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(Im)precise personae: The effect of socio-indexical information on semantic interpretation

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ABSTRACT

In this article, we address the following question: how do comprehenders reason about the *persona* embodied by the speaker to determine the referential meaning of numerical expressions such as 'The price is $200'? Using a picture selection task, we show that descriptions uttered by speakers embodying a Nerdy persona, indexically associated with highly precise speech, are interpreted more precisely than those uttered by speakers embodying a Chill persona, indexically associated with imprecise speech. These findings contribute to building a more integrative perspective between the socio-indexical and the referential domain of signification, highlighting comprehenders' social perception of the speaker as a crucial element informing pragmatic reasoning, and meaning interpretation more broadly. (Social meaning, personae, pragmatic reasoning, precision, numerals)*

INTRODUCTION

The notion of 'socio-indexical meaning' refers to the constellation of inferences that can be drawn about speakers based on how they talk; as shown by extensive work across sociolinguistics and linguistic anthropology, this category represents a fundamental semiotic resource for humans to interpret, reflect, and re-shape the social world they live in (Ochs 1992; Irvine 2001; Silverstein 2003; Agha 2005; Zhang 2005; Campbell-Kibler 2007; Eckert 2008; Podesva 2011; King 2021; see Hall-Lew, Moore, & Podesva 2021 for a recent overview). In recent years, a growing body of experimental research has expanded our understanding of how socio-indexical meaning shapes human communication, highlighting its intimate connection with the cognitive mechanisms behind language processing and understanding. In particular, work across different domains of speech perception and production—for example, sound categorization and recognition, convergence, imitation—illuminated how comprehenders promptly utilize information about different properties of speakers when navigating these processes—ranging from demographic categories such as speakers' location of origin, gender, or race (Strand 1999; Niedzielski 1999; Hay, Warren, & Drager 2006; Staum Casasanto

2008; Hay 2009; M. Babel 2012; Sumner, Kim, King, & McGowan 2014; Drager 2015; Wade 2020) to more idiosyncratic, specific 'types' of person, or *personae*, that these speakers project.[1] For instance, listeners primed with social types such as 'Valley Girl' and 'Business Professional' displayed a markedly backed perception of the boundary between the vowel in words like TRAP and LOT (D'Onofrio 2018), suggesting that listeners recruit knowledge about the distinctive speech style of these personae to carve out categorical distinctions along the vowel space continuum (see also D'Onofrio 2015). Significant effects of persona have also been unveiled in connection with other aspects of speech processing, including other cases of sound categorization (D'Onofrio 2015), assessments of 'foreign accented' speech (D'Onofrio 2019), and syntactic processing (Choe, Sloggett, Yoshida, & D'Onofrio 2019; see D'Onofrio 2020 for an overview). Taken together, these findings highlight socio-indexical meanings as a crucial resource that interlocutors extensively rely on when processing language—one that informs not only the unfolding of linguistic interaction, but also the cognitive mechanisms behind language processing—especially at the phonetic and morphological level.

These insights, at the same time, raise an important question: how does socio-indexical meaning aid language understanding when it comes to the semantic interpretation of linguistic utterances? As discussed above, while considerable progress has been made in understanding the role of socio-indexical associations in the perception and production of sounds, much less is known about how comprehenders rely on this information to decipher the message conveyed by an utterance, and ultimately assign it an interpretation. We believe that tackling this question is motivated by two important points.

First, it is well known that meaning interpretation does not boil down to a passive decoding of a sentence's literal meaning; rather, it is a dynamic enterprise in which conversational participants compute the message conveyed by an utterance by drawing inferences on the basis of contextual information (see Searle 1969; Grice 1975; Horn 1984; Sperber & Wilson 1995; Levinson 2000). For instance, interlocutors across conversational contexts have been shown to systematically take quantifiers such as 'some' as having an upper-bounded interpretation (i.e. as meaning 'some, but not all')—an inference generated by the general assumption that the speaker, by obeying the Quantity Maxim, would have used a stronger term like 'all' if they had been in the position of doing so truthfully (see Grice 1975; Horn 1984; Levinson 2000 among many others; see Gumperz 1982 for a perspective on conversational inferences from the view of interactional sociolinguistics). The key role of pragmatic reasoning, in turn, highlights meaning interpretation as a complex, highly situation-dependent process: one that comprehenders can successfully navigate only by paying attention to a variety of contextual cues available in the speech setting, and which is therefore amenable to being affected by the distinctive social characteristics of speakers. Yet, to date, much remains to be seen with regard to how this happens. In fact, even though most pragmatic theories do frame linguistic communication as an inherently social activity (see in particular

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Grice 1975; Sperber & Wilson 1997; and Goodman & Stuhlmuller 2013 for a more recent revisitation), the role of socio-indexical information in the computation of pragmatic inferences remains largely unexplored. In particular, work within these traditions notably focused on unveiling the universal conversational principles that underlie communicative exchanges, and how comprehenders uniformly reason about them, leaving axes of social differentiation between speakers in the background of the study of the contextual factors shaping meaning interpretation. This is illustrated by the fact that, in Gricean and neo-Gricean frameworks, meaning-related inferences are often framed as CALCULABLE—that is, amenable to being reconstructed in similar ways by different interlocutors, regardless of who they are, once other general contextual factors are kept constant. The upshot is that the role of interlocutors' identity remains rather under-theorized in the investigation of pragmatic inferences. Filling this gap, in turn, will put us in the position to develop a more complete understanding of processes of meaning making and interpretation—as well as the role of social information in linguistic cognition more broadly.

Second, a growing line of work across sociolinguistics and pragmatics has highlighted how social meanings can be inferred on the basis of the semantic and pragmatic properties of linguistic forms, unveiling a principled connection between the socio-indexical and the referential dimensions of meaning. In a paradigmatic study, Acton & Potts (2014) argue that the social meaning of solidarity and reciprocal affiliation conveyed by demonstratives 'this' and 'that' can be derived from the core semantics of these expressions—specifically, the presumption that the addressee can access the referent of the embedded noun phrase by considering the speaker's relation to entities in the discourse context—which distinguish them from competing expressions like 'the' or bare plurals. Similar inferential patterns from the semantic to the social plane have been unveiled for many other phenomena, including regular determiners (Acton 2019; Hunt & Acton 2022), intensifiers (Beltrama & Staum Casasanto 2017, 2021), modals (Glass 2015), and types of speech acts (Jeong 2021; see Beltrama 2020 for an overview). A crucial contribution of this work has been to show that social meanings, when conveyed by expressions above the sound level, can be grounded in, and shaped by, these expressions' semantic and pragmatic properties.[2] As a result, these findings further motivate the enterprise of investigating how the relation between the social and referential planes of signification works from the reverse perspective: that is, how socio-indexical information, besides being inferred from semantic and pragmatic properties, conversely shapes comprehenders' interpretation of descriptive content.

The emerging picture is one in which much remains to be seen in the interplay between two key elements of the meaning making process: the wealth of socio-indexical information contextually available to interlocutors; and the reasoning dynamics whereby comprehenders assign an interpretation to linguistic utterances. Accordingly, we see the endeavor of bridging this gap as a crucial step towards developing a truly comprehensive approach to the study of meaning making and interpretation—one that allows us to illuminate how interlocutors triangulate between

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the socio-indexical, semantic, and pragmatic levels to signal and interpret legible content (Gumperz 1982; Ochs 1992), and to situate the study of socio-indexicality 'in the larger context of language as a system of meaning' (Eckert 2019:752).

In this article, we set out to explore this hypothesis through the lens of *(im)precision* in the interpretation of numerals: the phenomenon observed when interlocutors use or interpret linguistic expressions in a way that does not fully adhere to their literal meaning, but is close enough to it—for example, describing an actual price of $307 as being '$300'. We now turn to introducing this case study.

IMPRECISION: A SOCIALLY MEANINGFUL SPACE OF VARIATION

Consider the following example:

(1) The ticket costs $300.

Although prices and other quantity expressions seem to denote specific values, they are routinely used in a more liberal way: it is generally reasonable for someone to utter (1) when the actual price is $295, suggesting that comprehenders can apply some deviation from the literal truth conditions when interpreting numerals. This phenomenon, known as *imprecision* (Lewis 1979; Pinkal 1995; Lasersohn 1999 inter alia), has been extensively investigated in work in semantics and pragmatics in relation to many different linguistic expressions. These include numerals and quantity expressions, as the prototypical case (Dubois 1987; Lasersohn 1999; Sauerland & Stateva 2007; Solt 2014; Aparicio Terrasa 2017; Solt, Cummins, & Palmovic 2017), but also various other types of expressions (e.g. noun phrases: Lasersohn 1999; Syrett & Aravind 2021; gradable adjectives: Kennedy 2007; Aparicio Terrasa 2017; Beltrama 2021; modals: Klecha 2014). We suggest that (im)precision emerges as an ideal testbed to investigate the interplay between social meanings and semantic interpretation for two distinct reasons.

One is that the possibility of speaking imprecisely introduces a space of indeterminacy around the interpretation of quantity expressions, such that comprehenders have to actively reason about the conversational setting to compute their descriptive meaning: '$300', for instance, can be taken to represent different price ranges—for example, the exact price of $300; the $295–$305 interval; or the larger $290–$310 interval. Only by tracking the specifics of the communicative setting can interlocutors settle on the extent of imprecision that should be applied, and hence zero in on what facts numerical expressions can be taken to describe (see Van Der Henst, Carles, & Sperber 2002; Aparicio Terrasa 2017; Solt et al. 2017 for work investigating this reasoning process).

The second property is that variation in precision is socially meaningful. In particular, speakers using sharp numbers (e.g. 203)—normally taken to signal a high level of precision—are perceived as embodying social qualities pertaining to high status and intellectual standing—for example, being articulate, intelligent,

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educated, hard-working—as well as low solidarity and likability—for example, annoying, pedantic, obsessive, and uptight; conversely, speakers using numerals in an explicitly imprecise fashion (i.e. 'approximately 200') have been shown to be perceived as embodying opposite sets of qualities—for example, likable, laid-back, friendly—and in a way that is remarkably robust across conversational contexts (Beltrama 2018; Beltrama, Solt, & Burnett 2022). This suggests that different levels of precision are taken by comprehenders to index distinct constellations of socio-indexical information, similar to what happens with countless other examples of linguistic variation.

Taken together, these two properties of precision—its socio-indexical richness, and its semantic indeterminacy—provide an ideal testbed to illuminate how social meanings affect the ascription of descriptive meaning. More specifically: how do comprehenders reason about socio-indexical information to determine the level of precision for interpreting an expression, and thus zero in on its referent? We address this question through the lens of numerals, arguably the most prototypical domain of manifestation of (im)precision in human language. The decision to focus on this phenomenon is motivated by two independent reasons. First, even though different theoretical approaches have been proposed to model their imprecise uses in formal theories of meaning (Solt 2014), there is by-and-large consensus among scholars that numerals are indeed amenable to being used imprecisely; the same is not the case for categories such as adjectives or modals: with respect to these, some scholars have indeed argued that seemingly imprecise uses are in fact surface manifestations of other semantic phenomena such as gradability and scalarity (Burnett 2014), introducing a possible confound that could have complicated our investigation. Second, from a more practical standpoint, the interpretation of numerals lends itself to being explored experimentally in a rather straightforward way and has in fact been the subject of substantive research in the past. This provides a rich backdrop for us to draw on in the implementation our own investigation, from the conceptual design of the study to more hands-on methodological considerations.

In what follows, we undertake this endeavor by deploying a picture selection task that has been used in prior experimental studies on meaning interpretation (Huang & Snedeker 2009). Specifically, we adapt this task to tap into comprehenders' interpretation of numeral utterances produced by two distinct TYPES of speakers: one embodying the social qualities typically perceived as indexed by high precision; and one embodying those linked to a lower degree of precision. To implement this contrast, we draw on the notion of speaker *persona*—a construct especially pertinent to our goals in two respects. First, as discussed in the introduction, personae are not just powerful semiotic resources for projecting and perceiving identity; they also shape language processing across different phenomena, thus emerging as a suitable dimension of social information to test the hypothesis that imprecision-related reasoning is similarly affected by identity-level distinctions between interlocutors. Second, persona-level constructs are often described with

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widely shared and recognizable labels and properties and indexed by a wealth of both linguistic and non-linguistic signs (e.g. smoking, clothing, etc.; see Eckert 2008 for further discussion), thus lending themselves to being made salient in an experimental setting. Accordingly, previous experimental work in sociolinguistics has successfully utilized these constructs, evoking them in different ways—for example, a textual description of the persona at stake (D'Onofrio 2018); the display of objects stereotypically associated with the persona (e.g. a shopping bag: D'Onofrio 2015; brand logos: MacFarlane & Stuart-Smith 2012); or pictures of people embodying a particular persona (D'Onofrio 2019). By the same token, research in social psychology has productively utilized the evocation of stereotypes, personality traits, or values to study *social priming*—the phenomenon observed when social representations affect people's real-world judgments, beliefs, and actions across different domains of behavior (see Bargh, Chen, & Burrows 1996; Molden 2014; Higgins & Eitam 2014 inter alia for overviews). Particularly relevant to our investigation is the idea that these effects are triggered by the mere activation of the social representation of interest, without respondents being given any explicit information of the connection between this representation and the behavior of interest. Applied to our case, this means that presenting the visual illustration of a speaker embodying a particular persona should be a viable strategy to make the relevant social representation salient, and thus to explore its effects on pragmatic reasoning.

To address our question, we proceed in two steps. First, we implement (and norm) the persona contrast of interest; second, we articulate our hypotheses concerning the effect of persona-based information on numeral interpretation.

THE PERSONA CONTRAST: IMPLEMENTATION, NORMING, AND HYPOTHESES

Nerdy vs. Chill speakers

While pragmatic precision has not been explicitly linked to specific personae in previous work, the social meanings of this variable very much align with those invoked by similar variations along detail-orientedness in the phonetic domain. Specifically, work on the indexicality of *hyperarticulation*, a domain in which precision involves different phonetic components of an utterance, has unveiled a link between hyperarticulated speech and individual social qualities very similar to those evoked by precise numerals, including 'articulateness' and 'learnedness' (Bucholtz 2001; Benor 2004), 'effortfulness' (Eckert 2008), and 'detail-orientedness' (Podesva, Reynolds, Callier, & Baptiste 2015). Moreover, some of these social traits have been argued to coalesce in specific personae, foremost the *Nerds* in a California high school (Bucholtz 2001), associated with an emphasis on learnedness and educatedness, and on qualities overtly divorced from mainstream likability such as pedantry and un-coolness. In light of these considerations, we see a *Nerdy*

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persona as one that, following the broader associative pattern between detail-orientedness and speaker qualities discussed above, should be associated with the precise use of numerals as well.

As for the persona indexed by a lower degree of precision, we adopt a fundamentally CONTRASTIVE approach: instead of searching for an elusive and perhaps nonexistent instantiation of a pragmatically 'neutral' baseline, we look to maximize the contrast between Nerdy speakers and speakers embodying a persona that can reasonably be expected to be associated with imprecision. To zero in on this persona, we draw on the observation that, similarly to the qualities associated with high precision, those linked to low precision/approximation—that is, laid-backness, friendliness, coolness—have also been suggested by previous work to coalesce in specific, largely overlapping, persona constructs such as 'Surfer dudes', 'Skaters', and 'Frat Boys' (Kiesling 2018)—a set of distinct types which share a common indexical core of effortlessness, laid-backness, and chillness, in line with the qualities found to be indexed by imprecise speech in prior work.

To implement this contrast in the visual presentation of speakers, we created cartoon images of two characters engaged in conversation, indicated by the use of empty speech bubbles. One cartoon involved two characters, Arthur and Rachel, expected to embody the social qualities linked to high precision; the other involved two characters, Alex and Eva, expected to invoke those indexed by low precision. The cartoons were drawn with the online software Pixton (www.pixton.com). To bring to the foreground the desired social qualities projected by each set of interlocutors, we manipulated a combination of different properties of the characters' appearance, drawing on the idea that socio-indexical information is normally simultaneously conveyed by multiple semiotic systems—verbal and nonverbal alike. Relatedly, the Nerdy characters were represented as wearing glasses and clothes akin to school uniforms, embodying a guarded stance, and featuring a serious, focused facial expression, functional to projecting the intellectual stature and meticulousness that is distinctive of different manifestations of this persona. By contrast, the Chill characters were represented as adopting a laid-back, relaxed bodily posture; wearing casual clothes; visibly smiling; and projecting an overall sense of comfort and pleasure in engaging in a social situation. The two sets of characters are displayed in Figures 1 and 2.

To ascertain the viability of the persona contrast implemented above, we conducted a norming study comparing the social evaluation of the two sets of characters in Figures 1 and 2.

240 participants recruited on Prolific were shown these vignettes in a between-subject design: one half were shown Arthur and Rachel; the other half were shown Alex and Eva. Participants were asked to list three attributes and a stereotypical label for the characters shown. Their responses, illustrated in the word clouds in Figures 3 and 4, show that the perception of Arthur and Alex largely aligns with what we aimed for: Arthur is overwhelmingly seen as embodying social qualities indicative of high intellectual standing (e.g. clever, smart) and is consistently

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FIGURE 1. Arthur and Rachel.

associated with a Nerdy/Geeky persona. In contrast, Alex is ascribed attributes pertaining to chillness—for example, laid-back, relaxed, easy, and cool; and high solidarity/sociability (e.g. friendly; outgoing). In the remainder of the article, we refer to the two characters as the *Nerdy persona* and the *Chill persona* respectively, as a way of capturing the qualities that emerged as especially prominent for each of them.

We can now utilize this contrast to explore how comprehenders' perception of the speaker's persona affects how they interpret numerals. Our main question of interest is the following: how do the social qualities embodied by the speaker affect the precision level required to interpret a numeral, and thus the computation of the range of values that the numeral can be taken to refer to? We hypothesize that an utterance produced by a speaker who embodies the qualities linked to high precision—a Nerdy one—will be associated with a higher standard of precision than the same utterance uttered by a speaker embodying the qualities linked to low precision—that is, the Chill one. Accordingly, imprecise numerals uttered by Nerdy speakers should be less likely to seen as 'close enough' to the target value shown on the visible screen, and therefore accepted as appropriate in the context, than imprecise numerals uttered by Chill speakers. We now proceed to test our hypothesis in an experiment deploying a picture-selection task: it will turn out that

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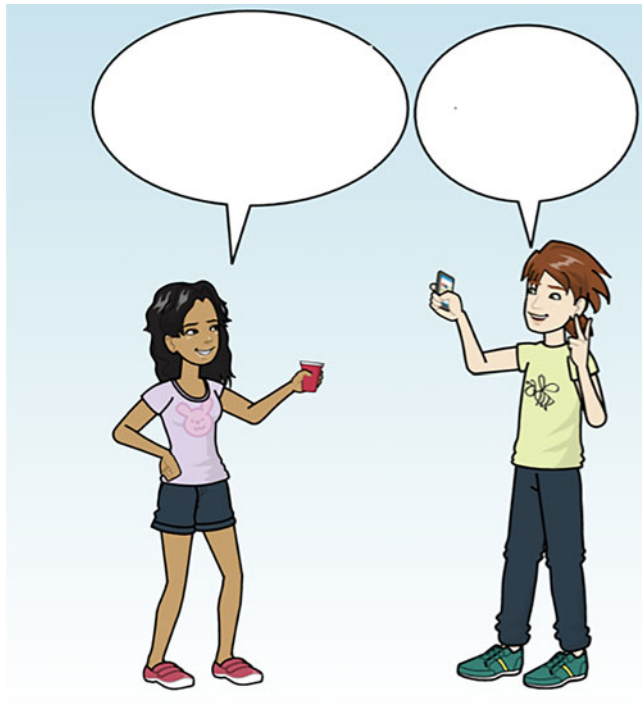

FIGURE 2. Alex and Eva.

Nerdy speakers' utterances indeed receive a higher rate of precise interpretations, lending support to our prediction.

PERSONAE AND (IM)PRECISION: A PICTURE MATCHING TASK

Methods and design

Our stimuli utilized visually displayed dialogues between a dyad of two characters, identical to those in the norming study: one set of characters embodied the Nerdy persona (Arthur and Rachel); one set the Chill persona (Alex and Eva). Each set of characters was framed in a conversation prefaced by a brief context sentence; in the dialogue, the female character would ask a question, and the male character would respond based on information they accessed by looking at their phone, uttering a quantity expression in the form of a round number. The presentation was identical to the cartoons in Figure 2, with the question and the response provided as text in the speech bubble.

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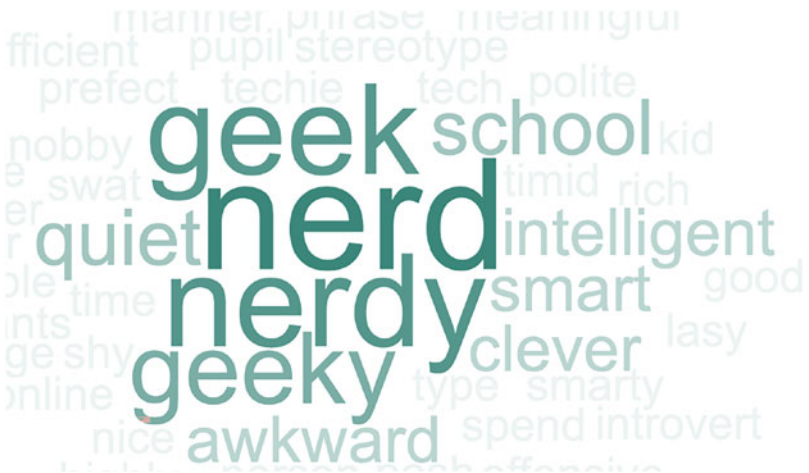

FIGURE 3. Qualities ascribed to Arthur.

FIGURE 4. Qualities ascribed to Alex.

After seeing the dialogue between the characters, participants were asked the question "Which phone is Arthur/Alex looking at?" and were shown two images of a phone. In one image, the phone was turned face down, making the content of the screen invisible (COVERED screen). In the other image, the phone was

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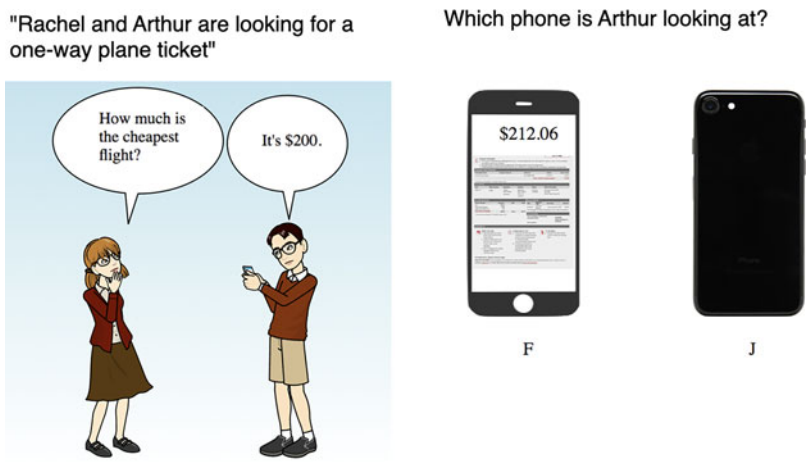

FIGURE 5. Display before making the choice (condition: Nerdy, Imprecise).

turned face up with the display fully visible (VISIBLE screen). Participants were instructed to select the visible screen "if you think that the information on the screen fits what is being said" and to select the covered screen if they believed it wasn't. Figure 5 provides a full illustration of the display that participants would see in a trial.

Two factors were crossed in a 2×3 design. Our first manipulation, implemented between subjects, varied the persona embodied by the displayed characters (Nerdy: Arthur and Rachel vs. Chill: Alex and Eva); participants would therefore see only one of the two sets of characters throughout the experiment. Our second manipulation varied the fit between the visible screen and the one uttered by the character, with three levels: *Match* with displayed numbers matching the utterance.[3] *Mismatch*, with a large divergence between the two; and the critical *Imprecise* level, with only a slight divergence between the uttered and the displayed number, where the display could plausibly be seen as being close enough to have prompted the utterance, depending on the standard of precision adopted by the respondent. The difference between the uttered and displayed numbers here varied between 5% and 18% of the first digit's unit. The Screen Fit manipulation for a sample item is shown in Figure 6.

The Match and the Mismatch conditions serve as controls and are expected to evoke COVERED responses at floor and ceiling levels respectively. By contrast, responses in the Imprecise condition crucially depend on the (im)precision standard employed by participants on a given trial. In particular, a strict interpretation—that is, one with a standard of precision that excludes the value displayed on the visible screen from the extension of the predicate—should lead to a COVERED screen

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FIGURE 6. Screen Fit manipulation.

response; and a relatively lenient interpretation—that is, one with a lower level of precision, which INCLUDES the value displayed on the visible screen—should translate into a VISIBLE screen choice. This means that COVERED choices in the Imprecise condition can be seen as an indicator of the standard of precision used.

Materials

Twenty-four experimental items were created, each varied across six different conditions resulting from the 2×3 manipulation of the factors described above. The Persona manipulation was administered between-subjects: a given participant was either assigned to dialogues between the Nerdy characters or between the Chill characters. The Screen Fit manipulation was administered within-subjects: each participant saw six items in the Match and the Mismatch conditions and twelve items in the Imprecise condition, with item-condition pairings counterbalanced in a Latin Square Design. Eight items contained utterances describing prices, expressed in dollars; eight items contained utterances describing distances, expressed in miles; and eight items contained items describing times, expressed in hours and minutes. The experiment also included twenty-four filler items.[4]

Procedure

The study was implemented and administered online on the PCIbex platform (https://www.pcibex.net). After providing informed consent, participants were shown the instructions. Participants entered their responses by pressing the key matching the letter displayed under the picture on the keyboard. Following the last trial, all participants, regardless of whether they had been assigned to the Nerdy or the Chill condition, were asked to complete a two question exit questionnaire aimed at assessing the degree to which they saw themselves as sharing the salient qualities of the speakers in the experiment. Participants responded by selecting a value on a 1–10 scale, with 1 indicating the

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minimum value and 10 indicating the maximum value. The two questions were presented incrementally (see below for details on how these responses were incorporated in the analysis).

(2) a. I'd describe myself as: 1 = not chill at all; …. 10 = very chill
b. I'd describe myself as: 1 = not nerdy at all; …10 = very nerdy

Participants

306 participants (192 self-identifying females; 110 self-identifying males; four non-binary; mean age: thirty-seven) were recruited online from Prolific and compensated $1.30 ($8/hr). All participants declared themselves to be native speakers of English and provided informed consent approved by our university's IRB.

Results

Task validation and overall persona effect. Our first step in the analysis is driven by two goals: ensuring that the control conditions behave as expected; and testing the predicted effect of Persona in the critical imprecise condition. To this end, we fit a mixed-effects logistic regression on the rate of COVERED response. Our fixed effects included Screen Fit, Persona, and their interaction: we see these factors as crucial to address our research question, and we therefore planned to include both of them in the model (see Sonderegger 2023 for further discussion on the conceptual motivation of including fixed effects that are part of the experimental design).[5] Random effects included random slopes for Screen Fit and random intercepts for Subjects and Items.[6] Persona was sum coded; Screen Fit was treatment coded with 'Imprecise' as reference. This allows us to extract two key conclusions from the model output. One is that the rate of COVERED responses in the Imprecise condition ($prob = 0.39$[7] is significantly higher than in the Match ($prob = 0.0001$; $\beta = -9.23$; SE = 1.20; $z = -7.68$; $p < 0.0001$) and lower than in the Mismatch conditions ($prob = 0.99$; $\beta = 10.97$; SE = 1.31; $z = 8.37$, $p < 0.0001$), suggesting that the controls behave as expected. The other is that, within the Imprecise condition, Nerdy speakers were associated with a higher rate of COVERED responses ($prob = 0.49$; $\beta = 0.88$; SE = 0.31; $z = 2.84$; $p = 0.004$) than Chill ones ($prob = 0.29$), confirming the predicted effect. To complete our analysis, we further compared the difference between Nerdy vs. Chill persona in the Match and Mismatch conditions. The comparisons were extracted using the *emmeans* package. As expected, no difference was found in either condition (Match: *prob*(Nerd) = 0.00; *prob*(Chill) = 0.00; $\beta = 0.48$; SE = 0.54; $z = -1.70$; $p = 0.51$; Mismatch: *prob*(Nerd) = 0.99; *prob*(Chill) = 0.99; $\beta = 0.50$; SE = 0.81; $z = -1.70$; $p = 0.50$).

Figure 7 illustrates the pattern tested in the model: on the left, we show the visualization directly obtained from the model predictions via the *emmip* R function; on

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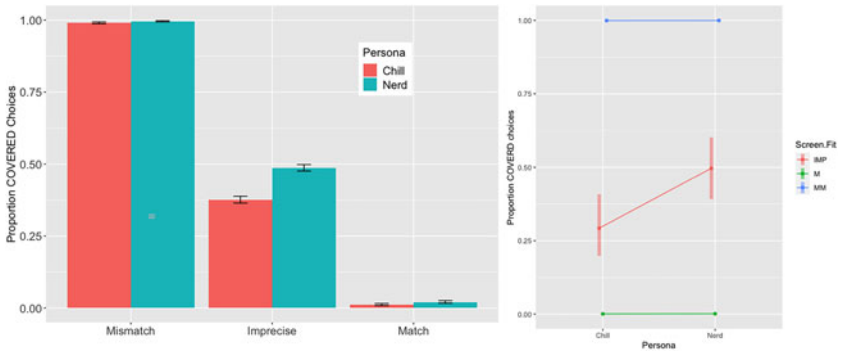

FIGURE 7. COVERED choices by Persona and Screen Fit. Plot from the model predictions (right: error bars indicate 95% confidence intervals) and from the original data (left: error bars indicate standard error).

the right, the barplot plotting the raw data. Note that rates of COVERED response in the Mismatch and Match conditions are at ceiling and floor respectively, as predicted in virtue of our experimental design.

In sum, our analysis supports our prediction: COVERED screen choices in the Imprecise condition are chosen to a higher rate when the speaker embodies the Nerdy, as opposed to the Chill persona.

The modulation of participants self-ascribed ratings. As a second step in the analysis, we assess whether, and how, the observed Persona effect on imprecision resolution is modulated by other factors that, while not part of the experimental design proper, might have plausibly played a role in further affecting participants responses in the critical condition. To this end, we carried out a post-hoc analysis on data from the Imprecise condition only, focusing on four factors: participants' own self-assessed nerdiness/chillness; participants' demographics (age and gender); and the margin of imprecision of the items. The choice of carrying out this analysis separately, and on a subset of the original data, is motivated by two reasons: first, as mentioned above, these factors are not part of the original design, making this part of the analysis exploratory; second, some of them (most notably, the proportion of imprecision) are only relevant in the Imprecise condition.

Our first step involved zeroing in on the best possible model that could describe the data. Our predictors of interest are the following: participants' age and gender; *Imprecision.Rate,* that is, the percentage of imprecision of a given item (ranging from 5% to 18%); and the similarity between respondents and the characters, measured in terms of what we call the *Similarity Index*. This measure was obtained from the responses to the exit questionnaire at the end of the study by taking self-ascribed nerdiness and chillness ratings from respondents seeing Nerdy vs. Chill characters,

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respectively, and combining these ratings into a single 1–10 scale. We treat this scale as an independent variable tracking the degree to which participants saw themselves as sharing the same qualities of the speakers: the lower the Similarity Index, the lower the degree to which participants seeing a Nerdy characters see themselves as Nerdy, and participants seeing the Chill characters see themselves as Chill.

Here, while each predictor is potentially relevant as a source of modulation of the Persona effect found above, none of them is part of our original experimental design. As a result, there are no independent conceptual reasons to include them in the final model above and beyond whether these predictors improve model fit. We thus relied on backward step-wise model comparison to isolate which predictors should be retained, and which ones can be dispensed with (see Sonderegger 2023 for further discussion of this approach). Our starting point was a model with main effects for all of the four predictors listed above, as well as the interaction of each of them with Persona.[8]

Our final model included Persona*Similarity, Age, and Imprecision.Rate as predictors, with random slopes of Imprecision.Rate and random intercepts for Items and Subjects. Consistent with our prior findings, there is a significant main effect of Persona ($\beta = 1.36$; SE = 0.23; $z = 3.22$; $p < 0.01$) with higher COVERED screen rates for Nerds than Chill. But this effect is qualified by a significant interaction ($\beta = 1.30$; SE = 0.41; $z = 3.14$; $p < 0.01$), such that the Persona effect is very strong when participants' Similarity Index is low and disappears when it is high. To further understand the nature of the interaction, we re-ran the same model using treatment coding with Nerd and Chill as respective baselines. This reveals a significant DECREASE of COVERED screen choice rates as the Similarity Index increases in the Nerdy speaker condition ($\beta = -0.71$; SE = 0.27; $z = -2.60$; $p = 0.009$); but no significant INCREASE of COVERED screen rates as the Similarity Index increases in in the Chill speaker condition ($\beta = 0.58$; SE = 0.30; $z = 1.90$; $p = 0.06$). This suggests that the observed interaction between speaker Persona and Similarity Index is primarily driven by participants seeing the Nerdy speakers.

The model further revealed a main effect of Imprecision.Rate ($\beta = 1.50$; SE = 0.12; $z = 12.05$; $p < 0.0001$) and Age ($\beta = 0.46$; SE = 0.21; $z = 2.21$; $p < 0.05$) such that the rate of COVERED choices increased as the margin of imprecision increased; no interaction with Persona was found, however ($\beta = 0.05$; SE = 0.15; $z = 0.3$; $p = 0.74$).

Figure 8 illustrates the proportion of COVERED choices in the Imprecise condition by Persona and Similarity Index.

Figure 9 illustrates the proportion of COVERED choices by Persona and *Proportion.Imprecision*. It can be seen that the rate of COVERED choices increases as the margin of imprecision increases; but this effect is uniform across Nerdy and Chill personae.

Finally, Figure 10 illustrates the proportion of COVERED choices by (speaker) Persona and (participants') Age. Note that the rate of COVERED choices increases

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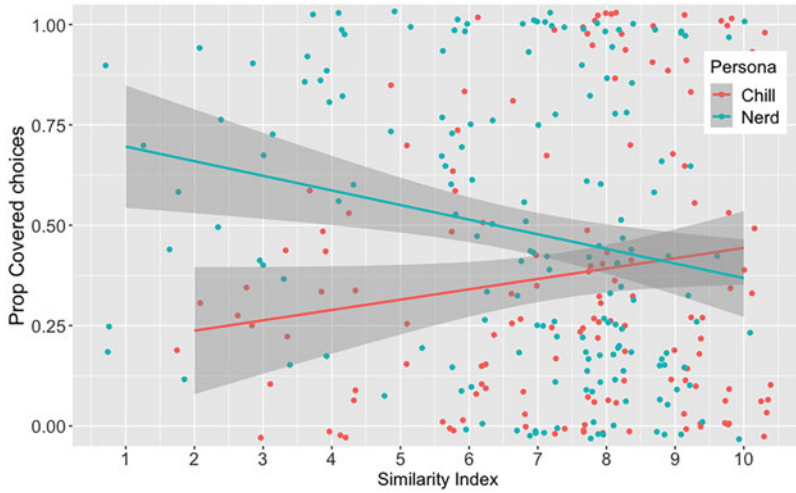

FIGURE 8. COVERED responses by speaker Persona and Similarity Index.

as participants' age increases; but this effect is uniform across Nerdy and Chill speaker personae.

Summary

The analysis revealed an effect of Persona in the expected direction: in the Imprecise condition, participants selected the COVERED screen more often with Nerdy speakers than with Chill ones. Furthermore, when it comes to Nerdy speakers, persona-induced differences in interpretation are most pronounced for comprehenders who see themselves as not embodying the distinctive qualities of the speaker—that is, who ascribe themselves a lower rating of Nerdiness. The persona effect was not modulated by either participants' age or gender.

GENERAL DISCUSSION

Our study was motivated by the following question: how do comprehenders rely on socio-indexical information—and more specifically on the persona embodied by a speaker—to navigate the resolution of (im)precision—and thus semantic interpretation more broadly? Our key finding is that, as hypothesized, numerals uttered by speakers whose social persona embodies the qualities indexed by precise speech—that is, the Nerdy ones—on average do receive a more narrow interpretation than numerals uttered by speakers whose social persona embodies the qualities indexed by imprecise speech—that is, Chill ones. In light of this, our findings highlight two key properties of the interpretive inferences targeting numerical precision.

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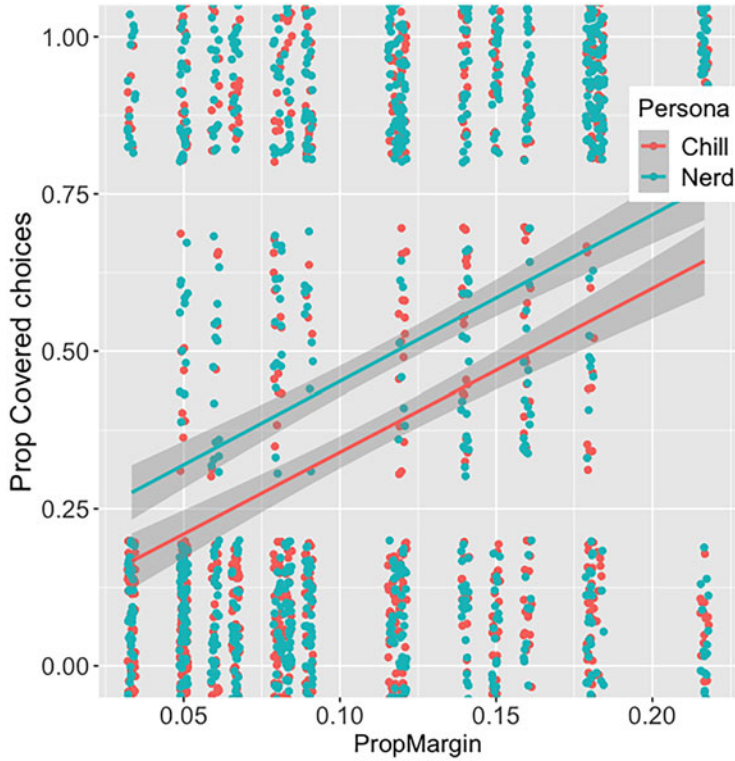

FIGURE 9. COVERED responses by speaker Persona and Proportion of Imprecision (random noise added via the geom.jitter() function in ggplot).

First, they are *socially embedded*: that is, they hinge on how comprehenders perceive and relate to the social qualities embodied by the speaker, and thus cannot be fully grasped if one abstracts away from such qualities. Second, they are *systematic*: that is, they are drawn by different comprehenders in a consistent way, which generalizes beyond the here-and-now of the single interaction. We take this result to carry two main implications for the study of meaning, which we now turn to elaborate on.

First, our results enhance our understanding of the link between social indexicality, personae and cognition, contributing a novel perspective on how social information shapes processes of language comprehension. As discussed in the introduction, work in sociophonetics increasingly showed that comprehenders keep track of different levels of speaker information across different domains of speech production and perception—for example, phonetic categorization, imitation, and convergence. These effects have been observed in relation to macro-level demographic features, such as gender, race, and geographical origin (Niedzielski

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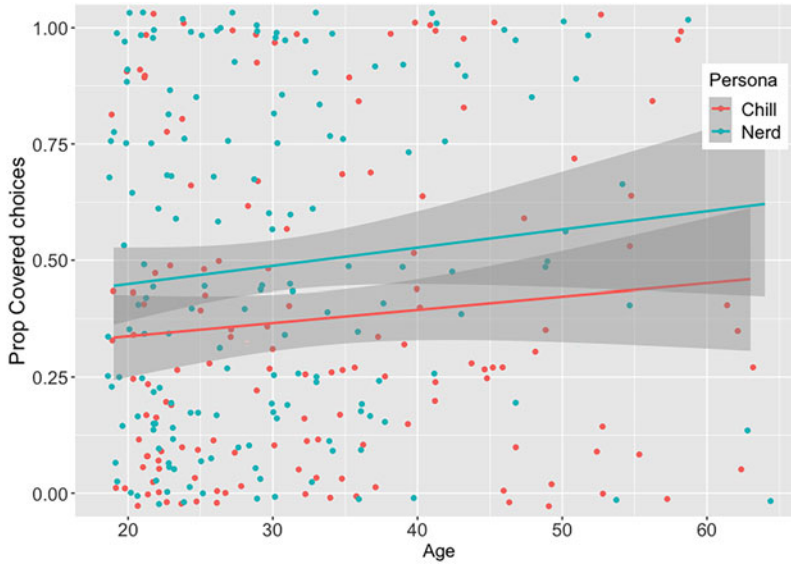

FIGURE 10. COVERED responses by speaker Persona and participants' Age.

1999; Strand 1999; Hay et al. 2006; Staum Casasanto 2008; Hay 2009; M. Babel 2012; Sumner et al. 2014; Drager 2015); but also, and crucially, with respect to more local persona-based constructs (D'Onofrio 2015, 2018, 2020; see the introduction for discussion). Yet, even as, following these results, the category of persona has gained an increasingly central role in theories of social meaning and language processing, much remains to be discovered on how these constructs 'are represented and connected in the mind, and how these connections influence processes of linguistic perception' (D'Onofrio 2020:9).

In this perspective, our results expand the range of areas of language understanding that have been shown to be influenced by persona-based information beyond those of phonetic and morphosyntactic processing, highlighting semantic interpretation, together with the context-based reasoning it requires, as similarly susceptible to the influence of these constructs. Notably, the idea that pragmatic reasoning should be seen as socially informed is not a new one. In particular, it has been shown that the ascription of referential meaning can be affected by a host of dimensions that pertain, in one way or another, to the social identity of the speaker—and the social context more broadly. These include, for instance, politeness considerations (Bonnefon & Villejoubert 2006; Zhang & Wu 2020 inter alia); knowledge about a speaker's language proficiency and/or nativeness (Fairchild & Papafragou 2018); and even information about someone's ideology, such as their political orientation (Mahler 2022). Against this background, the category of persona not only emerges as yet another dimension of social signification that shapes this process; it

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also crucially provides an analytical category that can help us better theorize the link between speaker information and pragmatic reasoning found by these studies. A relevant example is provided by Mahler's investigation of how truth judgments about factive complement clauses (e.g. "Ken didn't hear that Trump handled the pandemic badly") are affected, among other things, by both information about the political affiliation of the speaker, and information that, while not directly about the speaker's ideology, can still be seen as stereotypically related to it. For instance, comprehenders judge the clause above to be true more often when they know that the speaker is conservative; and when the speaker has a Southern accent, which can be seen as linked to conservative ideology. In light of our findings, the question emerges as to whether, and how, these effects can be seen as ultimately mediated by the personae associated with these affiliations—for example that embodied by a loud MAGA supporter wearing a red hat, enregistered throughout the past ten years of US politics; and, if so, what the distinctive traits of this persona are, above and beyond their party affiliation.

Looking at the study of social meaning and linguistic variation more broadly, our results highlight the issue of how systematic the observed associations between social meanings and sociopragmatic variables are, especially when compared to those observed at other levels of language structure. In particular, there is by-and-large consensus on the idea that the link between social meanings and phonetic variables, even when relatively stable across varieties and communities, is subject to variation and re-interpretation at the local level (see e.g. Schleef, Flynn, & Barras 2017 on regional variation of (ING) in the UK for a specific example). In light of this, the question emerges as to whether the indexical mapping between precision and social qualities should be seen as similarly subject to variability; and how this variability might differentially impact semantic interpretation. For example, one could hypothesize that, given the different ways in which precision and related notions (e.g. accuracy, granularity, punctuality) are represented and valued in different cultural contexts (see e.g. Ochs 1976), the use of numerical expressions might give rise to different patterns of social evaluation—and therefore of semantic interpretation—across distinct communities; and that a similar space of variation might similarly characterize other pragmatic variables that bear on similarly culturally sensitive ideas (e.g. directness/politeness). We see the endeavor of exploring this variability, and the way it relates to the systematicity of the inferences unveiled in the current study, as a crucial step towards developing a more unified view of sociolinguistic cognition—one in which distinct domains of language understanding are nevertheless shaped by the same categories of socio-indexical meaning, and can therefore be seen as related to one another.

The second implication of the present work concerns theories of meaning advanced in semantics and pragmatics—and in particular, how different layers of signification jointly inform the production and interpretation of content in communication. As discussed in the introduction, scholars of language across different traditions have long submitted to the view that communication

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simultaneously involves referential and indexical signs, 'one working in conjunction with the other' (Gumperz & Cook-Gumperz 2007); and that the interpretation of descriptive meaning cannot be conceived of independently of the social context (Silverstein 1985; Ochs 1992; Cook-Gumperz 1992; Eckert 2019). In a similar vein, a recent line of work at the interface of pragmatics and sociolinguistics showed that social meanings are productively and systematically inferred from the semantic properties of speech across a variety of linguistic expressions (Acton & Potts 2014; Glass 2015; Beltrama & Staum Casasanto 2017; Acton 2019; Jeong 2021; Beltrama et al. 2022; Hunt & Acton 2022; see the introduction for further details), motivating a view in which different dimensions of meaning cannot be seen as independent from one another. Against this background, the persona effects observed in our study make it possible to take a further step towards building a bridge between sociolinguistic and more abstract, reference-oriented approaches to the study of meaning, questioning the exclusion of identity considerations from pragmatic reasoning that has been tacitly advocated in much work in semantics and analytic philosophy. An important point to address, in light of these observations, revolves around how one should characterize the nature of the interaction between social indexicality and pragmatic reasoning observed in our study.

First, what specific aspect of imprecision resolution, and pragmatic reasoning more broadly, are comprehenders linking to the speaker persona? While the experimental findings show a connection between the speaker persona and the OUTCOME of meaning interpretation, we see a variety of possible pathways that could lead to this result. We would like to emphasize two here, which we plan to tease out in future research. One possibility is that Nerdy speakers, compared to Chill speakers, are perceived as more SEMANTICALLY strict—that is, committed to carefully observing extant form-to-meaning mappings, and avoiding loose talk. Along these lines, participants might posit that nerds simply reject the idea that approximate statements might ever be 'true enough' to utter; and that they only see precise truth as descriptively adequate. An alternative possibility might be that Nerdy speakers are instead perceived as PRAGMATICALLY strict—that is, as more likely than Chill speakers to consider details as relevant to the conversation, or alternatively as less likely to ignore them when they are not. This idea might be implemented by suggesting that Nerdy and Chill speakers differ in their construal of the Question Under Discussion (QUD; Roberts 1996/2012)—the issue that interlocutors are trying to solve at any particular point of the conversation, and that ultimately dictates what information is relevant to the exchange, and what information is not. For instance, Nerdy speakers might be taken to be guided by hyper-precise QUDs in their speech—that is, QUDs that can be resolved only by providing a highly granular answer (e.g. "How much is the ticket, *exactly*?"); whereas Chills speakers might be taken to be more likely to address QUDs that can be resolved by a more coarse-grained answer (e.g. "How much is the ticket, *more or less*?").[9] While these possibilities lead to the same observed results in the case of numerals

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and imprecision and are thus difficult to tease apart in our study, they remain crucially distinct on a conceptual level, and possibly amenable to being teased out by looking at other linguistic phenomena (He & Beltrama 2023).

A second question revolves around whether the association between numerical precision and a Nerdy persona extends across different subtypes of this persona or is instead specific to some particular aspects of the incarnations evoked in our experiment. The approach adopted here allows us to establish a link between CONTRASTS in meaning interpretation (i.e. rates of precise interpretations) and CONTRASTS at the level of personae (i.e. Nerd vs. Chill); this outlook is in line with the idea, central to sociolinguistic and anthropological theory, that personae do not exist in isolation, but are interpreted relative to a broader *system of distinctiveness* (Irvine 2001): they inherently evoke, and cannot therefore be fully divorced from, the opposition to possible other constructs that could have materialized in the context. In our conceptualization of the study, Nerdy and Chill can be thought of as an instance of such an opposition. Yet, as most social meaning categories, personae are indeed not internally homogeneous: different manifestations of nerdiness and chillness exist, which can be seen as sharing a common denominator, and yet differ with respect to other crucial properties of the people embodying them. For example, not all nerds are necessarily pedantic or uptight; and not all chill people are necessarily laid back or likable (see e.g. Pratt 2021). In this perspective, minimal variations of our paradigm—for example, testing the effect on numerals' interpretation of different incarnations of nerdiness and chillness, as well as of other persona constructs in opposition with either of these two—provide a promising avenue of future work to shed light on what specific constellation of qualities are primarily impactful on comprehenders' pragmatic reasoning; and thus better theorize the nature of the socio-indexical links that drive the impact of persona-based information on meaning interpretation.

As a final observation, we note that the effect of persona on imprecision resolution, while consistent across participants' age and gender, is further modulated by one characteristic of the respondents: the degree to which they see themselves as being Nerdy vs. Chill, based on the ratings provided in the exit questionnaire. In particular, the persona effect is especially prominent for participants who do not see themselves as sharing the social qualities embodied by the speakers, as opposed to those who do. Notably, interactions along these lines have already been found in the prior sociolinguistic literature, suggesting at least two possible explanations for this pattern of results. One is that participants identifying with the speaker (consciously or unconsciously) selectively block the indexical association from affecting their response choices, most plausibly to fend off potential negative evaluations of their shared persona. In contrast, when identification with the speaker is low, participants' own identity is not at stake, leading participants to be more susceptible to letting these indexical associations impact their behavior. This line of thought would be consistent with the observation that participants can resist, or altogether inhibit, convergence towards the interlocutor when it

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comes to linguistic features that are embedded in stigmatized stereotypes (M. Babel 2010; Walker & Campbell-Kibler 2015); and that, as suggested by Niedzielski (1999), speakers are more comfortable ascribing stereotypically rich social characterizations to others, while portraying themselves as unmarked language users, both from a linguistic and a social perspective. Alternatively, this modulation could reflect different degrees of having to rely on stereotypes when engaging in language processing. An explanation along these lines is suggested by Wade (2020) to capture the greater propensity of Non-Southerners than Southerners to converge towards Southern-labeled speech lacking actual Southern features. Accordingly, it is possible that respondents sharing the same traits as Nerdy speakers may have more and richer experiences with the relevant type of speaker, making socio-indexical information less impactful on their response behavior; while respondents who share the same speaker's traits to a lesser extent may end up relying on indexical associations more heavily.

At the same time, our case study presents some crucial differences from the phenomena discussed above, which will need to be carefully considered to further illuminate the interaction of interest. To begin with, the modulation discussed above is asymmetric: it emerges for participants evaluating Nerdy characters, but not (significantly) for participants evaluating Chill characters. This would suggest that, among these two personae, Nerds should be seen as more stereotypically salient—or more deeply enregistered—than the Chill characters, and thus more likely to affect how comprehenders relate to the speaker when interpreting their utterances. In addition, if the effect is driven by comprehenders' wanting to distance themselves from the speaker, this asymmetry would require positing that Nerdy are evaluated less favorably than Chill speakers—an assumption that, while in principle reasonable, would require independent verification. Second, in all of the cases discussed above the relevant social features are operating at a high level of consciousness: they are explicitly commented on in public discourse and embedded in widely circulating stereotypes; and their status along these lines is central to the explanations proposed to account for how they shape listeners' behavior. By contrast, whether the opposition between Nerdy and Chill features the same degree of consciousness is still an open question. While our norming study highlights the social perception of the two personae as internally consistent and clearly distinct, more work is required to zero in on the level of awareness at which (im)precision and its indexical association operates—especially in light of the role played by awareness in theories of sociolinguistic cognition (see A. Babel 2016 and contributions therein contained). Finally, it remains to be seen to what extent self-ascribed ratings of Nerdiness and Chillness can be seen as a reliable window onto participants' self-identification with the characters that they are seeing. Contrary to more clear-cut features such as age or geographical origin, the personae investigated here—and the category of *persona* more broadly—are more local and fleeting, and thus less amenable to being translated into participants' permanent features: for example, comprehenders might see

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themselves as embodying each of them in different conversational settings; as a result, the question remains open as to the degree to which these categories, above and beyond the experimental contrast implemented in our study, should be seen as inversely correlated vs. compatible with each other in the practices whereby speakers construct their identity across different interactional moments. While this issue could not be addressed in the scope of the current study, we see it as a central one to illuminate in future endeavors to further explore the significance of self-ascribed ratings as a proxy for participants' own orientation towards the speaker persona. In light of these considerations, while we see the interaction discussed above as worthy of being reported and discussed, we also believe that this aspect of our results should be a more targeted investigation in future work.

CONCLUSION

Based on data from a picture selection task, we showed that the social persona embodied by a speaker impacts how comprehenders go about ascribing an interpretation to numerical expressions. We take this result to provide novel insights into the role of social meanings in linguistic cognition.

The key take-away, in particular, is that socio-indexical meanings, and particularly their incarnation in the form of persona-based constructs, are even more central to language understanding than previously known: besides influencing different domains of speech perception and production, they shape the strategies that comprehenders rely on to navigate the uncertainties involved in meaning interpretation—and particularly those linked to the task of integrating contextual information to resolve the literal meaning of certain expressions. As discussed above, we see this finding as important for the study of social indexicality—and of meaning making more broadly. First, it lends further and novel support to the idea that social meanings, and persona-based categories in particular, are not just powerful resources for the construction and perception of identity in interaction; they are also central to the mental processes whereby comprehenders parse and make sense of the linguistic signal, providing further momentum to the integration of sociolinguistic and psycholinguistic approaches that has characterized the study of language-in-context in the past decades. Second, our findings provide novel empirical evidence that the descriptive and socio-indexical dimensions of meaning are linked by a principled, genuinely bi-directional relationship: comprehenders recruit the semantic and pragmatic properties of linguistic expressions to draw inferences about speakers, and rely on social information to draw inferences about descriptive meaning. The emerging picture is one in which different planes of signification are connected in a principled fashion and should therefore be investigated with an approach that is as integrative and comprehensive as possible.

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APPENDIX: SUPPLEMENTARY MATERIALS

Additional experimental materials are available at the following online repository: https://osf.io/vuga4/?view_only=ac41bdeda0c24656bed3833e73a89e77
These include:

- Anonymized dataset
- R Code for data analysis
- Model comparison report
- Stimuli list for experimental items
- Filler items
- Full instructions

NOTES

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[1]The category of *persona* has received extensive attention in sociolinguistics and linguistic anthropology, independent of its implications on language processing (Bucholtz 2001; Zhang 2005; Eckert 2008; King 2021)

[2]Furthermore, recent work in pragmatics proposed that the inference of social meanings can be formalized in a similar way to pragmatic inferences (Burnett 2017, 2019).

[3]The Match condition came into two slightly different variants: one in which the visible number was completely identical to the uttered one; and one in which it only matched in the integer, creating a minimal discrepancy (e.g. Uttered number: '$300'; Visible screen number: '$300.17'). This variation was introduced to ensure that participants would not reason to the effect of rejecting any occurrence of the visible screen that does not perfectly match the uttered number. A post-hoc comparison revealed no effect between whether the Match condition was implemented as a fully perfect Match or a near-perfect Match. See the appendix for supplementary materials.

[4]See the appendix for supplementary materials with links to full instructions, data, R code, and a complete list of stimuli (experimental + fillers).

[5]Regardless, this model was better than models with simpler fixed-effects structure. See the appendix for a report for this and all the other models used in the manuscript.

[6]See the appendix for a comparison with models with different random effects structure.

[7]Throughout this section, *prob* indicates the probability of choosing the COVERED screen based on the model's predictions. Probabilities were obtained from the log odds output via the PLOGIS function in R.

[8]See the appendix for illustrations of the descriptive patterns involving these factors.

[9]We thank a reviewer for suggesting this.

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SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/S0047404524000320.

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