup>6</sup>

Each story item was additionally supplanted with two closed type comprehension questions related to the content of the story. A sample pair, related to the story in *Figure 2*, is given in (11)–(12):

- (11) Kam je Ciril položil flavto?  
 Where-to is Cyril put flute  
 ‘Where did Cyril put the flute?’
- a) Na posteljo  
 on bed  
 ‘On the bed’
- b) Na stol  
 on armchair  
 ‘On the armchair’

<sup>6</sup> An anonymous reviewer suggests that choosing the target answer in Condition LP might be due to knowledge about veridicality rather than factivity of *know* (an operator *f* is veridical iff  $f(p)$ , where *p* is a proposition, entails *p*). Under this hypothesis, veridicality could be sufficient also in Condition MP for choosing the *know*-alternative over the *think*-alternative without reference to MP and by relying on the Maxim of Quantity since a *know*-alternative in a minimal pair asymmetrically entails a *think*-alternative. Indeed, the veridicality issue asks for a more serious consideration, which is beyond the focus of the current study. However, we believe in the credibility of our experimental design, especially because it is enriched with a negative condition (condition MP-Neg) which distinguishes directly between veridicality and factivity. We also rely on the works arguing that for a speaker to acquire the factive component of *know* it is sufficient to have knowledge about its doxastic entailment (a doxastic entailment expresses an attitude holder’s belief in a proposition) and the veridical entailment. If both entailments are in place, the latter automatically becomes backgrounded (cf. Stalnaker 1977; Abusch 2002; Simons et al. 2017). In this regard, knowledge about veridicality of *know* without knowledge about its factivity seems an unlikely acquisitional scenario. For more detailed and less direct scenarios of acquiring the pragmatic component of the meaning of attitude verbs we refer the reader to Hacquard (2014), Hacquard & Lidz (2019), among others.



**Figure 2** Sample story for Condition MP (actual stimuli were in Slovenian or Italian).

- (12) Kje je flavta zdaj?  
 Where is flute now  
 ‘Where is the flute now?’
- a) Na postelji  
 on bed  
 ‘On the bed’
- b) Na stolu  
 on armchair  
 ‘On the armchair’

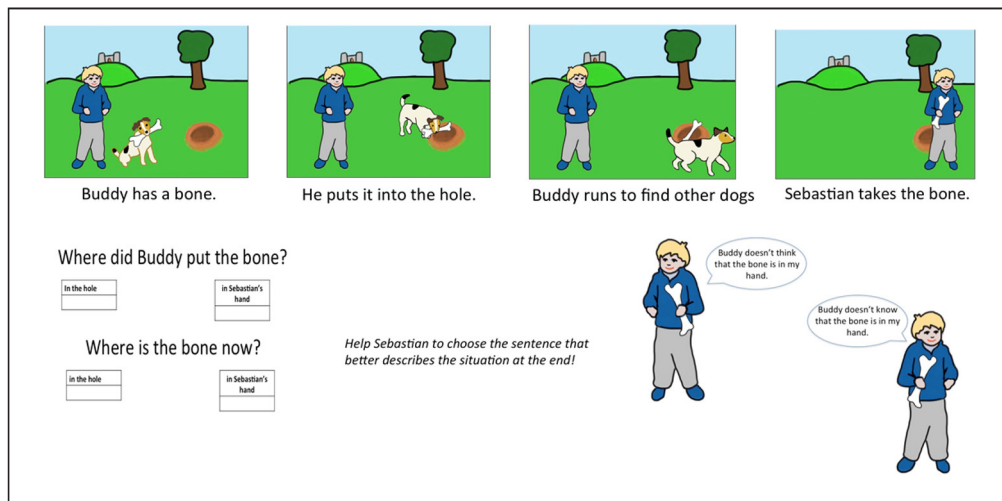
This comprehension task served a purpose to check participant’s attentiveness, and accuracy of responses to comprehension questions served as an exclusion criterion (see Section 5.3).

The Italian counterparts of the sample target sentences for Condition LP (cf. 7) and (8)) are given in (13) and (14), those for Condition MP (cf. (9)–(10)) are given in (15) and (16):<sup>7</sup>

- (13) La nonna pensa che il dolce sia sul tavolo.  
 the granny thinks that the cake be on-the. Table  
 ‘Granny thinks that the cake is on the table.’
- (14) La nonna sa che il dolce è sul tavolo.  
 the granny knows that the cake. is on-the table  
 ‘Granny thinks that the cake is on the table.’
- (15) Luca pensa che il flauto sia sul letto.  
 Luca thinks that the flute be on-the table  
 ‘Luca thinks that the flute is on the table’
- (16) Luca sa che il flauto è sul letto.  
 Luca knows that the flute. is on-the table  
 ‘Luca knows that the flute is on the table’

In addition, we were interested in estimating the role of negation in demonstrating sensitivity to MP in the context of the *know-think* pair. To that effect, we introduced another experimental condition, Condition MP-Neg. This condition probes into knowledge of MP in negated sentences such as (17)–(18). In contrast to Condition MP, in Condition MP-Neg, Character 2 moves the object to a new location and the target sentences, now involving one of the verbs from the *know-think* pair combined with negation, make reference to that location, as illustrated in [Figure 3](#). The corresponding Slovenian target sentences are in (17)–(18), the Italian counterparts are in (19)–(20).

<sup>7</sup> Note that *pensare* embeds a complement which is grammatically subjunctive, whereas the complement of *sapere* is indicative. For the present purposes, we assume that the choice of grammatical mood does not affect derivation of the sort of pragmatic inferences that we are interested in.



**Figure 3** A sample item for Condition MP-Neg (actual stimuli are in Slovenian or Italian).

- (17) Bobi ne ve, da je kost v moji roki  
 Bobby not knows that is bone in my hand  
 ‘Bobby doesn’t know that the bone is in my hand.’
- (18) Bobi ne misli, da je kost v moji roki.  
 Bobby not thinks that is bone in my hand  
 ‘Bobby doesn’t think that the bone is in my hand.’
- (19) Bobi non sa che l’osso è nella mia mano  
 Bobby not knows that the-bone is in-the my hand  
 ‘Bobby doesn’t know that the bone is in my hand’
- (20) Bobi non pensa che l’osso sia nella mia mano  
 Bobby not thinks that the-bone be in-the my hand  
 ‘Bobby doesn’t think that the bone is my hand.’

A priori, in the context depicted in [Figure 3](#), both sentences are true but the ‘doesn’t know’ option presupposes more and is the targeted choice in view of MP.

In sum, there were 8 stories for each of the three conditions (24 stimuli total), and 3 questions following each story which included 2 comprehension questions and the target request (72 questions total). Monolingual and bilingual participants were tested on all target 24 stories. We tested the bilingual participants in both of their languages. Following the methodology in Dupuy, Stateva et al. (2019), bilingual speakers received half of the items in Slovenian and the other half in Italian.<sup>8</sup> Within each language, the order of stimuli was pseudo-randomized for each participant by the (custom-created) presentation software. A full list of stimuli is available on request from the first author.

### 4.3 Experimental predictions

#### 4.3.1 Conditions LP and MP

Experimental predictions pertaining to these two conditions with respect to our monolingual populations in this experiment are straightforward: we expected that all children should perform at a comparable rate on Condition MP as on Condition LP. This follows from the hypothesis discussed above that knowledge of lexical presupposition is a prerequisite for successful derivation of pragmatic inferences according to MP. Given the age of our participants, all of them should perform around ceiling on both conditions.

Assuming consideration of propositional alternatives to be a possible function of Executive Control, inhibition and other cognitive mechanisms that were previously shown to be positively

<sup>8</sup> This methodology was chosen for a better assessment of the bilingualism factor. In the case of non-balanced bilingualism, theories often make different predictions about processing language in the first (L1) and second (L2) language. In the literature on experimental pragmatics, Slabakova (2010) is a good example of such a difference. As for early bilingualism studies like ours, hypotheses can be further falsified against each of the languages.

affected by bilingualism to create a particular kind of cognitive advantage (see the discussion above), we also expected that bilingual children will achieve better performance in computing MP-related pragmatic inferences based on the *know-think* pair than their monolingual peers. More specifically, we expected an advantage for the bilingual participants in their success rates with respect to Condition MP compared to their monolingual peers.

#### 4.3.2 Condition MP-Neg

In order to state the relevant predictions pertaining to Condition MP-Neg in both languages, we need to proceed more cautiously given the non-trivial role of negation as a complex interpretational component realized simultaneously at different linguistic levels, including syntax, semantics as well as pragmatics. With regard to the latter, there are diverging views in the literature about the impact of negation in computing pragmatic inferences, and relevant empirical effects of negation in pragmatic contexts are often difficult to evaluate. For instance, in the realm of scalar implicatures, those are often regarded as suspended in downward monotone environments including negation, whereas other works regard scalar implicatures in these environments as present but reversed (Levinson 2000; Chierchia 2004; among others). In addition, languages make use of different morphosyntactic means of realizing negation at the clause level, which raises an issue of a potential cross-linguistic variation in the interpretation of negation in embedded clausal complements of propositional attitude verbs. This, in turn, becomes also relevant in the context of investigating pragmatic principles such as MP that play on the interpretation of such clausal complements.

A language-specific factor that may potentially intervene in the process of deriving MP-related implicatures and therefore should be taken into account in our experiment, is associated with the linguistic phenomenon known under the umbrella of Neg(ative)-raising, which is relevant for the interpretation of sentences with clausal embeddings and matrix negation, as those used in Condition MP-Neg. Appendix I contains a brief discussion of the phenomenon and its cross-linguistic consequences for Slovenian and Italian. The key take-home point in this discussion is that Italian could be viewed as a ‘Neg-raising language’, while Slovenian is a non-Neg-raising language. This, in turn, reflects the important fact that interpretation of the respective sentences involving matrix negation in the two languages differ in a principled manner. Specifically, a pair of examples involving the *know-think* pair and negation (cf. (17)–(18)) is relevant qua MP only in Slovenian because only in that language the two alternatives have the same assertoric content. The Italian version of (18), namely, (20), might be construed with negation in the embedded clause, as in (21), since *pensare* is a Neg-raising verb.

- (21) Bobi pensa che l’osso non sia nella mia mano.  
Bobby thinks that the-bone not be in-the my hand  
Bobby thinks that the bone is *not* in my hand

But the content of the belief is different in the cases with matrix-clause and embedded clause negation. In case of lower construal of negation, which is only possible in Italian but not in Slovenian, the competition between the Italian counterparts in (19)–(20) will not be resolved as a result of reasoning due to MP, since the truth-conditional equivalence condition on its application is not satisfied. It follows from the above considerations that performance on Neg-raising sentences cannot be directly interpreted in the context of computation of MP in Italian. Consequently, the results on condition MP-Neg will not be informative for this purpose, for the Italian participants (this concerns both children and adult controls).

Taking that limitation into account, we expected that Slovenian adult speakers provide a comparable amount of target answers on Conditions MP-Neg and MP since both these conditions test sensitivity to MP. As for Slovenian-speaking children, we expected that the rate of expected responses to Condition MP-Neg (negated sentences) might be lower than that of Condition MP, which interacts with the assertive part of the sentences, given the added linguistic complexity associated with negation. This expectation holds for both monolingual and bilingual participants.

## 4.4 Procedure

### 4.4.1 C-test

The test was administered individually as a paper and pencil task. Each text was presented on a separate sheet of paper in its entirety. Bilingual participants received the test in their non-dominant language. The term non-dominant language is used rather liberally in this case. All participants had a very low age of acquisition (AoA) and they systematically used both languages on a daily basis. The decision about language (non-)dominance for each participant was based on an analysis of extensive questionnaire data filled in by parents. 37 bilingual participants were assigned to a dominant-Italian group and received a Slovenian c-test, whereas 23 bilingual participants were assigned to the dominant-Slovenian group and received an Italian c-test. 57 monolingual Italian participants and 60 monolingual Slovenian participants completed a c-test in their respective native language. Each participant was asked to complete a c-test after a short break following the main experiment. There was no time limit on this task, which took about 15 minutes to complete.

### 4.4.2 Main task

Each participant was tested individually in a quiet room by a native Slovenian or native Italian experimenter in the case of monolingual participants and by two experimenters in the case of bilingual participants. The experimenters had a short warming up conversation (for bilingual participants, the introductions occurred in both target languages) intended to supplement the information about general language abilities that was provided in parents' questionnaires. The material was presented on a computer screen. The participant's task was to help Character 2 choose one of two possible sentences which characterized Character 1's mental state in the respective story. The two options were presented on the last screen, each in a bubble containing a sentence for evaluation. The number of appearances of each verb from the *<know, think>* pair in the left or right bubble was balanced within conditions. Participants were informed in advance that there are no wrong answers to the task. Each session began with a short training containing 1 item per condition (altogether 3 items). The training set was created specifically for the training purpose and not included in the target set. While the children's progress through the training task was supervised by the experimenter and the children received feedback on the correctness of their choices, no feedback was provided during the main task.<sup>9</sup> During the session, participants read out loud the sentences accompanying each image, as well as the questions that followed. The monolingual participants saw all 24 items in their native language: Slovenian and Italian, respectively. The bilingual participants saw two blocks of items, one in Slovenian and one in Italian where the order of presentation was counterbalanced across participants. Each block was composed of 4 items per each of the three conditions with the items being randomized. Bilingual participants were assigned to two groups in which the order of language blocks was counterbalanced. The presentation of items was randomized. Child participants received a sticker of their choice as a reward for participation. The experiment lasted approximately 15 minutes for faster readers and maximally 20 minutes for the slower ones.

## 5 Results

### 5.1 Statistical analyses

For inferential statistical analyses of the main conditions in this study, we used mixed effects logistic regression models in R version 4.0.2, using the *glmer* function from the *lme4* package (Baayen et al 2008; Jaeger 2008; Bates et al. 2014; R Core Team 2020). Felicitousness of the chosen alternative in answering the target question was coded as a binary-valued dependent

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<sup>9</sup> An anonymous reviewer expresses a concern that using the same types of experimental items related to the *<know, believe>* pair in the training session might have biased the participants toward the intended response in the main task. We acknowledge this as a potential limitation of our design, but we should also note that it is difficult to find other pairs of predicates both in Slovenian and Italian that differ in precisely the same way as members of the *<know, believe>* pair, that is, in the presuppositional component only. Potential alternatives are often contaminated with unwanted additional connotations, frequency contrasts etc. What is important for our purposes, however, is the set of observed contrasts pertaining to our bilingual vs. monolingual populations, given that exposure to all of the stimuli was uniform across participants.



variable reflecting felicitous and non-felicitous answers, respectively. Logit model estimates are given in log odds (logarithms of odds of giving a targeted answer), which can be converted to probabilities by taking an inverse logit [ $\text{logit}^{-1}(\alpha) = \exp(\alpha)/(1 + \exp(\alpha))$ ]. Effects are graphically illustrated by predicted probabilities on the logit scale. In estimating main effects and interactions, we report  $\chi^2$  and  $p$ -values based on the likelihood-ratio test, whereby a model containing the fixed effect of interest is compared to a model that is identical in all respects except the fixed effect in question. In each analysis, the best fitting model was chosen by comparing pairs of models with different degree of complexity using the likelihood ratio test. The simplest model considered included only by-subject and by-item random intercepts. More complex models included by-subject and by-item random intercepts and slopes varying across subjects and items. For each pair of models, the results of the likelihood ratio test were used to evaluate whether inclusion of additional random-effects parameters provided a better fit to the data, so that more complex models were excluded only if the  $p$ -value for the significance of the difference between the two models was above 0.2 (cf. Matuschek et al. 2017). Posthoc planned comparisons were performed as Tukey's estimations using the *multcomp* package in R. Graphical representations of effects were plotted using the *effects* package (Fox & Hong 2010).

## 5.2 C-test

Figure 4 summarizes the c-test results. The percentage of correct reconstructions for the monolingual groups varied in the range between 53–80% (Italian) and 66–76% (Slovenian). The success rate for the bilingual group varied in the range between 48–81% (Italian) and 47–63% (Slovenian). Linear regression models revealed a significant interaction between the language status of participants and their age in both Italian ( $F = 3.21, p = 0.045$ ) and Slovenian ( $F = 4.67, p = 0.011$ ), bilinguals performing worse than monolinguals in both languages: the discrepancy persists through the 9 and/or 11 year old groups, and phases out in the 13 year old group. This is consistent with the generally known limitations concerning lexical competence in bilingual population (see Sections 1 and 3.4). Nevertheless, bilinguals (tested in their non-dominant language) never performed at less than 65% success of the monolingual population. Together with the early AoA, we take these results to suggest a level of linguistic proficiency sufficient for testing the impact of bilingualism on pragmatic abilities.

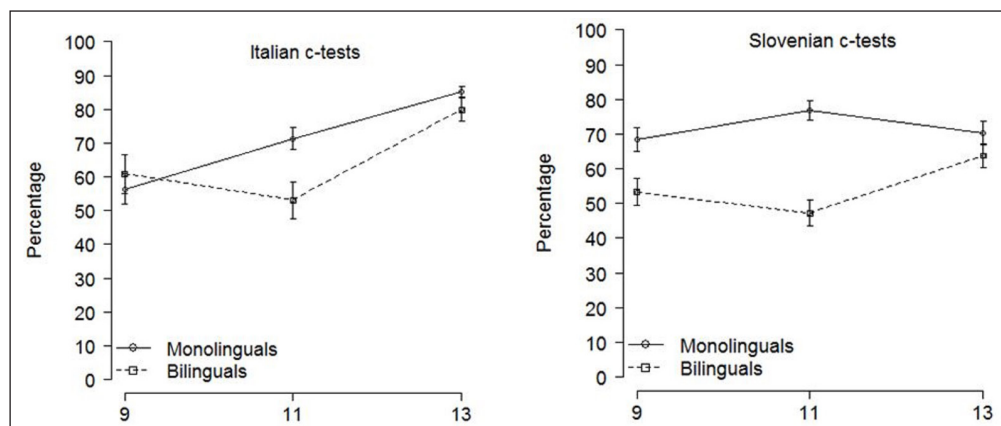


Figure 4 Results of the c-tests for each language group.

## 5.3 Pre-processing the data from the main task

At the pre-processing stage, the data from the main task were cleaned using the following criteria: i) correct responses to comprehension questions above 85%; ii) close fit to the age criterion, and iii) performance on the language ability test. Data from 4 participants was removed due to lower scores of control responses. The data from 5 children and 1 adult was removed as outliers with respect to criterion ii). Finally, we excluded 2 child participants who showed inability to understand the task in the language ability test. This left the data from 175 children and 41 adults for further statistical analysis. Table 1 shows distribution of participants per group after cleaning.

Group	Mean age in years (SE)	Number of participants
Monolingual Italian	9.09 (0.23)	18
	11.63 (0.48)	20
	13.74 (0.27)	19
<i>subtotal: 57</i>		
Early bilingual Slovenian-Italian	9.79 (0.23)	20
	11.84 (0.30)	20
	13.77 (0)	18
<i>subtotal: 58</i>		
Monolingual Slovenian	9.58 (0.23)	20
	11.58 (0.45)	20
	13.65 (0.34)	20
<i>subtotal: 60</i>		
<i>Total children: 175</i>		
Adult Italian	26.10 (4.7)	20
Adult Slovenian	26.9 (4.85)	21
<i>Total adults: 41</i>		

**Table 1** Distribution of participants after pre-processing.

We entered the following measures as fixed factors in our models: i) GROUP (monolingual, bilingual); ii) CONDITION (LP; MP; MP-Neg); iii) AGE (9,11,13, adults); and iv) LANGUAGE (Italian, Slovenian). Treatment coding of factors (default in R) was used whereby the Italian language, bilingual group and Condition LP were assigned reference values. The data from the control group of participants who were over 18 years of age were uniformly coded as adult.

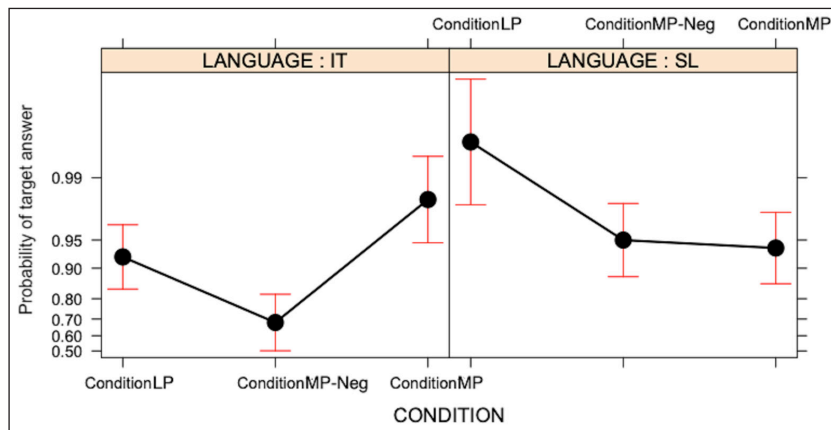
### 5.4 Monolingual adults

The percentages of correct answers per language and condition are shown in [Table 2](#).

Language/ Condition	Slovenian	Italian
LP	99	88
MP-Neg	89	63
MP	87	97

**Table 2** Percentage of correct answers per age group, adults (raw data).

A model fit to the adults-only subset of the data revealed a main effect of factors LANGUAGE ( $\chi^2(1) = 6.72, p = 0.009$ ), CONDITION ( $\chi^2(2) = 59.11, p < 0.0001$ ) and their interaction ( $\chi^2(2) = 46.36, p < 0.0001$ ). Post hoc pairwise comparisons in the form of Tukey estimations revealed a significantly higher rate of felicitous responses given by the Slovenian speakers compared to those given by the Italian speakers in condition LP (Estimate = 3.04, SE = 0.93,  $z = 3.26, p = 0.01$ ) as well as condition MP-Neg (Estimate = 2.19, SE = 0.60,  $z = 3.59, p = 0.003$ ), whereas there was no significant difference in response rates in condition MP (Estimate = -1.28, SE = 0.73,  $z = -1.75, p = 0.50$ ). Within the Italian-speaking group, performance on condition LP and condition MP differed only marginally (Estimate = -1.522, SE = 0.53,  $z = -2.875, p = 0.061$ ), whereas within the Slovenian-speaking group, performance on condition LP was higher than performance on condition MP (Estimate = 2.814, SE = 0.77,  $z = 3.651, p = 0.003$ ). In addition, within the Slovenian group, there was no significant difference in performance on condition MP and condition MP-Neg (Estimate = -0.21, SE = 0.37,  $z = -0.56, ns$ ), whereas, within Italian, performance on these conditions differed (Estimate = 3.26, SE = 0.50,  $z = 6.44, p < 0.001$ ). These contrasts are illustrated in [Figure 5](#).



**Figure 5** Interaction of factors LANGUAGE and CONDITION in (monolingual) adult controls, given in estimated probabilities of correct answers.

### 5.5 Children: Raw data

**Table 3** summarizes children’s raw per group results across all three conditions broken down also by language and bilingualism status.

Language	Slovenian						Italian					
	Monolingual			Bilingual			Monolingual			Bilingual		
Status	9	11	13	9	11	13	9	11	13	9	11	13
Condition/Age	9	11	13	9	11	13	9	11	13	9	11	13
LP	85	88	81	76	71	86	81	85	87	67	87	85
MP-Neg	84	94	95	77	71	76	70	77	63	75	70	72
MP	82	83	92	96	92	99	83	95	89	95	95	96

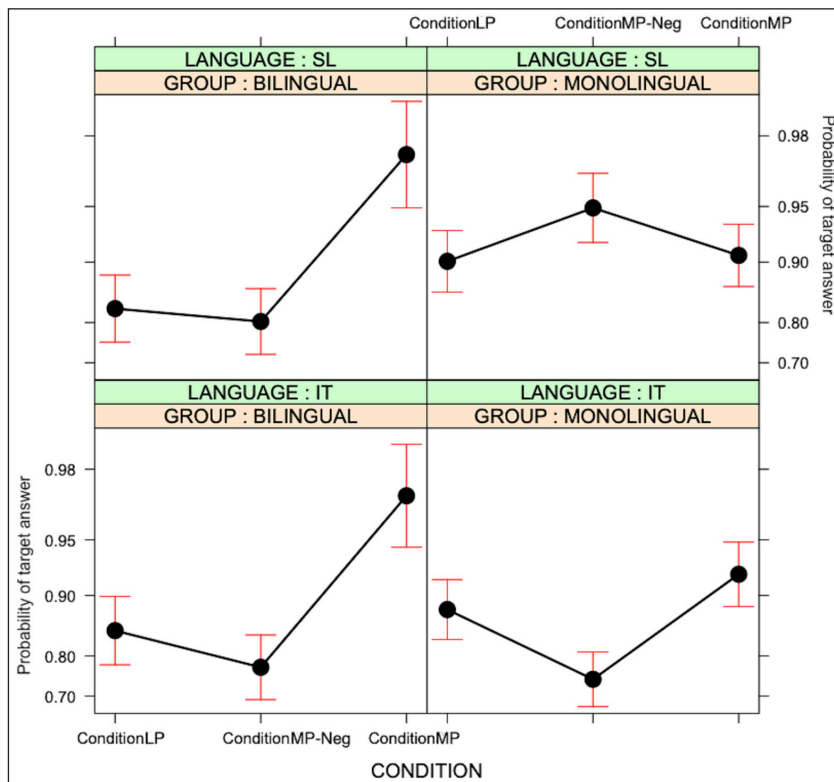
**Table 3** Percentage of correct answers per age group, children (raw data).

Within the children’s population, our constructed models revealed no main effect of AGE ( $\chi^2(2) = 3.36, p = 0.18$ ) and no interaction with any of the three other factors ( $p > 0.10$ ). We also did not find an age effect when sampled across children and adults ( $\chi^2(3) = 4.86, p = 0.18$ ). Put differently, children tend to produce a comparable ratio of targeted answers across conditions and groups. Factor AGE was then excluded from further analyses.

### 5.6 Children: Models and estimated contrasts

The model fit to the children’s sample data revealed a robust main effect of CONDITION ( $\chi^2(2) = 83.93, p < 0.0001$ ). Tukey’s planned comparisons confirmed a significant difference between estimated responses on each of the three conditions involved ( $p = 0.01$  for the pair of conditions LP – MP-Neg;  $p < 0.0001$  for the other pairs) across bilingualism and language groups. This factor thus emerges as a reliable predictor of the targeted responses. There was a marginal main effect of LANGUAGE ( $\chi^2(1) = 2.71, p = 0.09$ ). No main effect of GROUP was found ( $\chi^2(1) = 0.65, ns$ ). Furthermore, a significant three-way interaction of the factors CONDITION, LANGUAGE and GROUP was observed ( $\chi^2(7) = 109.65, p < 0.0001$ ). The three-way interaction model is summarized in Appendix II and illustrated in **Figure 6**.

To better understand the three-way interaction model and specific loci of the effects in the interaction terms, we constructed smaller two-way models, while keeping the third factor constant, and focusing on interactions that are likely to be of interest in the context of our present research questions. The results were the following. A significant interaction between GROUP and CONDITION was found across the LANGUAGE factor ( $\chi^2(2) = 45.30, p < 0.0001$ ). An examination of the respective model revealed that for the bilingual group, the odds ratio of giving a correct answer to Condition MP increase by factor 1.67 (84 %) compared to the monolingual group across the two languages. Post hoc pairwise Tukey comparisons indicated that this increase is significant (Estimate =  $-1.21, z = -3.881, p = 0.001$ ). In other words, bilinguals are more likely to give the targeted answer to Condition MP than monolinguals. This holds both for Slovenian and Italian. In contrast, the odds of giving the targeted answer to Conditions LP and MP-Neg were not significantly affected by bilingualism (Condition LP: Estimate =  $0.45, z = 1.900, ns$ ; Condition MP-Neg: Estimate =  $0.50, z = 2.137, ns$ ).



**Figure 6** Interaction of GROUP, LANGUAGE and CONDITION based on the children data, given in estimated probabilities of correct answers.

CONDITION also interacted with LANGUAGE across the GROUP factor ( $\chi^2(2) = 41.04, p < 0.0001$ ). Inspection of the model revealed that the interaction is confined to the monolingual group, and, further, to negative condition MP-Neg that has a greater success rate in Slovenian than in Italian (Estimate = 1.68, SE = 0.28,  $z = 6.049, p < 0.0001$ ), which implies increasing the odds of giving the targeted answer to that condition by factor 1.64 (or 83% probability) if the language is Slovenian, compared to Italian (Estimate = 1.08,  $z = 5.070, p < 0.0001$ ).

Speakers of both languages performed similarly with respect to condition MP (Estimate = -0.35, SE = 0.28,  $z = -1.261, p = 0.207$ ). Posthoc pairwise estimations with Tukey's adjustment method revealed that performance on condition LP (assumed as the base reference condition in the model) and condition MP does *not* differ significantly either in Slovenian (Estimate = -0.118, SE = 0.19,  $z = -0.609, p = 0.99$ ) or in Italian (Estimate = -0.345, SE = 0.29,  $z = -1.202, p = 0.83$ ). We also find that the actual success rate on condition LP within the Slovenian monolingual group of children (around 85%) is on a par with that within the Italian monolingual group (88%) but is lower than in the Slovenian adult controls (99%), the difference being significant (Estimate = 3.191, SE = 0.88,  $z = 3.637, p = 0.003$ ). In contrast, in Italian, performance on this condition does not differ between adults and children (Estimate = 0.349, SE = 0.369,  $z = 0.947, p = 0.93$ ), being relatively low in both cases (88% vs 87%). We will return to this point in Section 6.

Within the bilingual group, LANGUAGE and CONDITION do not interact ( $\chi^2(2) = 0.932, p = 0.627$ ). Slovenian bilingual children, similarly to monolinguals, performed worse than adult controls with respect to Condition LP (Estimate = 3.872, SE = 0.875,  $z = 4.425, p = 0.0001$ ). In contrast with the monolingual group, however, bilinguals' performance on condition MP is better than condition LP in Slovenian (Estimate = -2.079, SE = 0.37,  $z = -5.628, p < 0.0001$ ) as well as Italian (Estimate = -1.924, SE = 0.37,  $z = -5.180, p < 0.0001$ ). Performance on negative condition MP-Neg is on a par with Condition LP in Slovenian (Estimate = 0.174, SE = 0.24,  $z = 0.734, p = 0.97$ ) as well as in Italian (Estimate = 0.498, SE = 0.24,  $z = 2.088, p = 0.29$ ).

Finally, there was also an interaction between GROUP and LANGUAGE across the factor CONDITION, confined to Condition MP-Neg ( $\chi^2(1) = 17.48, p < 0.0001$ ). There was no significant interaction within Condition LP or Condition MP (all  $p > 0.10$ ). Post hoc pairwise comparisons revealed that Slovenian was the language in which the odds of giving a felicitous judgment on condition MP-Neg were lower by factor 1.63, or 84% probability, for bilinguals than for monolinguals. In contrast, within Italian, felicitousness was not affected by bilingualism.

### 6.1 Adult controls

The results obtained from the adults were intended to provide a comparison frame for our tested children's pragmatic knowledge. The null hypothesis was that both Italian and Slovenian-speaking adult participants perform at ceiling on the lexical presupposition Condition LP and Condition MP. Given the results in Stateva & Stepanov (2021), we expected that performance on condition MP will approximate that on condition LP in both tested groups, though not exceed it. The results we obtained largely confirmed this hypothesis: in neither tested language performance on condition MP exceeds that on condition LP. The performance of monolingual Slovenian adults on condition LP (about 99%) provides an indirect reference point for the 7-year-old children in the (2021) study which performed at (estimated) 97% success on that condition. This comparison reinforces the conclusion that the children in that study were quite close to the ceiling performance, hence near the end of the acquisitional path with respect to the ability to infer lexical presuppositions.

Furthermore, in the Slovenian-speaking group, performance on condition LP is better than that on condition MP, but still conforms with the predictions of the hypothesis that knowledge/ability to compute MP-related inferences is contingent on the ability to derive lexical presuppositions. In the Italian-speaking group, performance on both conditions is comparable, but performance on condition LP was somewhat lower than that in the Slovenian speakers. This lowering of ceiling performance in the Italian group compared to the Slovenian adult group appears surprising at first glance (see below for a possible explanation).

As for Condition MP-Neg, given that Neg-raising is available in Italian and not in Slovenian (Section 4.3.2), we predicted that Slovenian adults provide a comparable amount of target answers on Conditions MP and MP-Neg since both these conditions test sensitivity to MP. On the other hand, the alternatives in Condition MP-Neg in Italian are not truth-conditionally equivalent when a participant interprets the *pensare* ('think')-sentence with a negated embedded rather than matrix predicate. Under such interpretation of the Neg-raising verb *pensare*, the choice between *pensare*- and *sapere*- alternatives is not affected by MP and, therefore, no prediction within our set of assumptions is possible. Our predictions regarding Condition MP-Neg were borne out. The rate of target answers on Condition MP-Neg was comparable to that of Condition MP for the Slovenian speakers. In Italian, participants provided significantly less target answers to Condition MP-Neg which is in line with the hypothesis that Neg-raising dissociates the task in Condition MP-Neg from MP.

### 6.2 Child participants

In light of the finding reported in Stateva & Stepanov (2021) that age does not affect success in providing targeted responses across conditions, we expected that age would not affect performance on the MP-related conditions in the present study either. In line with this prediction, our results revealed no main effect of age and no interaction with the other manipulated factors. Performance on conditions LP and MP in our experiment was similar within the monolingual Slovenian group, and the actual (and predicted) success rates on these conditions (Condition LP: 85%, Condition MP: about 90%) are also on a par with monolingual Italian children's success on the same conditions (88% and 90%, respectively). This converging pattern across the two different language groups, in our view, provides strong support for the hypothesis concerning acquisition of MP being contingent on acquisition of lexical presuppositions.

Consider now children's performance on the MP-related conditions. Earlier we argued, following a number of previous findings, that adherence to MP requires competence about evaluation of alternatives and competition resolution and we linked that competence to the general cognitive functions of executive control and inhibition. On the hypothesis that bilingualism positively affects parts of the Executive Control system that are also relevant to language processing, we predicted that children's bilingualism will interact with factor Condition. More specifically, we expected an advantage for the bilingual participants in their success rates with respect to Condition MP. The results confirmed that prediction. Bilingual participants performed significantly better on Condition MP in comparison to their monolingual peers, which provides an important piece of support to our hypothesis that bilingualism indeed affects sensitivity to MP.



The Slovenian monolingual children's (actual and predicted) success rates on these conditions (Condition LP: 85%, Condition MP: about 90%) were somewhat lower than the reported ceiling rates in Stateva & Stepanov's (2021) study in which 7-year old participants were tested. However, they are on a par with monolingual Italian children's success on the same conditions (88% and 90%, respectively). A closer look suggests that a direct comparison of performance in the two studies may not be fully warranted. One source of potential difference is the mode of presentation: in the (2021) study, the verbal testing material was read to each child by an experimenter, whereas in the present study, participants read that material out loud themselves. More importantly, while in that study the children were tested on two conditions only, the present experiment included a third condition, MP-Neg, which increased the overall stimulus exposure both quantitatively by 33% (24 stimuli compared to 16) and qualitatively, because of the increased linguistic complexity of the entire task. It is possible that addition of this complex condition lowered the ceiling performance on the LP condition in both monolingual and bilingual children, and on the MP condition in monolinguals.

This, of course, begs another question regarding the top performance of our bilingual participants with respect to condition MP (about 98%), which is the only, but crucial, exception from the predicted pattern. In order to approach this aspect, we may want to return to the issue of the source of the potential bilingual advantage with respect to computing implicated presuppositions in the context of MP. As noted above, there are good reasons to believe that the enhanced cognitive functions pertaining to executive control and especially inhibition observed in bilinguals are relevant to their ability to evaluate different kinds of abstract alternatives from a given closed set (in particular, irrelevant alternatives are inhibited). In an experimental task where a speaker explicitly has to choose among two linguistic alternatives generated in the context of the <know, think> pair, deploying this enhanced evaluative ability may reasonably give the bilinguals a selective advantage compared to monolinguals. This may be just the kind of advantage we observe in our bilingual participants with respect to the MP condition. Furthermore, it is not surprising that the bilinguals' level of performance on this condition is unaffected by the hypothesized task complexity effect, precisely because it pertains to evaluation of otherwise identical alternatives which represents a typical case of competition resolution, for which bilinguals presumably have an enhanced capacity. In contrast, the task complexity effect may still affect the bilinguals' performance on the LP condition because, strictly speaking, the relevant forced choice does not involve otherwise identical alternatives: one of the alternatives, namely, the *know*-alternative, is always irrelevant (because of the presupposition failure as part of the condition design).

The only contrast that still remains unaccounted for concerns the seemingly lower performance of our monolingual Italian-speaking adult controls on condition LP, compared to their Slovenian counterparts. At this point we attribute this contrast to an artefact of our Italian stimulus material or participant pool and leave it to be clarified in further experimental research.

As for Condition MP-Neg which also tested sensitivity to MP, again, we could only make a prediction about the Slovenian data, given the difference between Slovenian and Italian with respect to Neg-raising as noted above. Similarly to Condition MP, we predicted that bilingualism will positively affect performance on Condition MP-Neg in Slovenian. Both Slovenian-speaking adults and Slovenian monolingual child participants performed very well with respect to Condition MP-Neg. However, our bilingual participants' responses revealed an interesting tendency. In both of their languages, they demonstrated a consistent linguistic behavior with respect to Condition MP-Neg, namely, they gave a comparable amount of targeted answers in each language. That rate was lower from that of monolingual Slovenian participants (and similar to the rate of targeted answers on Condition MP-Neg provided by monolingual Italian child and adult participants). This suggests that our bilingual speakers analyzed both of their translational equivalents of *think* as Neg-raising verbs, consistent with the Italian, but not the Slovenian, language. This conclusion is strengthened by the fact that our bilingual children showed the high success rate on Condition MP among all tested groups, thus disproving a potential hypothesis that they lack sufficient knowledge of MP.<sup>10</sup>

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<sup>10</sup> These results raise important questions regarding the identification of the class of neg-raising verbs in bilingual language acquisition. We put these aside for a future study.

In light of these findings, performance on Condition MP-Neg can be potentially interpreted as a case of what is known in the literature on bilingual acquisition as (*morpho*-)syntactic transfer, a phenomenon of cross-linguistic influence whereby, in the process of bilingual language acquisition, a morphosyntactic feature is transferred from one language to another if it has different values in the languages being acquired (see Jarvis & Pavlenko 2008 for an overview and discussion). Syntactic transfer has been studied both in bilingual children (Yip & Matthews 2000) and adults learning a second language (Gass 1980; Chan 2004). In our case one can speak of a transfer of the Neg-raising property from Italian to Slovenian. Indeed, negation and Neg-raising are morpho-syntactically encoded differently in Slovenian and Italian. More specifically, Slovenian and Italian differ with respect to the Neg-raising parameter, the latter being a Neg-raising language like English, and the former not (cf. Section 4.3.2). It is therefore conceivable that our bilingual speakers wrongly assume, at least in some cases, that Slovenian is a Neg-raising language on the basis of transfer of the relevant part of their knowledge of Italian. As a result, treating Slovenian as a Neg-raising language leads to a set of negation-related inferences that would be expected from speakers of Italian, but not Slovenian. This is particularly likely to occur for those bilingual speakers who are more fluent in Italian than in Slovenian, or those for whom Italian is a dominant language. Previous research in bilingual processing showed that, the more dominant a language is for a bilingual, the more processing resources will be required to suppress that language while the person is using the other language, and the resulting interference from the dominant language slows a person's processing and production of the weaker language (MacKay & Flege 2004). Future research in this direction should control for the language dominance factor as well as proficiency and their interaction with deriving MP-related pragmatic inferences related to *know* and *think*-type predicates.<sup>11</sup>

## 7 General discussion: The impact of bilingualism on sensitivity to MP

We have seen that bilingual speakers are more likely to detect MP contexts than their monolingual peers and to conform to linguistic demands in those contexts. Thus bilingualism may modulate children's performance on MP in small but significant ways, but the solid lexically-based knowledge keeps the obtained range of results around the ceiling.

At the same time, given the overall results of the monolingual participants who demonstrate a very high rate of compliance with MP, the advantage that the bilingual population in our experiment demonstrated appears to us to be an effect of performance, rather than competence. That is, even at the age of 9 years, all of our participants were sufficiently competent to respond to requirements of pragmatic nature but the bilingual population had a tendency of being more flexible in inhibiting a true but pragmatically non-optimal response. This conclusion is also in line with previous research. Study 2 in Kovács (2009) was designed to tease apart the predictions of a competence-based ToM from those of a performance-based ToM. According to the latter, reasoning competence is insufficient for developing the relevant abilities, and problem solving, inhibition and selection influence performance on ToM task. The results from testing 4 and 5-year-old children are argued to favour the latter theory. Therefore, the results of our study of the effect of bilingualism on adherence to MP bring another piece of evidence supporting the hypothesis that executive control functions might positively affect language use.

This conclusion is also in line with previous experimental evidence that links bilingualism to efficiency of the executive control system, as suggested in Section 3.4. It has been argued that executive functions (inhibition, flexible switching between tasks, working memory

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<sup>11</sup> Scontras et al. (2017) compared interpretation of doubly-quantified sentences such as *A shark ate every pirate* by heritage Mandarin speakers with that by monolingual English and Mandarin speakers. While English speakers allowed inverse scope interpretations and Mandarin speakers allowed only surface scope interpretations of these sentence, in accord with the usual findings in the literature, the tested heritage Mandarin speakers lacked inverse scope in English, their dominant language in adulthood. The authors take these findings as evidence for the pressure for a greater simplification of the grammar of scope, which, in the case of a heritage speaker's two competing grammars, results in the choice of a 'simpler' grammar as defined in the context of syntactic derivation and/or configurations. Applied in the present context (when the dominant language may impose its grammatical feature(s)), Scontras et al's suggestion would imply that a Neg-raising grammar is in some sense syntactically simpler than a non-Neg-raising grammar. This is conceivable, for instance, if a grammar without Neg-raising entertains an additional level of complexity, perhaps in the form of some grammatical constraint or filter blocking Neg-raising interpretations. We leave this interesting theoretical aspect for further exploration.

and monitoring attention control) contribute to a bilingual advantage in behavioural tasks (Hernández et al. 2010; Bialystok et al 2012 and references therein; Costa & Sebastián-Gallés 2014 and references therein; Garraffa et al. 2015; Antoniou et al. 2016; among others). The necessity to manage (parts of) two or more language systems typical for bilinguals is commonly suggested in the literature to enhance executive functions, attentional and other types of cognitive control, conflict resolution and/or inhibition, and working memory (Section 3.4). Indeed, in some obvious way, choosing a more informative, presuppositionally heavier, alternative out of semantically equivalent attitude reports constitutes a conflict resolution task, similarly to a Stroop or Simon task, that requires focus on relevant contextual cues. A further, rather straightforward, parallel can be drawn on children's performance on various false belief tasks. Such tasks usually involve conflicting mental representations that the child has to choose between: one regarding the actual state of affairs, and the other related to other people's beliefs about that state which can also be false. Similarly, the so-called 'appearance and reality (A&R)' tasks where evaluated objects do not have a prototypical form which enhances a misleading perception are often recognized as false-belief tasks even without false-belief questions (Carlson & Moses 2001; Carlson et al 2002; Bialystok & Senman 2004).

The bilinguals' better performance in these conflict-resolution tasks can also be interpreted in terms of enhanced inhibitory control. More specifically, such tasks could be construed as raising inhibitory demands because participants in such tasks have to inhibit the default belief that beliefs are usually true (cf. Kovács 2009). As such, false belief tasks are also competition-based tasks. Similarly, in the A&R tasks, bilinguals perform better at reality questions in which representational features have to be inhibited. Alternatively, or, perhaps, even complementary to the above, false belief tasks are argued by Kovács (2009) to parallel switching situations in which participants have to switch among the actual and possible worlds describing a certain state of affairs in settling an appropriate mental state. From that perspective, bilinguals might exercise a larger degree of cognitive flexibility developed as a result of handling language switching situations. This reasoning can be extended to the MP task in the sense of a parallel demand for inhibition in deciding between the two competing propositions. The choice that a speaker must make between *know*-sentences and *think*-sentences in the relevant context is a choice between two true propositions. Given that speakers generally contribute in discourse only propositions in whose truth they believe (cf. the Quality Maxim of Grice's 1989 Cooperative Principle), none of these alternatives is to be discarded by default. However, in the presence of an overarching pragmatic principle like MP, the presuppositionally weaker *think*-alternative has to be inhibited.

Finally, to the extent that the pragmatic component of language lies at the intersection of individual psychology and social cognition (cf. Grice 1989; Sperber & Wilson 1995; Levinson 2000), an interesting parallel may be observed with the status of bilingualism encompassing the same two domains. In particular, while the role of individual psychology is obvious in terms of bilingual grammars, social cognition skills in bilinguals regulate the choice of language considering the interlocutors' needs (cf. Ritchie & Bhatia 2008). One way to interpret this parallel is to suggest that both types of skills tap on the same or similar cognitive machinery. Under that view, the claim that bilingualism positively affects pragmatic abilities appears quite natural. We hope the present study represents a step toward a better understanding of this perspective.

## 8 Conclusion

In this study we reported the results of an experimental investigation of the use of the MP principle in monolingual and bilingual contexts. We found that across ages, children between 9 and 13 years are able to comply with the constraint, similarly to adults. These results are also in line with the experimental studies on scalar implicatures and therefore strengthen the parallel between acquisitional paths with respect to these two aspects of pragmatic knowledge.

We also traced a potential bilingual advantage linked to performance in relation to this pragmatic constraint and suggested that the ability to compute inferences in accord with MP is affected by factors similar to those that underlie certain general cognitive abilities. Finally, the study delineated some further avenues in which we believe a fruitful exploration of MP may proceed in the future.

The additional file for this article can be found as follows:

- **Supplementary Materials.** Appendices I and II. <https://doi.org/10.5334/gjgl.1236.s1>

## Ethics and consent

This study was carried out in accordance with the recommendations of the Comité de Protection des Personnes Sud Est II at the Université Hospital of Lyon (IRB number: 11263). Participation of participants in Italy was sanctioned by Comitato Etico del Dipartimento di Scienze Neurologiche e del Movimento dell'Università degli Studi di Verona. All participants or (if under-aged) their caretakers gave a written informed consent in accordance with the Declaration of Helsinki.

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## Competing interests

The authors have no competing interests to declare.

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