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RESEARCH ARTICLE

A register approach to modal (non-)concord in English: an experimental study of linguistic and social meaning

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Abstract

Modal concord refers to the phenomenon where the co-occurrence of two modal elements with the same flavor and force (e.g. *may possibly, must certainly*) gives rise to the interpretation of single modality. Given their (arguably) equivalent semantics, constructions with modal concord and single modal (e.g. *may*, *must*) can function as alternative choices in different contexts of use – how do speakers choose between them, and how is the choice perceived? In this article, we take a 'Register' approach and report an experimental study of MC in US English, addressing their linguistic and social meanings with versus without situational context. The results show that (i) modal concord constructions differ from single modal ones in linguistic meanings, which casts doubt on the concord assumption, and (ii) modal concord has distinct social meanings from those of single modal constructions. Our findings suggest a correlation between the meaning strength of a linguistic expression and the social perception about the speaker. Context, manipulated via the single situational parameter of interlocutor relation (close vs. distant), did not interact with the linguistic or social meaning of modal concord constructions, the implications of which are discussed in relation to the multidimensional nature of conversational situations and the method applied.

Keywords: modal concord; modal spread; speaker commitment; social meaning; English

1. Introduction

Recent research in formal and experimental linguistics shows growing interest in the social meaning of variation in language users' choices among functionally equivalent or similar variants, integrating formal grammar with methods of sociolinguistics, language comprehension and perception (e.g. Beltrama 2020; Hall-Lew *et al.* 2021; Pescuma *et al.* 2023). Doubling phenomena – constructions in which multiple elements with similar semantics co-occur (Barbiers *et al.* 2008) – are particularly useful for investigating variation as social behavior, since their semantics is – arguably – equivalent to that of their single element counterparts. In English, several such phenomena, including negative concord, multiple modals and double comparatives (see (1a), (1b) and (1c)), are commonly associated with dialects, though their distribution varies considerably across different varieties. For example, negative concord, where two negative elements co-occur (*not...nothing*), and double comparative, where the synthetic and analytical comparative merge (*more friendlier*), are among the eleven most frequently attested morphosyntactic features in at least 34 out of 46 English varieties

worldwide (Szmrecsanyi & Kortmann 2004). Given their wide distribution, understanding how language comprehenders perceive these constructions is key to exploring their social meaning and how linguistic variation is interpreted in different conversational contexts.

(1) (a) Negative concord:
I did**n't** see **nothing**. (i.e. 'I didn't see anything.') (Pullum 1999: 48)
(b) Multiple modals:
I thought you **might could** help me. (Mishoe & Montgomery 1994)
(c) Double comparatives:
Frida is **more friendlier** than Jasmine. (Alexiadou *et al.* 2025)

This article deals with the co-occurrence of modal verbs and adverbs in English – a phenomenon unlike the other ones listed in that it is not typically limited to dialectal use. As illustrated in (2), modality can be expressed through a single modal element (SM), either an auxiliary verb (2a) or adverb (2b), or with both co-occurring in the same clause (2c), known as modal concord (MC).

(2) Single modal and modal concord
(a) The project **may** move on independently. (SM)
(b) The project **possibly** moves on independently. (SM)
(c) The project **may possibly** move on independently. (MC)

According to some analyses (Geurts & Huitink 2006; Zeijlstra 2007), when both modal elements share the same modal flavor (e.g. epistemic modality) and force (e.g. existential or universal), MC is interpreted equivalent to single modality, thus aligning with the concept of *concord* (Dekker & Zeijlstra 2012).

Similar to other concord phenomena – like negative concord – MC may be subject to extralinguistic restrictions, such as register, defined as recurrent intra- and interindividual variation influenced by situational-functional parameters (Pescuma *et al.* 2023; Lüdeling *et al.* 2024). Language users are assumed to adjust their speech according to aspects of the situation, e.g. the interlocutor they talk to (*boss* vs. *mother*, Rotter & Liu 2023). Such choices can signal different social meanings, which is 'the set of inferences that can be drawn on the basis of how language is used in specific interactions' (Hall-Lew *et al.* 2021: 3).

The distribution and social meaning of negative concord has been extensively studied, whereas comparable work on the co-occurrence of modal verbs and adverbs is scarce. Unlike negative concord and double comparatives, which are frequently considered as stigmatized (see e.g. González-Díaz 2008; Eckert 2019), MC does not carry such a stigma. Recent experimental approaches have explored the influence of register on doubling phenomena and their counterparts, as well as their perceived linguistic and social meanings. The results revealed differences in register sensitivity (see Rotter & Liu 2024 for negative concord; Liu & Rotter 2023 for MC; Alexiadou *et al.* 2025 for double comparatives), social meaning and perceived grammaticality in the absence of situational contexts (see Liu & Rotter 2025 for MC; Rotter & Liu 2025 for negative concord). Crucially, the studies found interpretive differences between the doubling phenomena and their (single element) counterparts – challenging semantic equivalence as the core assumption of the concord-analysis (Dekker & Zeijlstra 2012).

Offering a unique lens on modality across interpretation, sociolinguistic variation and register, this article takes an experimental approach to investigate MC in US English – focusing on its linguistic and social meanings, grammaticality, and register sensitivity. Building on the experimental set-up (Liu & Rotter 2025), we extended the rating study with situational context, tackling the following research questions (RQ):

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(RQ1-linguistic meaning) What is the interpretation of MC constructions? Our results show that they differ from SM in terms of speaker commitment.

(RQ2-social meaning) What is the perceived social meaning of MC constructions? MC and SM showed distinct social meanings.

(RQ3-grammaticality) How are MC constructions perceived in terms of grammaticality? We found that MC is rated less grammatical than SM.

(RQ4-register sensitivity) Are MC constructions sensitive to the register, i.e. situational contexts? There was no evidence for register sensitivity with respect to the single parameter interlocutor relationship.

This article is structured as follows: section 2 reviews theoretical work on MC, register and social meaning. Section 3 details the rationale, method and results of the experimental approach. Section 4 discusses the results in relation to the research questions and section 5 concludes the article.

2. Background

The following two sections provide further theoretical background on previous analyses of modal doubling in section 2.1 and on register and social meaning in section 2.2.

2.1. *Previous analyses: modal* concord *vs.* spread

In terms of grammar, the discussion of co-occurring modal verb and adverb dates back to at least the 1970s, see the quote below:

> In most dialects of English not more than one modal verb can occur within the same clause. But both a modal verb and a modal adverb may be combined. When this happens a distinction is to be drawn between modally harmonic* and modally non-harmonic* combinations. For example, 'possibly' and 'may', if each is being used epistemically, are harmonic, in that they both express the same degree of modality, whereas 'certainly' and 'may' are, in this sense, modally non-harmonic. It has been pointed out by Halliday ([1970]: 331) that the adverb and the modal verb may, and normally do, "reinforce each other" in a modally harmonic combination; so that, ... there is a kind of concord running through the clause, which results in the double realization of a single modality. (Lyons 1977: 807–8)

More recent literature labels constructions like *may possibly* as MC (Geurts & Huitink 2006; Zeijlstra 2007), associating them with other concord (or agreement) phenomena under the central idea that doubling adds no effects to semantic interpretations. Following this approach, the – optional – modal adverb *possibly* would be semantically vacuous.

Giannakidou & Mari (2018) propose an alternative analysis of such phenomena under the label of 'modal spread' (see also Huitink 2012 for a similar proposal). They focus on the universal *must* vs. existential modal verb *might* with the three modal adverbs *definitely*, *probably* and *maybe* in English, Italian and Greek. Putting aside the technical details, universal modals – the weak necessity modal verb *must* – are inherently positively biased, whereas possibility modals, such as *might,* are neutral in terms of speaker commitment, i.e. the likelihood of the modified proposition being true or false to be equal for the speaker. Furthermore, the co-occurrence of *must* with the adverb *definitely* strengthens the default positive bias, *probably* merely maintains the default and *maybe* weakens it. In contrast, when the adverbs co-occur with *might*, the adverbs *definitely* and *probably* both introduce positive bias, whereas *maybe*

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merely maintains the default; see examples (77) and (78) in Giannakidou & Mari (2018: 648) for details.

In our study, we investigate the MC constructions *must certainly* and *may possibly*, which appeared as more frequent collocations than *must definitely* or *might maybe* in a preliminary corpus analysis of US American English. Both selected combinations are also attested in English, as reported in the literature (see e.g. Halliday 1970; Geurts & Huitink 2006; Zeijlstra 2007). Assuming (i) *certainly* and *definitely*, (ii) *may* and *might* in epistemic readings, and (iii) *possibly* and *maybe* to be similar, we derive the preliminary hypotheses in (3), based on the concord and modal spread analyses: the predictions diverge for *certainly* with universal modals, where the concord analysis assumes equal speaker commitment for *must certainly* and *must*, while the spread analysis predicts a strengthening effect of *must certainly* in comparison to *must*; see (3a). In contrast, the predictions align for existential modals, as both analyses interpret *may possibly* and *may* with equivalent speaker commitment; see (3b).

(3) Linguistic meaning of *must certainly* and *may possibly* based on the concord versus the spread analysis
  (a) universal modals:
    (i) concord: *must certainly* $=_{speaker\ commitment}$ *must*
    (ii) spread: *must certainly* $>_{speaker\ commitment}$ *must*
  (b) existential modals:
    (i) concord: *may possibly* $=_{speaker\ commitment}$ *may*
    (ii) spread: *may possibly* $=_{speaker\ commitment}$ *may*

Despite such attempts to integrate MC constructions into semantic theories, the empirical picture remains unclear. One of our goals is to experimentally investigate whether modal doubling of the same force and flavor has the same semantics as their single element counterparts.

2.2. *Register and social meaning*

The term *register* has been used in various ways (see Pescuma *et al.* 2023 for an overview and references therein). Following recent work, we define *register* as recurrent intra- and inter-individual variation in linguistic behavior shaped by situational-functional parameters (Lüdeling *et al.* 2024; Pescuma *et al.* 2023). Linguistic variation is typically described in terms of concrete instantiations – *variants* – of an abstract linguistic *variable* (Labov 1972), e.g. the [-ING] variable with its variants *-ing* and *-in'* (Campbell-Kibler 2010). Traditional definitions require variants to be semantically equivalent (Labov 1972: 188), which poses challenges for non-phonological variables (Lavandera 1978; Tagliamonte 2006), e.g. *dinner* and *supper* refer to the same activity (meal in the evening) but have different meanings. To address this, semantic sameness was replaced with functional equivalence (Lavandera 1978; Dines 1980), requiring variants to perform a similar function on some linguistic level. This, however, demands clear formal criteria to quantify all possible variants, and their actual and potential appearances (see a detailed discussion in Pichler 2010). For the present article, we assume that functions are multilayered and adopt the concept of *structural sameness* (Christensen & Jensen 2022). Thus, we look at syntactic variation, which is functionally similar on some level and structurally comparable, e.g. presence vs. absence of words. Furthermore, we use the broader term *alternatives* (Lüdeling *et al.* 2024) which allows us to compare MC and SM without assuming semantic or pragmatic sameness.

The concept of register presupposes that language users adjust their speech on all linguistic levels, with these adjustments being (culturally) conventionalized within a speech community

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(Agha 2007; Pescuma *et al.* 2023). Situational-functional parameters, shaping this variation, are multidimensional. For instance, the situational context varies depending on, among others, the location (e.g. *school* vs. *youth club*, Creber & Giles 1983), or clothing style (cf. Slepian *et al.* 2015). Functional parameters include the communicative purpose; speech can be used, among other things, to narrate a story adhering to specific rules (e.g. sequential reporting, see Pescuma *et al.* 2023) or to construct a specific persona (Eckert 2024). In such cases, linguistic choices are infused with social meanings (Eckert & Labov 2017). These choices, whether conscious or subconscious, become performative acts that convey supplementary, context-dependent meanings related to the speaker's stances, identities and group affiliations (Beltrama 2020; Eckert 2024). For instance, small semantic differences between the modal phrases *you need to* and *you have/got to* give rise to a unique social meaning – one that hinges on whether the speaker is authorized to advise the hearer on what is in their best interest (Glass 2015).

To approach linguistic phenomena from a register view, we need to include such extralinguistic parameters in experimental work (see Pescuma *et al.* 2023 for discussion). One option is to embed linguistic material into enriched situational context. For instance, a rating study assessed the influence of interlocutor relation on the perceived level of formality as a situational manipulation (Rotter & Liu 2023). The study used labels indicating social relations in the distant[1] (e.g. like *boss* or *judge*) compared to the private sector (e.g. *family* and *friends*); see (4). Participants native to US American English judged the expected degree of formality of the upcoming speech (see Q1) on a seven-point Likert scale.

(4) (S1) George Henderson works in a shop.
(S2) He says to his **boss**$_{distant}$ / **sibling**$_{close}$: ..
(Q1) Is George Henderson going to talk formally?

Results showed a clear distinction: more formal speeches were expected with distant relations than with close relations.

Recent experimental studies have used interlocutor relationships as a parameter to investigate the influence of register on doubling phenomena. However, few studies have examined MC from a register perspective, a gap we aim to fill with the experiment in section 3.2 by integrating the interlocutor relation manipulation as a contextual parameter.

3. Experiments

There is, to our knowledge, limited experimental research on the co-occurrence of modal verb and adverb in English. A previously conducted and published study – referred to here as Experiment 1 – investigated both the linguistic and social meanings of MC and its grammaticality (Liu & Rotter 2025) but did not include the potential influence of the situational context; section 3.1 briefly summarizes the design and key findings. Building on this, the current article extends the approach by incorporating register as central factor in Experiment 2. Section 3.2 outlines the rationale and reports on the method and section 3.3 details the results of Experiment 2.

3.1. Experiment 1: modal concord without context (Liu & Rotter 2025)

One recently published study investigated the perception of MC in comparison to its SM alternative in terms of linguistic and social meanings (Liu & Rotter 2025),[2] addressing the

[1] For conformity, we adjust the level names to *close* for the original label *public* and *distant* for *private*.

[2] In the study, the term *Interpretation* was used to address what is called *speaker commitment* in the current study (Experiment 2); see section 3.2. For conformity with Experiment 2, we use *speaker commitment* in Experiment 1.

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research questions on the linguistic (**RQ1**) and social meaning (**RQ2**), and the grammaticality (**RQ3**).

The rating study was employed in a 2×2-factorial design with the factors NUMBER and its levels MC and SM, as well as FORCE and its levels necessity and possibility. In total 104 native speakers of US American English participated. The items followed the structure as exemplified in (5): (S1) was a static sentence across all items. (S2) introduced the critical sentences with both NUMBER and FORCE manipulation. (Q1) used the speaker commitment (Liu *et al.* 2021) to access the linguistic meaning and (Q2) asked about the grammaticality.

(5) (S1) Somebody says:
(S2) '{**may possibly**$_{MC}$ / **may**$_{SM}$} have lost my keys.' (possibility)
'I {**must certainly**$_{MC}$ / **must**$_{SM}$} have lost my keys.' (necessity)
(Q1) Does the person believe they have lost their keys?
(Q2) Is the sentence grammatical?

The social meaning was assessed via antonyms on the end-points of a seven-point Likert scale as speaker perception in terms on the social background (*low/high socio-economic status*, *low/high education level*) and the persona (*in/formal*, *im/polite*, *un/confident*, *un/friendly*, *cold/warm*, *un/cool* and *obedient/rebellious*), the midpoint of the scale was labeled (*undecided*). Participants first rated the social meaning in random sets of three scales before rating the linguistic meaning (Q1) on the **speaker commitment** and finally, (Q2) on the **grammaticality**.

The results are summarized in table 1 and figure 1. MC was rated less grammatical than its SM alternative, reflecting its more restricted distribution. Regarding (**RQ1-linguistic meaning**), the interaction effect showed a weakening effect in possibility and strengthening effect in necessity of MC in comparison to SM. For (**RQ2**), MC received lower ratings for grammaticality than SM. Regarding (**RQ3-social meaning**), MC was rated as less friendly, warm and cool, and more specifically 'in possibility modals, MC was rated as significantly lower

Table 1. Summary of the significant results from Experiment 1 (Liu & Rotter 2025: 9, table 5). The abbreviation 'poss' stands for *possibility* and 'ness' for *necessity* conditions. MC stands for *modal concord* and SM for *single modal*. 2-int abbreviates the *two-way interaction* FORCE×NUMBER. The symbol < indicates that the left entity is smaller than the right one; > represents the reverse. The symbol '–' indicates the lack of a significant effect

	FORCE	NUMBER	2-int FORCE×NUMBER	
Speaker commitment	poss < ness	MC > SM	poss: MC < SM	ness: MC > SM
Grammaticality	–	MC < SM	–	–
Socioeconomic status	poss < ness	–	poss: MC < SM	–
Education level	poss < ness	–	poss: MC < SM	–
Formality	poss < ness	–	–	ness: MC > SM
Politeness	–	–	–	–
Confidence	poss < ness	–	poss: MC < SM	ness: MC > SM
Friendliness	poss > ness	MC < SM	–	–
Warmth	poss > ness	MC < SM	–	–
Coolness	–	MC < SM	–	–
Rebelliousness	–	–	–	–

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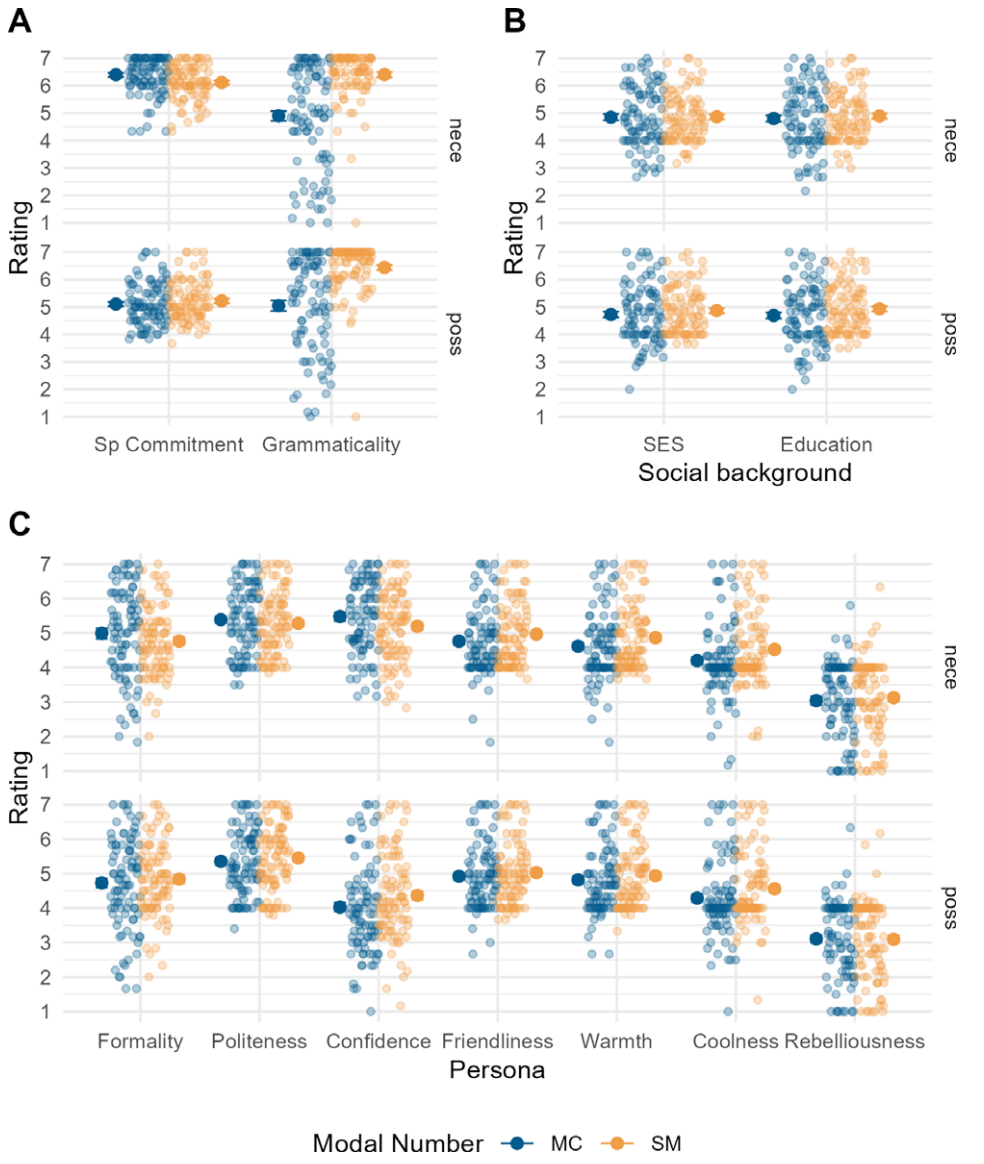

Figure 1. By-subject means (transparent dots) of the rating measures in comparison to overall means (opaque dots with error bars) of Experiment 1 (Liu & Rotter 2025: 5, figure 1). **Panel A** depicts the ratings of the *speaker commitment* (sp commitment) and grammaticality, **panel B** the social background measures, and **panel C** the persona measures. The x-axis indicates the specific measures. The top scale shows the ratings from the *necessity* conditions (nece), the one below those of the *possibility* conditions (poss). The colors indicate the factor NUMBER with MC (*modal concord*) in blue and SM (*single modal*) in yellow. The y-axis depicts the ratings on a seven-point Likert scale. SES abbreviates *socioeconomic status*.

than SM in SES [socio-economic status], education and confidence levels and in necessity modals, MC was rated as more formal and more confident than SM' (9–10).

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3.2. *Experiment 2: modal concord in context*

3.2.1. *Rationale*

Building on previous research, we adopted a register-based approach to MC and expanded the design of Experiment 1 by introducing the situational parameter interlocutor relation (see section 2.2) in Experiment 2. By enriching the context through the manipulation, we were also able to extend our investigation to include judgments of appropriateness (Rotter & Liu 2024; Alexiadou *et al.* 2025), thereby tapping into potential register sensitivities in a more nuanced – though still simplified – approximation of natural language use. We address the following extended research questions (RQ):

(RQ1-linguistic meaning) What is the interpretation of MC constructions in situational context?

(RQ2-social meaning) What is the perceived social meaning of MC constructions?

(RQ3-grammaticality) How are MC constructions perceived in terms of grammaticality?

(RQ4-register sensitivity) Are MC constructions sensitive to the register, i.e., situational contexts?

Furthermore, we formulate the following hypotheses (H):

(H1) MC constructions would receive higher speaker commitment ratings for necessity modals and lower speaker commitment ratings for possibility modals than SM constructions for necessity modals. (We expect a significant interaction NUMBER×FORCE: $MC_{nece} > SM_{nece}$, $MC_{poss} < SM_{poss}$)

(H2) MC constructions would receive lower friendliness, warmth and coolness ratings in the persona than SM constructions. (MC < SM)

(H3) MC constructions would be rated as less grammatical than SM constructions. (MC < SM)

(H4) MC constructions would be rated as less appropriate than SM constructions. (MC < SM)

(H5) Context (in terms of distant vs. close social relations) has an influence on the perception of MC vs. SM. (two-way interaction CONTEXT×NUMBER)

Our predictions rely on findings of Experiment 1 and would replicate them ((H1), (H2) and (H3)). Furthermore we formulate a non-directional hypothesis (H5) on the influence of context. Since we examine several measures not previously tested in context with MC, we take an exploratory approach and make no directional predictions. This marks a first step toward understanding how extra-linguistic factors shape perceptions of speakers based on their linguistic choices.

3.2.2. *Method*

The experiment was divided into four parts, conducted in the following sequence: (**P1**) an information sheet and consent form, (**P2**) a rating study assessing the appropriateness, speaker commitment and perception of the speaker, (**P3**) the autism-spectrum quotient questionnaire, not included in this report, and (**P4**) a brief survey on demographic and linguistic backgrounds (e.g. a force-choice task which is not included in this report).

Participants. We recruited 306 native speakers of US English through the crowdsourcing platform Prolific (www.prolific.co/). The experiment lasted approximately 45 minutes, and participants were monetarily compensated for their participation. We received from all participants informed consent as approved by the Ethics Committee of the Deutsche

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Gesellschaft für Sprachwissenschaft (DGfS) in the context of SFB 1412 'Register'. All participants met the inclusion criteria of being native English speakers and aged between 18 and 65 years (mean age = 38.4 (SD = 11.3), range = [18, 64]; female N = 152, male N = 153, nonbinary N = 1). The participants came from 45 different states across the United States.

The majority have completed college (46.7%) or high school (30.4%), 22.6% hold a graduate degree, and below 1% did not finish high school. Roughly half of the participants grew up in a suburban environment (47.7%), one-third (34%) grew up in an urban and 18.3% in a rural environment.

Overall, 6.5% of participants reported speaking one of six dialects: Hawaiian Pidgin (N = 1), Michigan (N = 1), Midwestern (N = 1), New York (N = 1), Southern (N = 6) and West American English dialect (N = 2), with an additional four participants naming more than one dialect (dialect information missing [N = 2]). In addition, several participants identified themselves as speakers of American (N = 14), British (N = 1), informal (N = 1) and standard English (N = 1), thereby showing register knowledge concerning both regional varieties and different levels of formality.

Material and design. The experiment was conducted using PCIbex (Zehr & Schwarz 2018) and hosted on the PCIbex Farm platform (https://farm.pcibex.net/).

The rating study in (**P2**) employed a 2×2×2-factorial design with the factors NUMBER[3] (modal concord/MC vs. single modal/SM), FORCE (necessity vs. possibility) and CONTEXT (distant vs. close). We utilized 24 critical items, along with 16 filler items of similar structure. CONTEXT was manipulated in (S1) as pairs of interlocutor relation labels that aligned with the story (see (6)). The agents in the short stories alternated between 'a woman' and 'a man', avoiding personal names to eliminate uncontrolled social meanings. The NUMBER and FORCE factors were manipulated in (S2). Participants responded to three questions in the indicated order: (Q1) speaker commitment, (Q2) appropriateness and (Q3) grammaticality of the sentence. Participants were assigned to one of eight lists following a Latin Square design.

(6) (S1) A woman says to the {landlord$_{distant}$ / boyfriend$_{close}$}:
(S2) 'I {**may possibly**$_{MC}$ / **may**$_{SM}$} have lost my keys.' (possibility)
'I {**must certainly**$_{MC}$ / **must**$_{SM}$} have lost my keys.' (necessity)
(Q1) Does the person believe they have lost their keys?
(Q2) Is this phrasing appropriate within the given context?
(Q3) Is the sentence grammatical?

Procedure. Participants completed (**P1–4**) in the specified sequence.

In (**P2**), participants used the space bar to advance and the mouse to click on the options. The experiment started with a practice item to help participants familiarize themselves with the setup. Each trial started with a fixation cross centered on the screen (see panel A of figure 2). (S1) was displayed in the center of the screen, followed by (S2) on a separate screen (see panels B and C of figure 2). (S2) remained on the screen while participants rated the perceived **social background** (*low/high socioeconomic status* and *low/high education*) and the **persona** (*in/formal*, *im/polite*, *un/confident*, *un/friendly*, *cold/warm*, *un/cool* and *obedient/rebellious*) of the speaker. These measures appeared in two groups (five and four traits, respectively) in randomized order (see panel D of figure 2). In the final screens of the trail, the participants separately rated (*Certainly no/Certainly yes*) the **speaker commitment** (Q1), **appropriateness** (Q2) and the **grammaticality** (Q3) of the sentence. This order was chosen to reduce potential bias, ensuring that previous ratings about the appropriateness and grammaticality do not influence the speaker commitment of the sentence. Additionally,

[3] Hereafter, factors are capitalized.

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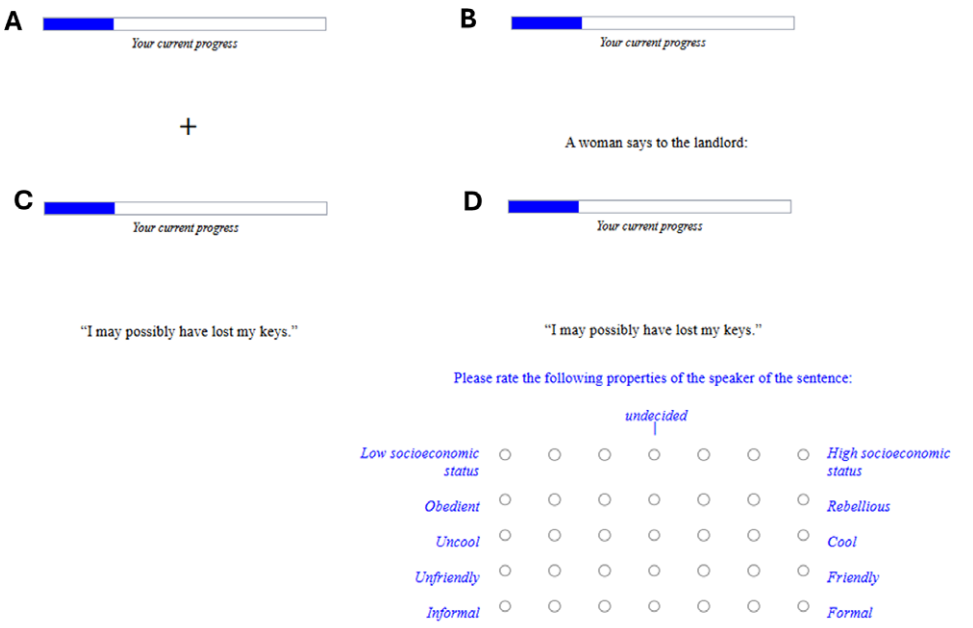

Figure 2. Screenshots of the experimental design. **Panel A** shows the fixation cross. **Panel B** shows the presentation of (S1), and **panel C** the presentation of (S2). **Panel D** shows (S2) together with the randomized Likert scale ratings.

appropriateness was rated before grammaticality for similar reasons. These measures all used a seven-point Likert scale in which end and midpoints were labels (e.g. 1:*informal* - 4: *undecided* - 7:*formal*).

In (**P4**), participants took part in a short survey on their demographic and language backgrounds. This information was used to verify the inclusion criteria and to gain insights into the sample population. No inferential analysis were conducted based on these self-reports.

Data analysis. We used the open source software 'R' (version 4.1.2, R Core Team 2024) in the RStudio environment to process and analyze the data. Since the study did not include attention checks, we visualized each participant's rating patterns for critical and filler items separately prior to analysis. Since the ratings across the items did not seem monotonic, we included all participants in the analysis.

The study comprised of 12 judgment ratings (i.e., appropriateness, grammaticality, speaker commitment, socio-economic status, education level, formality, politeness, confidence, friendliness, warmth, coolness and rebelliousness). Each measure was used separately as dependent variable for a model in the cumulative link function model framework (Liddell & Kruschke 2018) using the package 'ordinal' (cf. Christensen 2015).

We determined the link function of each model as the highest log-likelihood value of the five link functions (i.e. probit, logit, cauchit, loglog and cloglog) (Christensen 2015). The main factors were sum-coded in the following way: NUMBER (MC: 0.5, SM: −0.5), FORCE (necessity: 0.5, possibility: −0.5) and CONTEXT (distant: 0.5, close: −0.5). The models contained the three main factors as well as all possible two-way (i.e. NUMBER×FORCE, NUMBER×CONTEXT, FORCE×CONTEXT) and three-way interactions (i.e. NUMBER× FORCE× CONTEXT). Since the experimental design includes two sub-studies based on the FORCE factor, we conducted sub-analyses by splitting the data into *necessity* and *possibility*

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conditions whenever a significant interaction involving the FORCE factor was observed. In such cases, we only report effects from this sub-analysis.

We determined the random effect structure by using the most parsimonious model approach, the structures used are indicated in the respective result section. If the correlation turned out to be exactly 1 or −1, we regressed to the simpler model. The p-values were obtained with the help of log-likelihood ratio test comparisons of nested models (Bates *et al.* 2018). We report them as significant at a value below 0.05. All statistical values of means, estimates and the like are rounded to the second decimals except for p-values smaller than 0.01.

3.3. Results

Figure 3 depicts the overall and subject means of the ratings. In the following sections, we detail the results of the descriptive statistics and inferential analysis of each of the twelve dependent measurements. The results are indexed with continuous numbers in relation to the RQs (see section 3.2.1), e.g. **RQ1.1** for the first result in relation to (**RQ1-linguistic meaning**).

This section continues as follows: in section 3.3.1, we detail the results from the speaker commitment ratings. In section 3.3.2, we report the results from the social meaning measures. Section 3.3.3 focuses on the results from the grammaticality and section 3.3.4 on the appropriateness ratings.

3.3.1. Linguistic meaning: speaker commitment

For the speaker commitment ratings, the descriptive statistics are shown in table 2 and the output of the related model in table 3.

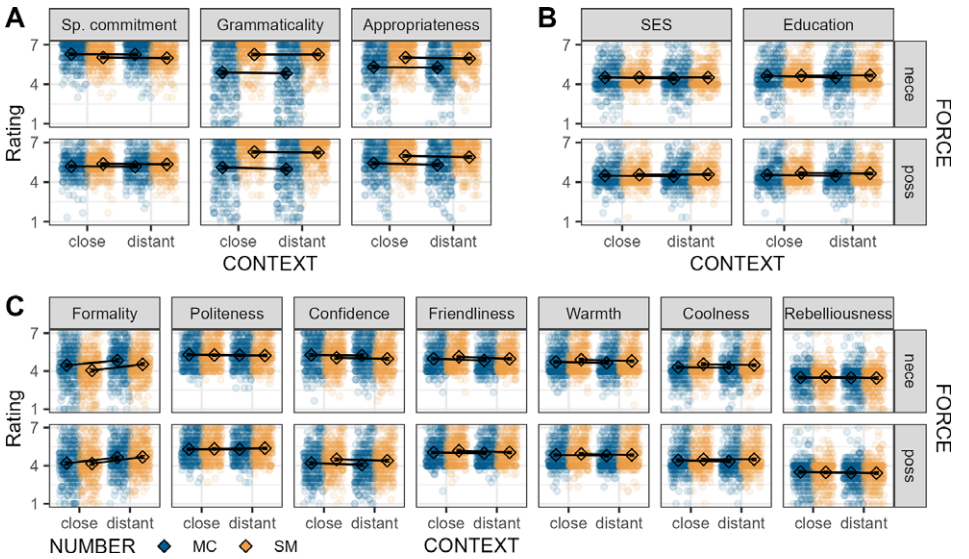

Figure 3. By-subject means (transparent dots) of the rating measures in comparison to overall means (squares). **Panel A** depicts the ratings of the *speaker commitment* (Sp. commitment), grammaticality and appropriateness, **panel B** the social background measures, and **panel C** the persona measures. The x-axis indicates the CONTEXT factor. The top scale shows the ratings from the *necessity* conditions (nece), the one below the *possibility* conditions (poss). The colors indicate the factor NUMBER: MC (i.e. *modal concord*) in blue and SM (i.e. *single modal*) in yellow. The y-axis depicts the ratings on a seven-point Likert scale. SES abbreviates *socioeconomic status*.

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Table 2. Descriptive statistics (n = 918) of the speaker commitment ratings. Nece abbreviates *necessity* and poss *possibility* conditions

			Speaker commitment			
Context	Force	Number	median	mean	SD	SE
close	nece	MC	7	6.28	1.01	0.03
close	nece	SM	6	6.03	1.01	0.03
close	poss	MC	5	5.20	1.11	0.04
close	poss	SM	5	5.38	1.09	0.04
distant	nece	MC	7	6.26	1.06	0.03
distant	nece	SM	6	5.98	1.02	0.03
distant	poss	MC	5	5.17	1.16	0.04
distant	poss	SM	5	5.34	1.10	0.04

Table 3. Output of the models using the speaker commitment measures as dependent variable. The symbol '⋆' indicates significant results

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Speaker commitment	NUMBER (N)	0.39	0.07	5.56	31.92	<0.0001
	FORCE (F)	2.59	0.15	17.19	86.88	<0.0001
	CONTEXT (C)	–0.08	0.07	–1.22	1.44	0.23
	N×F	1.60	0.13	12.33	136.06	<0.0001⋆
	N×C	0.06	0.09	0.59	0.35	0.55
	F×C	–0.06	0.09	–0.59	0.34	0.56
	N×F×C	0.12	0.19	0.63	0.40	0.53
Sub-analyses:						
necessity	N	0.87	0.08	10.63	113.64	<0.0001⋆
	C	–0.08	0.05	–1.66	2.77	0.10
	N×C	0.03	0.10	0.25	0.06	0.80
possibility	N	–0.43	0.06	–6.78	46.23	<0.0001⋆
	C	–0.06	0.06	–0.90	0.82	0.37
	N×C	–0.01	0.13	–0.04	0.01	0.97

The logit link model that included random intercepts for subjects with slopes for NUMBER, FORCE and their two-way interaction (NUMBER×FORCE), as well as intercepts for item intercepts with slopes for FORCE and CONTEXT provided the best fit to the data.

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The results showed a significant two-way interaction NUMBER×FORCE ($\hat{\beta}$ = 1.60, $\chi^2(1)$ = 136.06, p < 0.0001). No other interaction turned out significant.

Two models were fit to subsets of the data based on the FORCE levels. The necessity model showed the best fit using a cloglog link function, with random intercepts for subjects and items, and by-subject random slopes for NUMBER. The possibility-model used the logit link function with random subject and item intercepts. The results revealed a cross-over effect in that MC was rated higher than SM in necessity conditions (**RQ1.1**, $\hat{\beta}$ = 0.87, $\chi^2(1)$ = 113.64, p < 0.0001), while in possibility conditions the reverse effect was found (**RQ1.2**, $\hat{\beta}$ = -0.43, $\chi^2(1)$ = 46.23, p < 0.0001). No further effect turned out significant.

3.3.2 *Social meaning*

For the social background ratings, the descriptive statistics are shown in table 4 and the output of the related models are shown in table 5.

For the **socio-economic status** ratings, the probit link model that included random intercepts for subjects with slopes for NUMBER, FORCE and their two-way interaction (NUMBER ×FORCE), as well as intercepts for items with slopes for FORCE and CONTEXT fit the data best. The results showed no significant main or interaction effect.

For the **education level** ratings, the loglog link model that included only random intercepts for subjects with slopes for NUMBER, FORCE, CONTEXT, as well as the three two-way interactions. The results showed a significant main effect of NUMBER in that MC conditions were rated with lower education levels than SM conditions (**RQ2.1**, $\hat{\beta}$ = -0.14, $\chi^2(1)$ = 8.16, p = 0.004). The main effect CONTEXT showed significant levels in that distant conditions were rated with lower education levels than close conditions (**RQ2.2**, $\hat{\beta}$ = -0.08, $\chi^2(1)$ = 6.07, p = 0.01). No other main or interaction effects turned out significant.

The descriptive statistics of the persona ratings are shown in table 6 and the output of the related models are shown in table 7 and 8.

For the **formality** ratings, the loglog link model that included random intercepts for subjects with slopes for NUMBER, FORCE, CONTEXT and the two-way interaction NUMBER×-FORCE, along with intercepts for items fit the data best. The results showed a significant NUMBER×FORCE interaction ($\hat{\beta}$ = 0.58, $\chi^2(1)$ = 29.77, p < 0.0001). No other interaction turned out significant.

Table 4. Descriptive statistics (n = 918) of the social background ratings. Nece abbreviates *necessity* and poss *possibility* conditions

			Socio-economic status				Education level			
Context	Force	Number	median	mean	SD	SE	median	mean	SD	SE
close	nece	MC	4	4.52	1.27	0.04	5	4.63	1.33	0.04
close	nece	SM	4	4.52	1.09	0.04	4	4.65	1.08	0.04
close	poss	MC	4	4.49	1.13	0.04	4	4.54	1.17	0.04
close	poss	SM	4	4.56	1.06	0.03	5	4.70	1.06	0.03
distant	nece	MC	4	4.42	1.27	0.04	4	4.52	1.36	0.04
distant	nece	SM	4	4.51	1.13	0.04	4	4.66	1.12	0.04
distant	poss	MC	4	4.45	1.19	0.04	4	4.48	1.24	0.04
distant	poss	SM	4	4.58	1.12	0.04	5	4.66	1.11	0.04

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Table 5. Output of the models using the social background measures as dependent variable. The symbol '⋆' indicates significant results

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Socio-economic status	NUMBER (N)	–0.08	0.04	–1.79	3.19	0.07
	FORCE (F)	–0.03	0.04	–0.74	0.54	0.46
	CONTEXT (C)	–0.04	0.04	–0.94	0.87	0.35
	N×F	0.08	0.06	1.34	1.78	0.18
	N×C	–0.09	0.05	–1.87	3.51	0.06
	F×C	–0.06	0.05	–1.15	1.33	0.25
	N×F×C	0.01	0.10	0.05	0.01	0.92
Education level	NUMBER (N)	–0.14	0.05	–2.86	8.16	0.004⋆
	FORCE(F)	0.02	0.04	0.61	0.43	0.51
	CONTEXT (C)	–0.08	0.03	–2.43	6.07	0.01⋆
	N×F	0.12	0.08	1.50	2.19	0.14
	N×C	–0.13	0.07	–1.86	3.42	0.07
	F×C	–0.03	0.07	–0.44	0.16	0.69
	N×F×C	–0.21	0.11	–1.90	3.62	0.06

For the sub-analyses, the necessity-model was fit using the logit and the possibility model using the loglog link function, both used NUMBER and CONTEXT slopes for subject intercepts, along with item intercepts. The results revealed that in only the necessity conditions, MC was rated as more formal than SM (**RQ2.3**, $\hat{\beta} = 0.60$, $\chi^2(1) = 31.51$, $p < 0.0001$). Both models showed significant CONTEXT effects in that close conditions were rated higher than distant ones (**RQ2.4**, necessity: $\hat{\beta} = 0.66$, $\chi^2(1) = 40.15$, $p < 0.0001$; **RQ2.5**, possibility: $\hat{\beta} = 0.42$, $\chi^2(1) = 46.81$, $p < 0.0001$). No further interaction effect turned out significant.

For the **politeness** ratings, the loglog link model that included only random intercepts for subjects fit the data best. The results showed a significant two-way interaction NUMBER×FORCE (**RQ2.6**, $\hat{\beta} = 0.18$, $\chi^2(1) = 9.73$, $p = 0.002$). No other interaction effect turned out significant.

For the sub-analyses, the necessity-model was fit using the loglog link function and only subject intercepts, while the possibility-model used the logit link function along with intercepts for subjects and slopes for NUMBER, as well as item intercepts. The results for both models revealed no significant results.

For the **confidence** ratings, the logit link model that included random intercepts for subjects with slopes for NUMBER, FORCE and CONTEXT, as well as intercepts for item with slopes for FORCE and CONTEXT fit the data best. The results showed a significant two-way interaction NUMBER×FORCE ($\hat{\beta} = 0.58$, $\chi^2(1) = 130.88$, $p < 0.0001$). No other interaction turned out significant.

The necessity-model was fit using the cloglog link function together with NUMBER slopes for subject intercepts, and item intercepts. The possibility-model used the loglog link

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Table 6. Descriptive statistics (n = 918) of the persona ratings. Nece abbreviates *necessity* and poss *possibility* conditions

			Formality				Politeness			
Context	Force	Number	median	mean	SD	SE	median	mean	SD	SE
close	nece	MC	5	4.47	1.72	0.06	5	5.31	1.11	0.04
close	nece	SM	4	4.06	1.68	0.06	5	5.27	1.09	0.04
close	poss	MC	4	4.20	1.74	0.06	5	5.30	1.09	0.04
close	poss	SM	4	4.17	1.65	0.05	5	5.33	1.10	0.04
distant	nece	MC	5	4.85	1.59	0.05	5	5.27	1.14	0.04
distant	nece	SM	5	4.54	1.51	0.05	5	5.24	1.12	0.04
distant	poss	MC	5	4.64	1.55	0.05	5	5.30	1.12	0.04
distant	poss	SM	5	4.69	1.54	0.05	5	5.38	1.09	0.04
			Confidence				**Friendliness**			
close	nece	MC	5	5.28	1.39	0.05	5	4.98	1.15	0.04
close	nece	SM	5	5.06	1.37	0.05	5	5.14	1.11	0.04
close	poss	MC	4	4.21	1.53	0.05	5	5.05	1.08	0.04
close	poss	SM	5	4.50	1.41	0.05	5	5.19	1.12	0.04
distant	nece	MC	5	5.24	1.38	0.05	5	4.85	1.14	0.04
distant	nece	SM	5	4.98	1.40	0.05	5	4.98	1.11	0.04
distant	poss	MC	4	4.08	1.57	0.05	5	4.99	1.08	0.04
distant	poss	SM	5	4.40	1.46	0.05	5	5.06	1.09	0.04
			Warmth				**Coolness**			
close	nece	MC	5	4.74	1.19	0.04	4	4.30	1.34	0.04
close	nece	SM	5	4.91	1.16	0.04	4	4.55	1.22	0.04
close	poss	MC	5	4.85	1.12	0.04	4	4.43	1.28	0.04
close	poss	SM	5	4.94	1.14	0.04	4	4.50	1.26	0.04
distant	nece	MC	4	4.65	1.19	0.04	4	4.28	1.30	0.04
distant	nece	SM	5	4.81	1.14	0.04	4	4.49	1.24	0.04
distant	poss	MC	5	4.79	1.13	0.04	4	4.33	1.26	0.04
distant	poss	SM	5	4.85	1.16	0.04	4	4.51	1.25	0.04
			Rebelliousness							
close	nece	MC	4	3.50	1.24	0.04				
close	nece	SM	4	3.55	1.24	0.04				

(*Continued*)

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Table 6. *Continued*

				Rebelliousness		
close	poss	MC	4	3.51	1.21	0.04
close	poss	SM	4	3.47	1.24	0.04
distant	nece	MC	4	3.47	1.31	0.04
distant	nece	SM	4	3.46	1.25	0.04
distant	poss	MC	4	3.44	1.25	0.04
distant	poss	SM	4	3.41	1.30	0.04

Table 7. Output of the models using the first part of the persona measures as dependent variable. The symbol '★' indicates significant results

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Formality	NUMBER (N)	0.30	0.08	3.67	13.15	<0.0003
	FORCE(F)	0.09	0.05	1.62	2.61	0.11
	CONTEXT (C)	0.78	0.10	7.93	58.23	<0.0001
	N×F	0.58	0.10	5.56	29.77	<0.0001★
	N×C	–0.15	0.09	–1.80	3.25	0.07
	F×C	–0.10	0.09	–1.21	1.47	0.23
	N×F×C	0.01	0.17	0.08	0.01	0.93
Sub-analyses:						
necessity	NUMBER (N)	0.60	0.11	5.73	31.51	<0.0001★
	CONTEXT (C)	0.66	0.10	6.47	40.15	<0.0001★
	N×C	–0.13	0.12	–1.07	1.15	0.28
possibility	NUMBER (N)	–0.01	0.06	–0.10	0.01	0.92
	CONTEXT (C)	0.42	0.06	7.01	46.81	<0.0001★
	N×C	–0.03	0.08	–0.35	0.12	0.72
Politeness	NUMBER (N)	–0.01	0.03	–0.39	0.16	0.69
	FORCE(F)	–0.07	0.03	–2.52	6.36	0.01
	CONTEXT (C)	0.02	0.03	0.82	0.67	0.42
	N×F	0.18	0.06	3.12	9.73	0.002★
	N×C	0.03	0.06	0.55	0.30	0.58

(*Continued*)

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Table 7. *Continued*

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
	F×C	–0.11	0.06	–1.91	3.65	0.06
	N×F×C	0.03	0.11	0.27	0.07	0.79
Sub-analyses:						
necessity	NUMBER (N)	0.05	0.04	1.27	1.62	0.20
	CONTEXT (C)	–0.02	0.04	–0.43	0.18	0.67
	N×C	0.02	0.08	0.25	0.06	0.80
possibility	NUMBER (N)	–0.13	0.07	–1.78	3.14	0.08
	CONTEXT (C)	0.10	0.07	1.59	2.53	0.11
	N×C	–0.17	0.13	–1.29	1.67	0.20
Confidence	NUMBER (N)	–0.02	0.05	–0.29	0.09	0.77
	FORCE(F)	1.59	0.14	11.71	62.42	<0.0001
	CONTEXT (C)	–0.17	0.07	–2.58	5.85	0.02
	N×F	1.00	0.09	11.39	130.88	<0.0001★
	N×C	–0.01	0.09	–0.03	0.01	0.98
	F×C	0.07	0.09	0.75	0.56	0.45
	N×F×C	0.18	0.17	1.05	1.11	0.29
Sub-analyses:						
necessity	NUMBER (N)	0.35	0.06	5.72	32.01	<0.0001★
	CONTEXT (C)	–0.08	0.04	–1.90	3.61	0.06
	N×C	0.03	0.08	0.41	0.17	0.68
possibility	NUMBER (N)	–0.34	0.05	–6.49	39.52	<0.0001★
	CONTEXT (C)	–0.11	0.06	–1.88	3.28	0.07
	N×C	–0.04	0.08	–0.49	0.24	0.62

function, NUMBER slopes for subject and CONTEXT slopes for item intercepts. The results showed a cross-over effect in that MC was rated more confident than SM in necessity conditions (**RQ2.7**, $\hat{\beta} = 0.35$, $\chi^2(1) = 32.01$, $p < 0.0001$) and the reverse pattern occurred for possibility conditions (**RQ2.8**, $\hat{\beta} = -0.34$, $\chi^2(1) = 39.52$, $p < 0.0001$). No further effect turned out significant.

For the **friendliness** ratings, the logit link model that included random intercepts for subjects with slopes for NUMBER and CONTEXT as well as random intercepts for items provided the best fit to the data. The result showed a significant main effect of NUMBER in that MC was rated as less friendly than SM (**RQ2.9**, $\hat{\beta} = -0.17$, $\chi^2(1) = 26.21$, $p < 0.0001$). The main effect of FORCE turned out significant in that necessity conditions were rated as less

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Table 8. Output of the models using the second part of the persona measures as dependent variable. The symbol '★' indicates significant results

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Friendliness	NUMBER	–0.17	0.03	–5.24	26.21	<0.0001★
	FORCE	–0.12	0.03	–4.70	22.09	<0.0001★
	CONTEXT	–0.19	0.03	–6.61	41.29	<0.0001★
	NUMBER×FORCE	–0.05	0.05	–1.03	1.07	0.30
	NUMBER×CONTEXT	0.07	0.05	1.44	2.08	0.15
	FORCE×CONTEXT	–0.06	0.05	–1.24	1.53	0.22
	3-way interaction	–0.04	0.10	–0.41	0.17	0.68
Warmth	NUMBER	–0.18	0.03	–6.59	43.53	<0.0001★
	FORCE	–0.07	0.03	–2.68	7.19	0.007★
	CONTEXT	–0.11	0.03	–4.10	16.81	<0.0001★
	NUMBER×FORCE	–0.09	0.06	–1.58	2.49	0.12
	NUMBER×CONTEXT	0.07	0.06	1.29	1.67	0.20
	FORCE×CONTEXT	–0.05	0.06	–0.96	0.92	0.34
	3-way interaction	–0.03	0.11	–0.29	0.09	0.77
Coolness	NUMBER	–0.22	0.03	–8.09	65.57	<0.0001
	FORCE	–0.06	0.03	–2.04	4.17	0.04
	CONTEXT	–0.06	0.03	–2.27	5.16	0.02
	NUMBER×FORCE	–0.10	0.05	–1.94	3.76	0.05★
	NUMBER×CONTEXT	–0.06	0.05	–1.14	1.29	0.26
	FORCE×CONTEXT	0.03	0.05	0.53	0.28	0.60
	3-way interaction	0.12	0.11	1.12	1.26	0.26
Sub-analyses:						
necessity	NUMBER (N)	–0.25	0.04	–7.05	49.74	<0.0001★
	CONTEXT (C)	–0.06	0.04	–1.63	2.66	0.10
	N×C	0.04	0.07	0.57	0.33	0.57
possibility	NUMBER (N)	–0.15	0.04	–3.54	12.26	0.0005★
	CONTEXT (C)	–0.05	0.04	–1.52	2.30	0.13
	N×C	–0.12	0.07	–1.73	2.98	0.08

(*Continued*)

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Table 8. *Continued*

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Rebelliousness	NUMBER	0.01	0.04	0.18	0.03	0.86
	FORCE	0.08	0.04	1.77	3.13	0.08
	CONTEXT	–0.17	0.04	–3.76	14.15	0.0002⋆
	NUMBER×FORCE	–0.15	0.09	–1.69	2.87	0.09
	NUMBER×CONTEXT	0.08	0.09	0.94	0.89	0.35
	FORCE×CONTEXT	0.05	0.09	0.61	0.37	0.54
	3-way interaction	0.10	0.18	0.56	0.32	0.57

friendly than possibility conditions (**RQ2.10**, $\hat{\beta}$ = -0.12, $\chi^2(1)$ = 22.09, p < 0.0001). There was a significant main effect of CONTEXT in that distant conditions were rated as less friendly than close ones (**RQ2.11**, $\hat{\beta}$ = -0.19, $\chi^2(1)$ = 41.29, p < 0.0001). No interaction turned out significant.

For the **warmth** ratings, the loglog link model that included only subject intercepts fit the data best. The results showed a significant main effect of NUMBER in that MC was rated as less warm than SM (**RQ2.12**, $\hat{\beta}$ = -0.18, $\chi^2(1)$ = 43.53, p < 0.0001). The main effect FORCE turned out significant in that necessity conditions were rated as less warm than possibility conditions (**RQ2.13**, $\hat{\beta}$ = -0.07, $\chi^2(1)$ = 7.19, p = 0.007). There was a significant main effect of CONTEXT in that distant conditions were rated as less warm than close ones (**RQ2.14**, $\hat{\beta}$ = -0.11, $\chi^2(1)$ = 16.81, p < 0.0001). None of the interactions turned out significant.

For the **coolness** ratings, the loglog link model including only subject fit the data best. The results showed a significant two-way interaction NUMBER×FORCE ($\hat{\beta}$ = -0.10, $\chi^2(1)$ = 3.76, p = 0.05). No other interaction turned out significant.

For the sub-analyses, the necessity-model was fit with only subject intercepts and the possibility-model with item intercepts and NUMBER slopes for subject intercepts. Both models used the probit link function. The results showed that in both necessity (**RQ2.15**, $\hat{\beta}$ = -0.25, $\chi^2(1)$ = 49.74, p < 0.0001) and possibility (**RQ2.16**, $\hat{\beta}$ = -0.15, $\chi^2(1)$ = 12.26, p = 0.0005) conditions, NUMBER turned out significant in that MC was rated less cool than SM. No other effect of interaction turned out significant

For the **rebelliousness** ratings, the logit link model that included intercepts for subjects and items provided the best fit to the data. The results showed a significant main effect of CONTEXT in that distant conditions were rated as less rebellious than close ones (**R.Q2.17**, $\hat{\beta}$ = -0.17, $\chi^2(1)$ = 14.15, p = 0.0002). No other main or interaction effect turned out significant.

3.3.3. Grammaticality

For the grammaticality ratings, the descriptive statistics are shown in table 9 and the output of the related model is shown in table 10.

For the **grammaticality** ratings, the probit link model that included random intercepts for subjects with slopes for NUMBER, FORCE and their two-way interaction (NUMBER×FORCE), as well as intercepts for items with slopes for NUMBER and FORCE fit the data best. The results showed a significant main effect of NUMBER in that MC was rated as less grammatical than SM conditions (**RQ3.1**, $\hat{\beta}$ = -1.49, $\chi^2(1)$ = 90.44, p < 0.0001). No other main effect or interaction turned out significant.

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Table 9. Descriptive statistics (n = 918) of the grammaticality and appropriateness ratings. Nece abbreviates *necessity* and poss *possibility* conditions

			Grammaticality				Appropriateness			
Context	Force	Number	median	mean	SD	SE	median	mean	SD	SE
close	nece	MC	5	4.89	1.98	0.07	6	5.30	1.57	0.05
close	nece	SM	7	6.25	1.20	0.04	6	6.03	1.15	0.04
close	poss	MC	6	5.10	1.85	0.06	6	5.42	1.44	0.05
close	poss	SM	7	6.29	1.15	0.04	6	5.99	1.17	0.04
distant	nece	MC	5	4.83	2.03	0.07	6	5.26	1.61	0.05
distant	nece	SM	7	6.25	1.17	0.04	6	5.94	1.26	0.04
distant	poss	MC	6	4.98	1.91	0.06	6	5.30	1.51	0.05
distant	poss	SM	7	6.24	1.22	0.04	6	5.89	1.28	0.04

Table 10. Output of the models using the grammaticality measure as dependent variable. The symbol '⋆' indicates significant results

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Grammaticality	NUMBER (N)	−1.49	0.10	−15.20	90.43	<0.0001⋆
	FORCE (F)	−0.07	0.07	−1.10	1.18	0.28
	CONTEXT (C)	−0.05	0.03	−1.87	3.50	0.06
	N×F	−0.08	0.09	−0.90	0.80	0.37
	N×C	−0.03	0.06	−0.53	0.29	0.59
	F×C	0.05	0.06	0.83	0.69	0.41
	N×F×C	−0.03	0.11	−0.22	0.05	0.83

3.3.4. Register sensitivity: Appropriateness

For the appropriateness ratings, the descriptive statistics are shown in table 9 and the output of the related models is shown in table 11.

For the **appropriateness** ratings, the probit link model that included random intercepts for subjects with slopes for NUMBER, FORCE and the two-way interactions NUMBER×FORCE and NUMBER×CONTEXT, along with intercepts for items with slopes for FORCE fit the data best. The results showed a significant NUMBER×FORCE interaction ($\hat{\beta}$ = -0.13, $\chi^2(1) = 3.95$, $p < 0.05$). No other interactions were significant.

For the sub-analyses, the necessity-model fit best using the probit link function and NUMBER and the two-way interaction NUMBER×CONTEXT as slopes for subject, and NUMBER and CONTEXT slopes for item intercepts. The possibility-model used the probit link function with NUMBER slopes for subject intercepts, along with item intercepts. The results

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Table 11. Output of the models using the appropriateness measure as dependent variable. The symbol '⋆' indicates significant results. Nece abbreviates *necessity* and poss *possibility* conditions

		Fixed effects			Model comparison	
	Estimates	$\hat{\beta}$	SE	z-value	$\chi^2(1)$	p-value
Appropriateness	NUMBER (N)	–0.72	0.06	–12.09	120.17	<0.0001
	FORCE (F)	0.01	0.05	0.22	0.05	0.82
	CONTEXT (C)	–0.09	0.03	–3.36	11.30	<0.0008
	N×F	–0.13	0.06	–1.99	3.95	<0.05⋆
	N×C	–0.01	0.06	–0.22	0.05	0.82
	F×C	0.05	0.05	0.99	0.99	0.32
	N×F×C	0.07	0.11	0.66	0.46	0.50
Sub-analyses:						
necessity	NUMBER (N)	–0.79	0.08	–10.46	56.26	<0.0001⋆
	CONTEXT (C)	–0.06	0.06	–1.12	1.22	0.27
	N×C	0.01	0.08	0.15	0.02	0.88
possibility	NUMBER (N)	–0.67	0.07	–9.84	85.38	<0.0001⋆
	CONTEXT (C)	–0.12	0.04	–3.15	9.91	<0.002⋆
	N×C	–0.02	0.07	–0.26	0.07	0.80

showed that in both necessity (**RQ4.1**, $\hat{\beta}$ = -0.79, $\chi^2(1) = 56.26$, $p < 0.0001$) and possibility (**RQ4.2**, $\hat{\beta}$ = -0.67, $\chi^2(1) = 85.38$, $p < 0.0001$) conditions, MC was rated as less appropriate than SM, indicating a general NUMBER difference. Furthermore, there was CONTEXT effect in the possibility subset in that distant conditions received lower ratings than distant conditions (**RQ4.3**, $\hat{\beta}$ = -0.12, $\chi^2(1) = 9.91$, $p < 0.002$). No other interaction effect turned out significant.

4. Discussion

The current study takes a first step to MC from a register approach by exploring the linguistic and social meaning of modal concord in US English. We extended a previously published design – Experiment 1 investigating the social meaning of MC and SM without situational contexts (Liu & Rotter 2025) – using interlocutor relation to address the following research questions: in section 4.1, (**RQ1-linguistic meaning**) What is the interpretation of MC constructions? In section 4.2, (**RQ2-social meaning**) What is the perceived social meaning of MC constructions in? In section 4.3, (**RQ3-grammaticality**) How are MC constructions perceived in terms of grammaticality? Lastly, in section 4.4, (**RQ4-register sensitivity**) Are MC constructions sensitive to the register, i.e. situational contexts?

The results of the current study (Experiment 2) are summarized in table 12, which we discuss in the following sections comparing them with the results from Experiment 1.

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Table 12. Summary of the results from Experiment 2. The abbreviation 'p' stands for *possibility* and for 'n' *necessity* conditions. MC abbreviates *modal concord* and SM *single modal*. The symbol ⋆ indicates the significance of an interaction effect, – marks the lack of a significant effect, the two-way N×C, F×C and three-way interactions showed no significant results. Replicated results from Experiment 1 are in bold font

	NUMBER	FORCE	CONTEXT		NUMBER×FORCE	
					necessity	possibility
Sp. comm.				⋆	**SM > SM**	**MC < SM**
SES	–	–	–		**–**	
Education	MC < SM	–	distant < close		–	
Formality				⋆	**SM > SM**	–
					distant > close	distant > close
Politeness				⋆	–	–
Confidence				⋆	**SM > SM**	**MC < SM**
Friendliness	**MC < SM**	**n < p**	distant < close		–	
Warmth	**MC < SM**	**n < p**	distant < close		–	
Coolness				⋆	MC < SM	MC < SM
Rebel.	–	–	distant < close		–	
Gramm.	**MC < SM**	–	–		–	
Appr.				⋆	MC < SM	MC < SM
					–	distant < close

4.1. Linguistic meaning (RQ1)

To access the linguistic meaning of MC and SM relating to (**RQ1**), we used the speaker commitment as measure (Liu *et al.* 2021). We found evidence that MC strengthens the statement in necessity (*must certainly*, **RQ1.1**) and a weakening effect in possibility conditions (*may possibly*) in comparison to their SM alternatives (**RQ1.2**). This is a replication of the finding from Experiment 1 and further supports (H1: MC_{nece} > SM_{nece}; MC_{poss} < SM_{poss}) – co-occurrences of modal adverb and verb in the same flavor do not have a concord interpretation.

Whereas the strengthening effect was predicted by Giannakidou & Mari's (2018) 'modal spread' analysis, the weakening effect in *may possibly* was not predicted by either analysis. Going back to the assumptions we made in (3), that (ii) the modal verbs *may* and *might* in epistemic readings, and (iii) the modal adverbs *possibly* and *maybe* are similar, we provide some tentative answers for the finding: it is possible that *may* and *might* in epistemic readings differ in terms of speaker commitment. This is not implausible as *may* can be coerced to have a stronger reading, e.g. when the speaker uses it to convey a necessity (e.g. *This may happen*) or obligation (e.g. *You may leave now*). It is also possible that the modal adverbs *possibly* and *maybe* also differ in terms of speaker commitment. Both are empirical questions that we cannot answer with the current study but will leave for future experimentation.

The current study did not test the speaker commitment of SM involving a single adverb (*possibly*/*certainly*), which may differ from that of the modal verbs. This also needs to be further addressed in future studies.

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4.2. Social meaning (RQ2)

Relating to (**R2**) and the social meaning of MC and SM, we found mostly converging evidence in line with those of Experiment 1. The most differences compared to Experiment 1 were revealed in the speaker's social background: there was no replication of modal use effects in socio-economic status, i.e. *must certainly/may possibly* vs. *must/may*, or interactions. In Experiment 1, there was a force difference and the association with higher socio-economic status in SM *may* in comparison to MC *may possibly* use, which we attribute to the weakening effect influencing the social perception of the speaker. In the education measures, we found MC to be associated with lower levels than SM in Experiment 2 (**RQ2.1**). This finding is different from the Experiment 1, where there were only differences between possibility and necessity condition. These differences between the studies can be due to the inclusion of the context and show the influence of social hierarchy on the judgments, i.e. the influence of situational functional parameters.

Relating to the persona measures, we found that MC conditions were rated as less friendly (**RQ2.9**), warm (**RQ2.12**) and cool (**RQ2.15/16**) than SM conditions, which replicated results of Experiment 1 and confirm (H2: MC < SM). Moreover, relating to the differences between MC vs. SM in necessity and possibility conditions, we found some replications: formality (**RQ2.3**) and confidence (**RQ2.7**) were stronger for necessity MCs (*must certainly*) compared to SM (*must*) along with the opposite effect (**RQ2.8**) where confidence was weaker for possibility MCs (*may possibly*) compared to SM (*may*). In addition, there were some general differences between necessity and possibility conditions: compared to possibility, necessity conditions were rated as less friendly (**RQ2.10**) and warm (**RQ2.13**), which also mirrors results from Experiment 1. Lastly, as in experiment 1, we did not find differences between MC vs. SM in necessity or possibility conditions in terms of politeness (**RQ2.6**). These replications may hint at how the context did not further enrich the social meanings. In Experiment 1, no concrete situational context was given, however, participants might have contextualized the statements while rating. In the current experiment, the concrete situational parameter may have not been one that impacts the doubling of modal verb and adverb – indicated by many replications of results. New results were found in both necessity and possibility conditions: MC was rated as less cool than SM (**RQ2.15/16**). The main effects in socio-economic status and education, and formality from Experiment 1 were missing in Experiment 2. These findings may be influenced by how interlocutor relationships interact with the semantics of the modal expressions. As shown by Glass (2015) for universal force modals, subtle semantic distinctions can give rise to social meanings, particularly depending on whether the speaker is perceived as having authority or access to the relevant domain of knowledge. The details have to be further addressed in future experimental work.

4.3. Grammaticality (RQ3)

Relating to the grammaticality judgments, we found that MC was overall perceived as less grammatical than SM (**RQ3.1**), which replicates the finding from Experiment 1 and confirms (H3: MC < SM). However, for all eight conditions, the mean ratings were above 4.8 with medians above 5, in this set-up 4 marks *undecided* and the shift from ungrammatical to grammatical. Moreover, the visual inspection of figure 3 shows that the participants' means are scattered across the entire scale for both necessity (*must certainly*) and possibility (*may possibility*) MC, while both SM conditions (*must/may*) received rather uniform ratings mostly above the value 5. Thus, participants were less certain about the grammaticality of MC than SM with great intra-individual variation.

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4.4 Register sensitivity (RQ4) and influence of the context

Relating to (**RQ4**), we found the following evidence: MC shows lower appropriateness ratings than SM in both modal force conditions (**RQ4.1/2**), providing evidence for (H4: MC < SM).

Crucially, both MC constructions were rated as less grammatical (**RQ3.1**) and appropriate (**RQ4.1/RQ4.2**). Necessity MC (*must certainly*) was perceived as more formal (**RQ2.3**) and confident (**RQ2.7**) than (*must*), while possibility MC (*may possibly*) received no formality difference but its use indicated lower confidence levels than SM (*may*) (**RQ2.8**). Moreover, figure 3 shows that the appropriateness ratings of both necessity (*must certainly*) and possibility (*may possibly*) MC are more scattered across the plot than SM constructions, but that they are more focused on values above 4 – more so than the grammaticality judgments, which is even more spread out. This represents an interesting mismatch: alternatives can be perceived as rather appropriate but as not entirely grammatical and English speakers have different intuitions about the degrees. This indicates that the measures we used are distinct but inter-related concepts and that crucially, necessity and possibility MC constructions have distinct situational-functional requirements and effects.

Lastly, in terms of the influence of the situational context, which was a major extension to the design of Experiment 2, justifying a register approach. We only found main effects but no interactions, thus, (H5: two-way interaction CONTEXT×NUMBER) has to be rejected. Distant conditions are rated as more formal (**RQ2.4/5**), but lower in educational level (**RQ2.2**), less friendly (**RQ2.11**), warm (**RQ2.14**) and rebellious (**RQ2.17**). In addition, we found lower appropriateness ratings for distant than for close conditions but only for possibility modal verbs and adverbs (**RQ4.3**). While especially the formality differences show that the context manipulation was perceived by the participants, the results may show expectations of language behavior in the social space, e.g. when someone talks to their *boss*, they are less warm and more formal than when they talk to their *sister.* But also that less certain statements like those with possibility modals are disfavored in specific social spaces. Additionally, the topic of the sentences – as another situational-functional parameter – could have also an influence on these ratings. All of the critical items were first person singular statements about everyday events, which might be less suitable in situations involving distant social relations.

Overall, these effects of the context indicate that participants were sensitive to the manipulation we introduced, namely, interlocutor relationship. However, this specific situational parameter may not be a primary factor influencing the perception of modal verbs, adverbs and their co-occurrences. Since registers are multi-dimensional, the influence of specific situational factors and interrelated communicative requirements must be considered. Future research should therefore consider additional parameters to gain a more comprehensive understanding of registers in general, as well as the use and co-occurrence of modal verbs and adverbs.

5. Conclusion

The research presented in this article illustrates a register approach to the interpretation and social meaning of a doubling phenomenon – modal concord (MC) – in American English. Our results support that necessity MC increased the speaker commitment ratings, but possibility MC did the opposite, suggesting asymmetries not fully captured by existing theories. While MC was rated as less grammatical and appropriate than the single modal constructions (SM), it was perceived as less friendly, warm and cool – yet also more formal in necessity conditions. These results largely replicate those from our previous study without context manipulation (Liu & Rotter 2025), while the current experiment revealed limited interaction with context, suggesting that the chosen situational parameter –

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interlocutor relation – does not impact the perception on modal verbs, adverbs and their co-occurrences. What remains clear is that MC has distinct linguistic and social meanings from that of SM, but the concrete situational-functional parameters driving this variation remain uncertain.

Notably, while MC is not typically marked as a dialectal feature, yet our constructions *may possibly* and *must certainly* are still perceived as less grammatical and appropriate than their single modal alternatives *may* and *must.* Given the overall – rather high – ratings for the tested constructions (see table 9), we attribute these to distributional differences, that is, the lower frequency of MC than SM. Crucially, necessity MC is also rated as more formal than SM, setting it apart from the doubling phenomena negative concord and double comparatives (cf. Rotter & Liu 2024, 2025; Alexiadou *et al.* 2025). Moreover, similar to findings on negative concord (Rotter & Liu 2025), our results indicate that the interpretation of concord constructions differs from that of their single element alternatives, challenging the core assumption of semantic equivalence underlying the concord analysis. This contrast highlights a unique perceptual profile for MC and underscores how doubling and concord constructions more broadly offer rich ground for investigating register and social meaning.

Before concluding, we briefly address the study's limitations. First, we did not compare modal adverbs in isolation with MC or modal verb constructions – an important next step for clarifying their respective semantic contributions. Additionally, future research should examine a broader range of modal verb–adverb combinations to capture the full scope of variability and interpretation (see, e.g., Glass 2015). Second, context was manipulated solely via interlocutor relation, oversimplifying the multidimensional nature of conversations. Future work should incorporate more contextual parameters. Additionally, while we included several social meaning measures, only some (e.g. formality, confidence) were strongly theory-driven, highlighting the need for more principled selection. Despite these limitations, our study offers a first step toward exploring MC as a doubling phenomenon and as a case of modality from a register perspective, with implications for both semantic theory and experimental methodology.

Data repository. The data sets for this study can be found in the online repository: https://osf.io/v6sjt/

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