1 Introduction

Interlocutors simultaneously extract (at least) two distinct kinds of meaning from a linguistic utterance: its descriptive meaning, that is, what the utterance says about the state of the world; and its socio-indexical meaning, that is, what the utterance reveals about the speaker themselves – e.g., their demographic background, ideological orientation, and personality traits (Labov 1966; Ochs 1992; Silverstein 2003; Eckert 2008; Podesva 2011 among others). While the capacity of language to convey information on multiple levels has long been acknowledged (see §2.1), much remains to be discovered about the link between these different domains of signification – and specifically, how interlocutors triangulate between these different streams of information to compute the overall message conveyed by linguistic utterances.

In this paper, we take a step in this direction by addressing the following question: how do comprehenders reason about social meaning – and in particular, the social persona embodied by the speaker – to assign a descriptive meaning to numerical expressions such as the one in (1)– and specifically, to compute the admissible amount of (im)precision that can be applied to their interpretation?

(1) The ticket costs $300.

Using a picture selection task, we show that descriptions uttered by speakers embodying a nerdy persona are interpreted with higher standards of precision than those uttered by speakers embodying a chill persona; and that the less comprehenders identify with the stereotypical properties of the speaker, the more prominent this effect gets. These findings contribute to building a more integrative perspective on the study of natural language meaning, as they help us bridge the investigation of two central questions: what factors bear on assigning semantically indeterminate expressions an interpretation in context – a question traditionally explored in semantics and pragmatics; and how social information about the speaker affects language processing – a concern central to socio- and psycholinguistics.

The paper is structured as follows. §2 provides general background on social meaning, imprecision, and the relationship between the two. §3 introduces the key theoretical notion of persona,
discusses the relationship between persona and imprecision, and presents a norming study grounding the hypotheses for our main experiment. §4 presents the design and implementation of this experiment, as well as the analysis of the resulting data. §5 turns to a more general discussion of the findings. §6 concludes.

2 Social meaning, indeterminacy, (im)precision

2.1 Semantic and social meanings: integrating perspectives

Much foundational work in linguistics sees meaning as a multi-layered phenomenon (Jakobson 1965; Ochs 1992; Silverstein 1985; Eckert 1989; Brown and Levinson 1987; Sperber and Wilson 1995); yet, the investigation of the nature, use, and processing of the distinct layers of content has largely been carried out in separate linguistic subfields. Especially pronounced, in this regard, is the divide between the study of the descriptive vs. social dimensions of meaning with respect to one particular aspect: the role played by interlocutors’ identities in the dynamics whereby meanings are signaled and interpreted.

The study of social meaning, on the one hand, puts the interlocutors’ properties front and center in two different ways. First, speaker features are, by definition, what social meanings are ultimately about: work in sociolinguistics and linguistic anthropology has laid out in great detail how linguistic forms convey – or index\(^1\) – information about language users whenever they are used in interaction (Ochs 1992; Silverstein 2003; Eckert 2012; Podesva 2011). This process has been extensively investigated for a wide range of aspects of linguistic forms – e.g., phonological variables (e.g., *ing* vs. *in’*: Trudgill 1972; Campbell-Kibler 2011); prosodic contours (e.g., raising declaratives: Podesva 2011; Levon 2016); morpho-syntactic constructions (e.g., negative concord: Eckert 2008) – and a host of social dimensions, including speakers’ demographic background (e.g., social class; gender; age), personality traits, and ideological orientation (see Eckert 2008 for an overview). Second, social meanings are crucially contingent not only on the identity of the speakers, but also on that of the interlocutors who take them up in interaction. For example, *-in’* can be taken to index unpretentiousness and laid-backness, or insincerity and condescension, depending on where in the US the listener is from (Campbell-Kibler 2007); and demonstratives such as *this* and *that* in politicians’ speech can highlight the speaker as down to earth and likable, or disingenuous and presumptuous – depending on the political affiliation of the interlocutors (Acton 2014). As a result, even though to a certain extent social meanings can become conventionalized, or enregistered (see Agha 2003; Johnstone 2016), they inherently remain highly fluid, perspective-dependent constructs, whose interpretation can greatly vary from one language user to another, and cannot be conceived of independently of the identity of all the interlocutors involved in interaction.

In contrast, research in semantics and pragmatics rarely, if at all, considers interlocutors’ social profile and positioning as relevant to the study of meaning. Of course, most theories ascribe conversational participants considerable agency in the interpretation process, especially when it comes to linguistic forms that have indeterminate, underspecified content, and thus require comprehen-

\(^1\)The term is grounded in Peirce (1955)’s categorization of signs, where an index represents a sign that is grounded not in convention, but in a co-occurrence between the sign and the object, such as causality, co-presence, or some other form of spatio-temporal contiguity. Peirce’s original semiotic theory has been heavily relied upon to theorize the nature of the link between linguistic forms and social meanings; see Ochs (1992); Silverstein (2003); Eckert (2008); Gal and Irvine (2019) for further discussion.
ders to embark on contextual reasoning to assign them a meaning. For instance, interlocutors can treat quantifiers such as *some* as having, or lacking, an upper-bounded interpretation (i.e., "some, but not all") depending on what specific question is being addressed in discourse, what the speaker’s communicative intention is, and what specific body of world knowledge can illuminate these assessments in a given conversational setting (e.g. Grice 1975; Horn 1972; Roberts 2012 i.a.). However, social differentiations between interlocutors remain largely irrelevant to this enterprise; in most semantic and pragmatic frameworks, language users are indeed assumed to partake in conversational exchanges as socially uniform, rational agents, whose only relevant property is that they act cooperatively, in accordance with Grice’s cooperative principle and the related maxims. As long as this assumption is met, and controlling for any other general contextual factors, all interlocutors are expected to resolve the meaning of a particular expression in essentially the same way.  

Social identity considerations are similarly excluded from the interpretation process even when it comes to expressions argued to be crucially anchored to the *perspective* of a specific individual, and thus to bear a special connection to conversational participants. For instance, the semantic contribution of a host of different phenomena, including predicates of personal taste like *tasty* Lasersohn (2005), expressives like *damn* (Potts 2007), evidentials (Aikhenvald 2004; Murray 2010), and epistemic modals (Stephenson 2007), has been been conceptualized as relative to someone’s assessment or emotive/epistemic state – e.g., in the case of predicates of personal taste, whoever adjudicates whether something is tasty; and in the case of *damn*, whoever is upset about a particular course of events or entity. But here, too, the role of the perspective-taking individual (typically a discourse participant) is represented in an abstract, disembodied way – typically via context-sensitive parameters on the interpretation function, where particular properties of these individuals do not come into play (see Stephenson 2007 for an example). For example, on standard analyses, the social identity of a speaker uttering “The soup is tasty” does not bear on how the interpretation of *tasty* is resolved: all that matters is that the comprehender will relate this term to a particular source of assessment.  

The upshot is that, while central to work on social meaning, the role of interlocutors’ identity remains highly under-theorized in semantic and pragmatic theories. While, to our knowledge, no proposal explicitly claims that social identity considerations should *not* matter (see also §5.1), these have effectively escaped the purview of standard accounts of meaning in these subfields, leaving very much open the question of whether, to what extent, and how interlocutors reason about speakers’ identity when computing the descriptive content of an utterance.

This issue has become especially prominent after recent work in pragmatics called into question the exclusion of speakers’ properties from the study of meaning, highlighting a host of case studies in domains in which the social and descriptive dimensions of content seem to interact. For example, research on the processing of implicatures highlighted politeness (Bonnefon and Villejoubert

---

2This idea is also crucially reflected in the notion that conversational inferences (e.g., implicatures) must be calculable (Grice 1975) – that, *ceteris paribus* they should be amenable to being rationally reconstructed in similar ways by cooperative interlocutors.

3This is not to say that conversational identities do not matter to the interpretation of these expressions *tout court*. See, among others, Silverstein (2006) for an influential anthropological analysis of how social class considerations intersect with the use and interpretation of subjective language in practices of wine tasting. The point we wish to drive home here is simply that in general, work in semantics and pragmatics has by and large not even considered specific individual properties relating to social identity as something that needs to be taken into account for properly analyzing interpretation in context – including for expressions whose interpretation is inherently dependent on who the speaker is.
2006; Bonnefon et al. 2009; Mazzarella et al. 2018; Zhang and Wu 2020) and speakers’ status as native vs. non-native (Fairchild and Papafragou 2018) as factors affecting whether, and how, interlocutors draw scalar inferences from quantifiers and numerals, calling for an enriched view of the array of contextual factors that determine these inferences (see also Mahler 2020 on the effect of speakers’ political background on the computation of projection inferences). Moreover, a growing body of research has demonstrated how social inferences targeting different aspects of speakers’ identity can be drawn from (often very subtle) components of the semantic meaning of linguistic expressions. For instance, Acton and Potts (2014) argue that the social meaning of solidarity and reciprocal affiliation between the interlocutors conveyed by demonstratives such as this and that can be derived from the core semantics of these expressions – specifically being grounded in the presumption that the addressee must be able to access the referent of the embedded noun phrase by considering the speaker’s relation to entities in the discourse context. Similar inferential patterns from the semantic to the social plane have been invoked for many other phenomena, including intensifiers (Beltrama and Staum Casasanto 2017, 2021), determiners (Acton 2019), modals (Glass 2015; Karawani and Waldon 2017), exclusive particles (Thomas 2021), and particular types of speech acts (e.g., rising declaratives, Jeong 2021). Taken together, these findings have highlighted the interplay between the social, semantic and pragmatic dimensions of signification as tighter and more intricate than assumed by traditional perspectives, spearheading the expansion of research on meaning in two directions: one aiming to capture the communication of social meanings within frameworks originally tailored to model semantic and pragmatic content (Acton 2014, 2019; Burnett 2017, 2019; see Beltrama 2020 for an overview); and one concerned with further unpacking the empirical connection between different layers of meaning, to better understand how interlocutors integrate different sources of information to determine the overall message conveyed by linguistic utterances.

Our project addresses a question that we see as central to illuminating both of these angles: given how social meaning can be inferred or sometimes even directly derived from semantic and pragmatic features, does the social perception of a speaker conversely affect the interpretation process at the semantic and pragmatic level – and in particular, the resolution of meanings that can only be fully interpreted via pragmatic reasoning about the context? We see this issue as a gateway to further develop an integrative approach to the study of meaning. It indeed allows us to test if, and how, interlocutors rely on social perception to compute descriptive meanings, opening a window onto a dimension of semantic interpretation which remains empirically uncharted thus far. By doing so, it crucially opens up new directions for reconsidering – and enriching – the array of contextual factors that affect the interpretation of an utterance’s descriptive message, providing a novel perspective on how the interface between different dimensions of meaning should be treated in semantic and pragmatic theory.

Our case study for this endeavor is the resolution of (im)precision in the interpretation of numerical expressions, the basics of which we turn to next.

2.2 Imprecision and indeterminacy: a case study

Numerical expressions constitute a prominent instance of semantically indeterminate meanings. Consider the following two examples:

(2) It’s 6 o’clock.
The ticket costs $300.

Although, in a sense, times and prices seem to denote specific and precise values, they are routinely used in a more liberal way: it is indeed perfectly common for someone to utter (2) when the time is in fact 5:57; or to utter (3) when the actual price is $295. Despite this slight discrepancy between facts and their descriptive content, these utterances seem intuitively felicitous in many circumstances, suggesting that comprehenders clearly can tolerate some amount of deviation from the literal truth conditions in interpreting numerical expressions – a phenomenon known as imprecision (Lewis 1979; Pinkal 1995; Lasersohn 1999; Syrett et al. 2009; Kennedy 2007; Burnett 2014; Solt 2014; Klecha 2014; Cummins et al. 2012; Aparicio 2017).

Two distinctive properties of imprecision make it an ideal testbed to address our question. One is that the possibility of speaking imprecisely introduces a space of indeterminacy around the interpretation of quantity expressions, which comprehenders have to resolve by reasoning about the specifics of the conversational setting: an utterance like “it’s 3 o’clock”, for instance, can be taken to represent different ranges of time – e.g., the exact time of 3:00, the interval comprised between 2:59 and 3:01, or an even larger interval comprised between 2:55 and 3:05. Psycholinguistic and experimental approaches have explored how interlocutors navigate this indeterminacy when encountering numerals (Van Der Henst et al. 2002; Cummins et al. 2012; Solt et al. 2017; Aparicio 2017) and other lexical categories (e.g., noun phrases: Syrett and Aravind 2021; gradable adjectives: Aparicio et al. 2016; Leffel et al. 2016), pinpointing a variety of contextual factors that affect how interlocutors resolve indeterminacy in context: the relevance of details in the communicative setting (Lasersohn 1999; Kennedy 2007); the interlocutors’ goals (Aparicio 2017); the perceived optimal trade-off between accuracy and processing costs (Dubois 1987; Van Der Henst et al. 2002; Krifka 2007); and the modality with which the information is being supplied (e.g., whether time is provided digitally vs. analogically, Van Der Henst et al. 2002). However, this work adopted an approach in line with that outlined in §2.1 – one in which interlocutors’ identities are generally not considered to be relevant sources of information for meaning interpretation and pragmatic reasoning, thus leaving the question open as to what role they might play in the process.

The second important property of (im)precision is that the level of precision with which quantity expressions are used has been shown to work as a salient index of social meanings for listeners. Work in social psychology, for example, has suggested that the use of sharp numbers (e.g., 203) – normally taken to signal a high level of precision (Krifka 2007) – boosts the perceived competence of the speaker in a variety of domains. It enhances the perceived accuracy of quantity estimation (Welsh et al. 2011) and the effectiveness of negotiators’ first offers, making them “seem more informed of the good’s true value than negotiators who use round first offers” (Mason et al. 2013); in addition, sharp numbers contribute to making an advertised company look more competent (Xie 2010).

4Theories in formal semantics in fact differ with regards to how the imprecise interpretation of round numbers is analyzed. Some treat it as a pragmatic phenomenon – that is, they model imprecision as external to an expression’s truth conditions, and as ultimately grounded in how interlocutors choose to use these expressions in communication (e.g., Lasersohn 1999; Klecha 2018). Others treat imprecision as semantic (e.g., Sauerland and Stateva 2011; Solt 2014) – that is, they posit that the level of precision at which a numeral is interpreted is part of the truth-conditions of the numeral itself. Both approaches, however, converge in treating numerals as having context-sensitive, indeterminate interpretations, whose resolution requires reasoning about the context. Since it’s precisely this property that makes (im)precision a suitable case study for our purposes, what we say in the remainder of the article does not hinge on one particular semantic view. While for expository purposes we choose to frame our discussion in terms of a pragmatic view, our findings – and our interpretation thereof – would still hold under a semantic view.
and Kronrod 2012) or a product sound more likely to deliver on its promise (Zhang and Schwarz 2011). Recent sociolinguistic work echoed and expanded these findings, showing that speakers using numerals precisely are rated more highly than speakers using them imprecisely along a variety of both favorable qualities, mostly linked to status and intellectual standing – e.g., being articulate, intelligent, educated, hard-working – as well as other, less favorable dimensions associated with low solidarity and likability – e.g., being annoying, pedantic, obsessive, and uptight (Beltrama 2018). Furthermore, speakers using numerals in an explicitly imprecise fashion (i.e., “approximately 200”) have been conversely perceived as indexing opposite sets of qualities: high solidarity and likability, but also low status and intellectual respectability. While the prominence of the positive vs. unfavorable associations with numerals used at different precision levels partially depends on the conversational context, these associations by-and-large hold robustly across widely different communicative settings (Beltrama et al. 2022).

Considering these two aspects from a broader perspective, (im)precision involves both semantic indeterminacy and the indexing of social meaning, emerging as the ideal testbed for investigating a specific instance of our general question above: does the relationship between socio-indexical information associated with the precise vs. less precise use of numerals work in the reverse direction as well? And if so, how is this reasoning modulated by comprehenders’ own orientation towards the speaker persona? We believe that engaging with these questions offers the opportunity not only to explore novel factors affecting (im)precision resolution, but also to more broadly shed light on the potential role of social perception in semantic interpretation – and thus the interplay of different streams of information in the computation of meanings.

We proceed in two steps. The first step, in §3, is to establish a contrast between two social identities that are differentially indexed by the use of more vs. less precise use of numerals, implemented by juxtaposing what we will refer to as a Nerdy vs. a Chill speaker. The second step, in §4, deploys a picture selection task to tap into how these social personae affect the interpretation of numerals, potentially in interaction with relevant social properties of the comprehender.

### 3 Personae and (im)precision: implementation and hypotheses

Our first goal is to implement a contrast between two speaker identities that are sufficiently and clearly distinct in being indexed by different degrees of precision – and thus allow us to make principled predictions about their possible effect on meaning interpretation. To this end, we capitalize on the notion of speaker persona – a social construct shown to be central to social meaning across various domains of language, which also lends itself to tackling methodological challenges of experimental implementation. In the following, we introduce the notion of persona (§3.1), as well as the way in which contrasting personae relate to varying expectations about (im)precision (§3.2); we then discuss how this contrast was implemented and normed experimentally (§3.3); and finally outline hypotheses for the effect of the persona manipulation on imprecision resolution (§3.4).

---

5By contrast, product characteristics described in round, hence less precise, numbers are perceived as more stable and performing for a longer time, suggesting that lower levels of precision can also boost product attitudes on particular dimensions (Pena-Marín and Bhargave 2016)
3.1 Personae, cognition and language processing


The construct of persona is especially pertinent to our research questions in two ways. First, personae are not only well-known and readily available constructs for projecting and perceiving social identity in interaction, but have also already been shown to shape language processing at different levels. In particular, findings from experimental sociolinguistics show persona-based information to be central for perceiving and processing speech at the phonetic level, on par with other, more established sources of social information (e.g., the speaker location of origin: Niedzieski 1999; gender: Strand 1999; or race: Staum Casasanto 2008). For instance, listeners primed with social types such as “Valley Girl” and “Business Professional” displayed a more backed perception of the boundary between the vowel in /a/ retraction (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 et al. 2019).

A second property making persona-level representations promising for our purposes is their amenability to straightforward experimental implementation: the fact that personae tend to be described with widely shared and recognizable labels and properties, together with their propensity to be indexed by a variety of both linguistic and non-linguistic signs (e.g., smoking, clothing etc.; see Eckert 2008 for further discussion) makes it relatively easy to invoke them in experimental participants. Previous work has successfully done so in different ways, including a mere textual description of the persona at stake (D’Onofrio 2018); the display of objects stereotypically associated with the persona (e.g., a shopping bag for Valley Girls, see D’Onofrio 2015); or pictures of humans embodying a particular persona (D’Onofrio 2019).

3.2 Personae and numerals: from precision to nerdiness

While the association between pragmatic precision and personae has not been explicitly tested thus far, the social meanings that have been shown to be indexed by detail-orientedness in the numerical domain very much align with those invoked by detail-orientedness in the phonetic domain. Specifically, work on the indexicality of hyper-articulation, a style of utterance production whose phonetic form displays a high degree of detail along one or more components (Lindblom 1990; de Jong et al. 1993; Johnson et al. 1993; Podesva 2011; Bucholtz 2001; Freeman 2014), showed that hyper-articulated speech conveys individual social qualities very similar to those evoked by precise numerals, including articulateness (Podesva et al. 2015), learnedness (Bucholtz 2001;
Benor 2004), effortfulness (Eckert 2008), and detail-orientedness (Podesva 2007). Crucially, some of these social traits have been argued to coalesce in specific personae, foremost the Nerds in a California high school, investigated in great detail by Bucholtz in a foundational ethnography (Bucholtz 1999, 2001). This persona, in particular, is distinctively associated with a cluster of traits similar to those indexed by precise numbers, including an emphasis on intellectual standing, embodied in qualities such as learnedness and educatedness, as well as qualities overtly divorced from mainstream likability – e.g., pedantry and purposeful un-coolness. Moreover, the linguistic practices of Nerds projecting such properties crucially include both hyper-articulated speech (e.g., resisting co-articulation and reduction processes) and more idiosyncratic speech patterns that hinge on detail-orientedness and granularity in other dimensions, such as spelling (as opposed to phonetic) pronunciations, hyper-correction, and a strong orientation towards language form (e.g., in word coinage, punning). In light of these considerations, we single out the persona construct of Nerds 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 – and should therefore serve as a fruitful testing ground to explore whether, conversely, speech by Nerds is taken to be associated with a heightened degree of precision.

As the next step towards investigating this question, we need to identify a viable comparison case that can serve as a reference for comparison. A standard experimental design approach might aim to assess this relative to a neutral baseline: intuitively, a “default” type of speaker who fails to carry any specific persona-based associations, and can therefore be used as a reference point to assess the effects of nerdiness on imprecision resolution. An appealing possibility, in this regard, would involve adopting a speaker that lacks a persona altogether: the absence of a persona would a fortiori ensure the absence of pragmatic expectations linked to that particular persona, providing a suitable baseline. But this possibility is a conceptual idealization, which is very difficult to implement in the first place. Indeed, there is consensus in the sociolinguistics literature that every speaker always, necessarily embodies a substantive social identity – i.e. there is no such thing as a zero identity, in a similar way to how there are no truly neutral instantiations of other phenomena embedded in speakers’ sociolinguistic life, such as putatively “neutral” accents (Lippi-Green 2011) or ideologies about language (Irvine and Gal 2000; Cameron 1995). As a result, whatever type of speaker one might choose as a comparison for the Nerdy persona – even the seemingly most nondescript one – would necessarily embody another set of distinctive, non-trivial identity features. As such, it would not be any more of a default case than the Nerdy persona, hardly providing a pure, reference-level baseline: the identity of the comparison case indeed might possibly (and independently) interact with interpretation on its own, making it difficult to isolate the effect of the Nerdy persona from whatever is happening with the other case.

In light of these considerations, we adopt a fundamentally contrastive approach to the persona manipulation: instead of searching for an elusive and perhaps non-existent neutral instantiation as

---

6Bucholtz suggests that these distinctive linguistic habits, by means of showing a degree of attention to detail that most interlocutors do not adopt in their linguistic choices, coherently serve as resources for Nerds to signal, and perform, the act of distancing themselves from mainstream values and practices – a cornerstone element of their social identity as a group and as individuals.

7Mutatis mutandis, this is indeed the default approach used to explore the reverse question – that is, the effect of linguistic properties on social inferences. For instance, Beltrama and Staum Casasanto (2021) investigate the social meaning of intensifiers such as totally by comparing the social perception of an utterance containing this form to that of an utterance lacking it and otherwise identical in content, serving as a baseline, intensification-free control.
a baseline, we look to maximize the contrast between Nerdy speakers and speakers embodying
a persona that can reasonably be expected to be associated with less precision in speech. While
the resulting contrast doesn’t make it possible to infer with certainty whether eventual effects on
interpretation are primarily associated with one persona or the other, or both, (though see §6.2
for further discussion), it still speaks directly to our core question of whether and how the social-
identity dimension impacts numeral interpretation – all the while avoiding the conceptual pitfalls
and empirical uncertainties linked to choosing a supposedly neutral reference case.

To zero in on this persona, we once again turn to the sociolinguistic literature. To begin with,
previous work on (im)precision suggests that approximate speech, as a rough opposite of hyper-
articulation, indexes a constellation of traits that appear to be distinctively different from those
linked to precision and Nerds (Beltrama et al. 2022; see §2.2): among others, a combination of
laid-backness, friendliness, and sociability; a low investment in projecting intellectual stature and
articulateness; and a general rejection of pedantry, uptightness and other dimensions linked to re-
duced likability. As with the qualities associated with high precision, these characteristics have
also been suggested by previous work to coalesce in specific, largely overlapping, persona con-
structs. In particular, Kiesling (Kiesling 2004, 2016, 2018) suggests that stereotypes such as
“Surfer dudes”, “Skaters”, and “Frat Boys” all embody a common core of effortlessness, laid-
backness and chillness, thus aligning well with the qualities associated with approximate speech.
We thus hypothesize that, in contrast to Nerds, a persona embodying these characteristic will be
associated with lower levels of precision.

3.3 Implementation and norming

To ascertain the hypothesized association and assess its implementation, we conducted a norming
study comparing the social evaluation of two sets of characters that we thought closely embodied
the opposition between a persona indexing a high level of precision – i.e., a Nerd – vs. a persona
indexing a lower one – i.e., a persona embodying laid-backness, such as a Surfer Dude or a Skater.
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. The cartoons
were drawn using the cartoon drawing software Pixton.8 One cartoon involved two stereotypical
nerdy characters, called Arthur and Rachel. The second cartoon involved two characters,
named Alex and Eva, whose salient social qualities were hypothesized to index a lower degree of
precision. The two sets of characters are displayed in figure1-2.9

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 perform two tasks. In the first task, participants were asked to list three attributes
and a stereotypical label for the characters shown, with the goal of confirming that the two sets
of characters indeed differ in their social properties and embody the desired personae reasonably
well. Participants’ responses are illustrated in the word clouds in Figure 3-4, and 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)

8https://www.pixton.com
9Note that while there are many interesting questions and further possibilities arising from other potential combi-
nations of the personae and gender of the two interlocutors, we opted for having both characters represent the same
persona as the simplest first test case, as well as keeping the relation between gender and role in conversation constant.
and introvert personality (e.g., quiet; awkward) and is consistently associated with a Nerdy/Geeky stereotype. In contrast, Alex is ascribed attributes such as chill, laid-back, relaxed, easy, and cool; and in addition, a sociable personality (e.g., friendly; outgoing). While less homogeneous than Arthur’s, the stereotypical associations for Alex also broadly align with a coherent set of personae linked to combinations of these qualities – e.g., skater, sporty. In the remainder of the paper, we refer to the two characters as the *Nerdy persona* and the *Chill persona* respectively, in an attempt to allude to the constellations of qualities that emerged as especially prominent for each of them: nerdiness/intellectual standing for Arthur; chillness/laid-backness for Alex.

In the second task, participants were asked to rate how precisely they thought the character they saw would speak about times and quantities on a 1-10 scale (10=maximally precise). This aimed to confirm the hypothesis that, in addition to being perceived as socially different, the two
characters were also linked to different expectations with regard to the degree of precision in their speech. The average precision ratings for Arthur and Alex differed, with the former significantly more precise in talking about quantities than the latter (M= 7.20; sd = 2.36 vs. M = 5.63; sd = 2.29). The difference was confirmed to be significant by a paired two-tailed t-test (t(238.67)= 5.63; p < 0.001).

### 3.4 Personae and (im)precision resolution: hypotheses

Our main experiment explores how comprehenders’ perception of the two personae affects the way in which they interpret numerals. We’re interested in exploring two angles in particular. First, we ask whether, and how, the social persona embodied by the speaker affects the resolution of the standard of (im)precision adopted by comprehenders when interpreting numerals in a general way. If this is the case, we hypothesize that an utterance produced by a speaker who is socially expected to speak precisely – in our paradigm, the Nerdy one – will be associated with a higher standard of precision than the same utterance (in the same context) uttered by a speaker who is socially expected to speak less precisely – in our paradigm, the Chill one. We call this Hypothesis 1.

Second, to gain a more comprehensive understanding of how imprecision resolution may be affected by speaker persona, we deem it important to consider the identity of comprehenders, and how it relates to that of the speaker. As we discussed in §3.1 above, social meanings are indeed highly fluid constructs: rather than a mere reflection of speaker identity, they result from a complex interpretation process mediated by who the listener is, and how they orient towards the key social features of the speaker. Accordingly, we also investigate whether, and how, effects of persona are modulated by experimental participants’ properties relative to those of the speaker. To do so, we incorporate a further factor into our analysis: the degree to which participants see themselves in the stereotypical features of the character that is presented to them.

As to the nature of such a possible modulation, prior work on the relationship between social information and speech processing suggests two equally plausible hypotheses. One hypothesis is that the predicted persona effect on imprecision resolution could be enhanced for respondents who share the salient properties of the speaker – i.e., that utterances by Nerdy speakers are ascribed an especially strict degree of precision by comprehenders that see themselves as also embodying that particular persona; and, conversely, that utterances by Chill speakers are ascribed an especially lenient precision standard by speakers who identify with the Chill characters. This possibility aligns with the general observation that listeners’ perception tends to track production, and thus to be especially accurate when involving linguistic forms that are part of the listeners’ own repertoire – a proposal that has been put forward by work on phonetic processing on different phenomena, and focused on different kinds of social information (Preston 2005; Hay et al. 2006 Sumner and Samuels 2009; Kendall & Fridland 2012). Applied to our case, this would suggest that comprehenders identifying as nerdy vs. chill should be especially attuned to the practice of describing things to a high vs. low degree of detail respectively; and that they should therefore be prone to process the utterances of characters sharing their same identity accordingly, resulting in more nerdy comprehenders interpreting numerals uttered by nerdy speakers more precisely than less nerdy ones; and more chill comprehenders interpreting numerals uttered by chill speakers more loosely than less chill ones. We call this possibility Hypothesis 2A.10

10Note that this hypothesis amounts to positing that the production/perception parallelism in phonetic processing
However, findings from work specifically concerned with investigating the effects of stereotypes on speech processing make the reverse interaction plausible as well. This possibility is suggested by experimental evidence indicating that listeners are especially prone to rely on social stereotypes in speech processing when such stereotypes concern social groups other than their own. This pattern was famously illustrated by Niedzelski’s (1999) study on the perception of raised diphthongs, in which listeners from Michigan correctly categorized the same diphthong as raised when they were told that the speaker was from Canada, in line with the dominant stereotype; but erroneously perceived it as centralized when they were told that the speaker was from Michigan – even though raised diphthongs are routinely produced by speakers from Michigan as well. Niedzielski explains this result by suggesting that Michiganders lacked a sufficiently accurate stereotype about their own speech, a flaw possibly grounded in social hesitancy to identify themselves as speakers deploying non-standard features – i.e., to the fact that Michiganders were ultimately more comfortable with a perception of themselves as speakers of standard English, and preferred to associate the use of non-standard features such as raised diphthongs with speakers from other areas (e.g., Canada, or Minnesota). *Mutatis mutandis*, comparable patterns have emerged in subsequent studies, and across different experimental paradigms. For example, Wade (2020) shows that Non-Southerners exhibit convergence towards Southern dialect features when these were labeled as “Southern”, even in the absence of actual Southern-shifted speech features in previous discourse; but that Southerners did not exhibit the same behavior, suggesting that speakers of the same variety as the one cued by the label did not actually behave in a way that aligns with the stereotype evoked by the label. This pattern, once again, suggests a greater propensity to recruit stereotypical knowledge in speech processing for listeners whose identity is not targeted by the stereotype in question. In this particular case, however, Southerners’ lack of convergence is not ascribed to a supposed reluctance of members of this group to ascribe themselves the relevant linguistic features, but to the fact that, due to their superior acquaintance with Southern speech, these participants based their response solely on the actual phonetic profile of the stimulus, effectively ignoring the stereotype evoked by the label.\(^{11}\) Taken together, these findings suggest an alternative possibility for how participants’ own identity might modulate the persona effect, which we call Hypothesis 2B: Nerdy/Chill speakers might be held to especially high vs. low standards of precision, respectively, by respondents who do not see themselves as embodying the relevant identity traits, regardless of the particular reason behind this behavior.

We now proceed to test out hypothesis in an experiment deploying a picture-selection task.
4 Personae and (im)precision: a picture matching task

Our main experiment utilizes a picture selection task inspired by the covered box task, previously used in the study of scalar implicatures and presuppositions (Huang et al. 2013; Schwarz et al. 2016). We first present the basic logic and manipulations involved in the task, and how we utilize them to operationalize our research questions (4.1-4.2); we then proceed to discuss the procedure involved in the task (4.3), as well as results of a second norming study confirming the linking hypothesis behind our measure of participant properties (4.4); finally, we present the results (4.5).

4.1 Methods & Design

Our stimuli utilized visually displayed dialogues, like those in the norming study reported above, with variants resulting from manipulations that crossed two factors in a $2 \times 3$ design. Our first manipulation, implemented between-subjects, varied the persona embodied by the displayed characters (Nerdy: Arthur and Rachel vs. Chill: Alex and Eva). Each set of characters was framed in a conversation prefaced by a brief context sentence; in the dialogue, the female character 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.

The second manipulation was a within-subjects factor. 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 turned face up with the display fully visible (VISIBLE screen). The visible screen displayed a number, whose relation to the one uttered by the character was varied across three levels: Match with identical displayed and uttered numbers; 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 (see §4.3 for further details).

Participants were instructed to select the visible screen ‘if you think that the information on the screen fits what is being said’ (see full instructions below); and to select the covered screen if they believed it wasn’t. 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 standards employed by participants on a given trial. In particular, a relatively strict interpretation – that is, one with a standard of precision

12 A parallel version of the experiment, differing only in the Match condition, was also run. In this version, the number in the visible screen was identical to the uttered one only in the part before the decimals, allowing for a minor discrepancy between the two (e.g.: Uttered number: “$300”; Visible screen number: “$300.17”). We won’t discuss this study here. For further details on this other study, as well as the rationale to adopting this approach, see this anonymized version of the manuscript: https://osf.io/vc5qn/?view_only=ae169881b34847c4906b520390888276
that excludes the value displayed on the visible screen from the extension of the predicate – should lead to a covered screen 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.

4.2 Materials

24 experimental items were created, each varied across 6 different conditions resulting from the $2 \times 3$ 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 6 items in the Match and the Mismatch conditions and 12 items in the imprecise condition, with item-condition pairings counterbalanced in a Latin Square Design. 8 items contained utterances describing prices, expressed in dollars (as in Figure 1-5); 8 items contained utterances describing distances, expressed in miles; and 8 items contained items describing times, expressed in hours and minutes.13

The experiment also included 24 filler items, which featured a dialogue between two separate characters called Becky and Tyler.14 The dialogue was also prefaced by a brief context sentence and was concluded by Tyler uttering a description with the quantifier some. In 8 filler items the visible screen would report a list of items which would make the description true; in 8 filler items it would report a list of items that would make the description false; and in 8 filler items, it would make the description under-informative, in that an ‘all’ statement would also have been true, thus yielding a condition where acceptance of the visible picture would correspond to adopting a literal ‘some and possibly all’ meaning of ‘some’, parallel to standard studies on scalar implicatures.

---

13 Across the three types of numerals, the range of deviation in the imprecise condition was always comprised between 5% and 18%: cost and distance diverged from the uttered value by 5, 6, 8, 9, 12, 14, 16, or 18; and time diverged by 1, 2, 3, 4, 5, 7, 9, 11, or 13. The ranges of divergence for times were smaller since proportionally, a minute makes up a greater proportion of an hour (1/60th) than 1 mile or dollar makes of a 100 miles/dollars, and quarter hour intervals intuitively constitute a salient degree of coarseness.

14 See Figure 12 in the appendix for illustration of the filler dialogue.
The fillers were alternated with the experimental items, so that participants would never see two consecutive occurrences of a filler or an experimental item.

4.3 Procedure

The study was implemented and administered online on the PCIbex platform\(^{15}\) (see Schwarz and Zehr 2021 for details). After providing informed consent, participants were shown the instructions in the box below.

**Instructions.** We’re going to play a little guessing game: you’ll see some cartoon-like dialogues where one person asks another one a question. That person checks their phone and responds based on information they see there. You’ll then be presented with two phone pictures. In one of them, you can see the details of the screen, while in the other one the phone is turned upside down. Your goal will be to guess which of the two phones is the one that the person is looking at, based on what this person is saying in the picture. As a general rule, you’ll select the phone with the visible screen if you think that the information on the screen fits what is being said. You’ll select the one turned upside down, instead, if you think that the information on the visible screen does not fit with what the person said. Note that just one of the pictures goes with what the second person responds. So you should only choose the phone that’s turned upside down if you don’t think the person giving the answer would have said what they did if they had been looking at the visible phone screen”.

For each item, the context sentence was introduced first on the top left of the screen. After a 4-second pause to provide time to read this, images of the two characters would appear; after another 3-second pause to allow time to look at these characters (and the critical visual cues on their persona), the question asked by the first character was shown in the form of a speech bubble; following another 3 second pause, the answer from the other character was displayed to complete the dialogue. Finally, the question reminding the participant of the experimental task as well as the two pictures of the phone appeared on the right-hand side of the screen. Participants entered their responses by pressing the key matching the letter displayed under the picture on the keyboard. The experimental items were preceded by three practice filler items in which the response would involve the use of a quantifier, and the content of the visible screen would be either a perfect match or an obvious mismatch. Feedback was provided on the practice items, so as to help the participants familiarize themselves with the task. Besides the screen choice, response times for making this choice were also recorded, but we will only discuss response patterns in this article. Figure 6 provides a full illustration of the display that participants would see once all the elements appeared.

\(^{15}\)https://www.pciibex.net
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 key qualities of the speakers in the experiment. Participants responded by selecting a value on a 1-10 scale, with 1 indicating the minimum value and 10 indicating the maximum value. The two questions were presented incrementally.\textsuperscript{16}

(4) 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

The linking hypothesis behind these questions is that the responses provide a proxy for the extent to which participants identify with the chill and nerdy speakers, respectively, which can be utilized as an independent variable to test how the effect of Persona on imprecision resolution is modulated by participants’ identity (see Hypothesis 2A-B; §3.4). Specifically, the two Likert scales above provide two pieces of information: the degree to which respondents saw themselves as featuring the social quality distinctive of the persona they had just seen in the study, which we henceforth refer to as the predominant identity trait – i.e., nerdiness for participants seeing Arthur and chillness for participants seeing Alex; and the degree to which they see themselves as featuring the quality distinctive of the persona they did not see and which was thus irrelevant to the persona that they had just seen, henceforth labelled secondary identity trait – i.e., chillness for participants seeing Arthur; nerdiness for participants seeing Alex. In light of the hypotheses in the previous section, we would only assume self-ascribed predominant traits to modulate response patterns.

\textsuperscript{16}Links to the full online experiment for both lists containing Nerdy and Chill characters are provided in the Appendix.
4.4 The nature of participants’ self-ascribed ratings: establishing the linking hypothesis

The data from our main experiment relied on the linking hypothesis just stated, but did not include any direct evidence supporting it. Before illustrating the results from the experiment, we thus first anchor the validity of this assumption empirically. To this end, we collected a further norming study aiming at directly testing the degree to which each of these two traits tracks participants’ identification with these characters. 240 participants recruited on Prolific participated in this study: similar to the first norming experiment, half of them saw a vignette featuring Arthur and Rachel, and half saw a vignette featuring Alex and Eva. In the study, participants were first asked to respond to the same two questions concluding our main experiment, repeated in (5):

(5)  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

They were then shown the cartoon with the characters and asked to respond to a third question, henceforth referred to as the character identification question, also on a 1-10 Likert scale:

(6) **Character identification question**: To what extent do you see yourself as sharing the stereotypical features displayed by {Alex and Rachel/Arthur and Eva}?

To assess the relationship between the response to the identification question and the Nerdiness and Chillness ratings collected with the first two questions, we explored the correlation between the former and each of the latter. Our linking hypothesis predicts that, for Alex and Rachel, a positive correlation should be observed between the rating provided in response to the identification question and Nerdiness, but not Chillness; conversely, we expect that, for Alex and Eva, a positive correlation should be observed between the rating provided in response to the identification question and Chillness, but not Nerdiness. The resulting scatterplots are shown in Figure 7.

Correlation analyses support the predictions of our linking hypothesis. For participants seeing the nerdy characters, participants’ nerdiness – i.e., the predominant trait – positively correlates with participants’ identification with the characters ($r = 0.36; t(119) = 4.20; p<0.001$); no correlation is observed between participants’ chillness – i.e., the secondary trait – and identification with the characters ($r = 0.00; t(119) = 0.00; p=0.99$). For participants seeing the chill characters, *mutatis mutandis*, the same pattern is observed: participants’ chillness – in this case, the predominant trait – positively correlates with participants’ identification with the characters ($r = 0.26; t(119) = 2.65; p<0.001$); no significant correlation is observed between participants’ nerdiness – in this case, the secondary trait – and identification with the characters; in fact, this association shows a numeric trend towards a negative correlation ($r = -0.12; t(119) = -1.19; p=0.24$).

This norming study thus confirms the hypothesis that each predominant trait – self-ascribed nerdiness for the nerdy characters and self-ascribed chillness for the chill characters – tracks the degree to which participants see themselves in nerdy and chill characters respectively; and that, by contrast, each secondary trait – self-ascribed chillness for the nerdy characters and self-ascribed nerdiness for the chill characters – is not an informative indicator of the identification between participants and characters.
4.5 Participants

For the main experiment, 273 participants were recruited online, 141 from Prolific and compensated $1.30; and 132 from our university’s subject pool, consisting of undergraduate students taking coursework in psychology or linguistics, who participate in experiments for course credit. In order to take part in the study, subjects were required to self-identify as native speakers of English. All participants provided informed consent approved by our university’s Institutional Review Board.

4.6 Results

Task Validation  Our first step is to validate the task and general setup of the critical condition by confirming that response patterns in the control conditions are as expected, and the critical condition taps into the right range of imprecision. Our control conditions were set up to lead to ceiling and floor levels of covered box choice rates, while the imprecise condition aimed to get sufficient variation to detect differences based on our persona manipulation. To confirm these goals of the design, we present the proportions of covered box choice rates across conditions in Figure 8. The descriptive pattern suggests that both expectations are met. First, there is a clear step-wise effect of Screen Fit Manipulation, with ceiling and floor-level response rates for the controls, and the imprecise condition in the middle, as expected. Second, covered box choice rates are right in
the middle for the Imprecise condition, and a contrast between Nerdy and Chill speaker appears to be observable there, but not in the Match or Mismatch conditions. Based on this validation of our task and general setup, we now turn to the main analysis looking at the effects of persona and participant properties in the Imprecise condition.

**Main analysis: effects of persona and participant properties** To zero in on the effect of speaker persona on imprecision resolution, possibly modulated by participants’ properties relative to the characters, our main analysis models picture selection responses with speaker persona and participants’ self-ascribed ratings from the post-experiment questionnaire as interacting predictors.

Drawing on the results from our second norming study (see §4.4), our linking hypothesis is that the predominant traits – i.e., nerdiness for participants seeing the nerdy characters and chillness for participants seeing the chill characters – are indicative of the degree of self-identification between participants and characters. In contrast, ratings for the respective secondary traits – i.e., chillness for participants seeing the nerdy characters and nerdiness for participants seeing the chill characters – are not related to self-identification with the speaker. This pattern suggests that nerdiness and chillness do not constitute opposite extremes of the same dimensions, but are mostly orthogonal to one another. To explore the overall distribution of participants’ self-ascribed Nerdy and Chill ratings, we first plotted the density distribution of the two ratings across the participants, as shown in Figure 9. Both ratings show a right-skewed distribution, with participants’ responses clustering towards the upper part of the scale (Nerdy: mean= 6.60; sd=1.95; median=7; Chill: mean= 7.19; sd=2.01; median=8). Next, we consider the relationship between ratings for the two traits. Figure 10 suggests that they are not correlated. This is confirmed statistically by a simple regression analysis ($r(271)=0.007; p = 0.89$).
We now move on to the central analysis, examining how participants’ responses are related to persona and their own properties relative to that. In light of the independence of secondary traits from identification with the persona, we only include predominant trait ratings as a predictor in our model. Figure 11 illustrates the proportion of covered choices, by speaker persona, in the Imprecise condition in relation to participants’ self-ascribed ratings along the predominant trait. The rate of covered choices appears to be higher for Nerdy speakers than for Chill speakers when identification of participants with the speaker persona (as reflected in the predominant trait rating) is low. But the difference in covered responses for Nerdy vs. Chill speakers seems to decrease, and eventually disappear, as identification between participants and speaker persona becomes stronger.

To explore the relationship between speaker persona and participants’ identification statistically, we fit a mixed-effect logistic regression with screen choice as our dependent variable, speaker persona and predominant trait as interacting predictors, and random intercepts for Subjects and Items (the maximal random effect structure that would converge). Persona was a sum-coded categorical predictor, and Predominant Trait was a centered continuous predictor (i.e., the scale from 1-10 was transformed to range from -4.5 to 4.5). The output from the model is reported in Table 1.

<table>
<thead>
<tr>
<th>Level</th>
<th>Coeff.</th>
<th>SE</th>
<th>z-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.37</td>
<td>0.25</td>
<td>1.44</td>
<td>0.15</td>
</tr>
<tr>
<td>Persona</td>
<td>-1.30</td>
<td>0.45</td>
<td>-2.90</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Predominant Trait</td>
<td>0.004</td>
<td>0.09</td>
<td>0.04</td>
<td>0.97</td>
</tr>
<tr>
<td>Predominant Trait*Persona</td>
<td>0.48</td>
<td>0.18</td>
<td>2.67</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Table 1: Mixed-effects models summary for Persona and Predominant Trait

But note that the key results also obtain in a more complex model that includes secondary traits; see details in the Appendix.
We find a significant main effect of Persona, with higher covered box choice rates for Nerds, but this effect is dominated by a significant interaction, such that the Persona effect is very strong when participants’ dominant trait scores are low, but disappears at the upper end. To further understand the nature of the interaction, we re-ran the same model using treatment coding with Chill and Nerd set as respective baselines. This reveals a marginally significant decrease of covered box choice rates as the predominant trait increases in participants in the Chill speaker condition ($\beta = -0.24$, $SE = 0.13$, $z = -1.83$, $p = 0.067$); and a marginally significant increase of covered box choice rates as the predominant trait increases in participants in the Nerd speaker condition ($\beta = 0.24$, $SE = 0.13$, $z = -1.95$, $p = 0.051$). This suggests that the impact of the predominant trait factor is indeed present for both personae, in opposite directions.\(^{18}\)

5 General Discussion

Our results support two conclusions. First, numerals uttered by speakers whose social identity triggers the association with precise speech – i.e. Nerds – are overall interpreted more narrowly than numerals uttered by speakers whose social identity carries an association with looser speech – i.e. Chill ones, supporting Hypothesis 1. Second, this effect is crucially modulated by comprehenders’ own positioning with respect to this persona, in that persona-induced differences in interpretation are most pronounced for comprehenders that identify the least with salient properties of the speaker, but disappear when speaker and comprehender are similar in relevant respects. This aligns with Hypothesis 2B, while providing evidence against Hypothesis 2A. We now turn to the broader implications of these findings for both semantics and pragmatics (§5.1) and sociolinguistics (§5.2).

\(^{18}\)For additional data analyses, including a breakdown by subject pool population in addition to consideration of secondary traits, see the Appendix.
5.1 Identity, context, and reasoning: enriching theories of meaning

The key takeaway of our study is that comprehenders reason about the speaker social identity – and in particular about the persona that they embody – to compute the standard of precision required to interpret numeral expressions. On a narrow level, our findings extend the inventory of factors that have been shown to contribute to the process. More specifically, besides being affected by contextual factors canonically considered in pragmatic research – e.g., the situational relevance of details (Lasersohn 1999; Kennedy 2007; Cummins et al. 2012); the interlocutors’ conversational goals (Aparicio 2017); or the modality of presentation of the information (Van Der Henst et al. 2002); see §2.1 – reasoning about imprecision is also tied to genuine identity-level properties of conversational participants, and to how comprehenders orient towards these properties. Combining our results with those from the previous literature in formal and experimental semantics and pragmatics, (im)precision emerges as a multi-layered linguistic phenomenon in at least two distinct senses. It is found across different lexical and syntactic categories, transcending the specific features of each of them (e.g., numerals, adjectives, noun phrases, modals; see Klecha 2014; Aparicio et al. 2016; Leffel et al. 2016; Syrett and Aravind 2021); and it is crucially situated at the intersection of different dimensions of meaning, so that its ability to convey content can only be fully appreciated by considering how these dimensions interact, as opposed to parceling them out separately. This point, in turn, aligns with the findings on other semantic and pragmatic phenomena showing that, conversely, social inferences are productively and systematically drawn from semantic and pragmatic properties (Acton 2014, 2019; Beltrama and Staum Casasanto 2017; Glass 2015; Jeong 2021; Thomas 2021; see §2.1 for further details).

At the same time, our results carry implications for semantic and pragmatic theory on a broader level, well beyond the scope of (im)precision or other specific phenomena. In particular, they pinpoint comprehenders’ social perception of speakers as central to the process whereby indeterminacy in meaning is resolved, establishing a novel empirical link between two domains that have largely been considered as independent. Establishing this link, in turn, raises a new challenge for the traditional separation between the propositional and the socio-interactional dimension of meaning that has characterized much research in semantics and pragmatics. While Grice already acknowledged that “there are all sorts of other maxims (aesthetic, social or moral in character) [...] that are also normally observed by participants in talk exchanges [...] and could also generate inferences” (Grice 1975: 47), work in the Gricean tradition generally puts such other factors aside, at least implicitly suggesting that they are somewhat independent of the core strategies for coordinating the exchange of propositional information. But this assumption crucially breaks apart once we consider the results from our study. Our task indeed utilizes conversational situations that, modulo identity-level differences between speakers, would fare as very similar in all respects normally considered in pragmatic analysis: both speaker types can be expected to be rational and cooperative to the same extent; and both speaker types are addressing the same question under discussion and share the same plans and goals, ensuring that their utterances can be seen as equivalent with respect to relevance. Against this background, the differences in interpretation associated with the two personae suggest that social distinctions between speakers do ultimately impact the outcome of interlocutors’ endeavor to exchange information to zero in on the state of the current world – the central purpose of linguistic communication under Gricean and neo-Gricean theories (see Roberts 2012 for extended discussion) – calling for a more explicit treatment of how, and at what level, social identity considerations can be incorporated in semantic and pragmatic theory.
As to how one should go about approaching this endeavor, we see two issues as especially important. One issue concerns how social identity should be treated vis-a-vis other streams of contextual information – and in particular, whether it should be considered as a qualitatively distinct factor from the other contextual elements known to affect pragmatic reasoning. More precisely: do existing approaches for representing contextual information suffice to accommodate social identity, or do they require revision and extension to do so? While a full answer will require more extensive investigation, we would like to consider one area of semantic and pragmatic theory that seems closely related to this issue: the study and modeling of perspective-dependent phenomena – that is, those expressions whose meaning is inherently linked to the point of view of a specific conversational participant, and most often the speaker. As discussed in §2.1, this category includes a host of different phenomena, including predicates of personal taste like tasty (Lasersohn 2005), expressives like damn (Potts 2007), evidentials (Aikhenvald 2004; Murray 2010), and epistemic modals (Stephenson 2007). While these are not necessarily a homogeneous class, they all are generally thought of as being anchored, in one way or another, to the doxastic or emotive state of an agent. And on standard accounts, their treatment does not involve anything more than capturing whose perspective is at stake – e.g., by incorporating an index of some sort in the accessible contextual information, to allow for the interpretation to be relativized to the relevant agent. The effects in our experiment also involve the interlocutors’ perspective, suggesting that the interpretation of numerals is impacted by both who the speaker is and how the comprehender relates to the speaker identity. Yet, they differ in several important ways from the other perspectival phenomena mentioned. First, they do not involve a direct relation between an attitude holder and a proposition: utterances containing numerals are indeed meant to be factual, descriptive representations of state of affairs, which do not depend on the speaker’s opinion, emotions or epistemic state any more than regular assertions do. Second, to capture the effects, it won’t suffice to make available information on just who the perspective-holder is – i.e., what an index generally does; rather, a richer constellation of properties have to be accessible to interlocutors – such as those indexed by the Nerdy vs. Chill personae tested in our study. Third, the observed modulation on the persona effects by participants’ own identity suggests that there isn’t only one, but two conversational participants whose identity properties are relevant here – i.e., the speaker and the comprehender – indicating that the effects discussed above would be best captured in the form of an interplay between two related, yet distinct anchors. Taken together, these differences highlight yet another, and thus far unexplored, way in which meaning interpretation can be anchored to specific conversational participants: one that cannot be straightforward captured by current approaches to incorporating perspective-dependent expressions, and therefore calls for an enrichment of how this category of meaning should be handled in semantic and pragmatic theory.

The second issue revolves around how such social information pertaining to conversational participants might be represented formally. A common approach in semantic theory is to posit a context parameter on the interpretation function \(J^c\), which consists of a sequence of bits of information (e.g., the time of utterance, the speaker, the hearer, a ‘judge’ for certain perspectival purposes, etc.). In this regard, a tempting route might be to capitalize on this already established formal device, and just add a set of properties for speaker and hearer as additional ingredients of \(c\). This move has indeed been commonly made in previous cases, as many additions of this sort have been proposed to capture other types of context-sensitivity, crucially including the degree of precision required to interpret an expression – represented in terms of a continuous index measuring the tolerated deviation from the literal meaning of an expression in Morzycki (2011), or the
appropriate level of granularity for a given expression (Sauerland and Stateva 2011). However, when it comes to our case, we see several reasons that may speak against this approach. First, the way in which social identity properties impact interpretation seems to be a further step removed from the process relative to the other ingredients of \( c \), in that they would indeed impact not the interpretation of a given form directly, but rather the setting of another part of \( c \) (say a precision parameter of the sort referenced above). In other words, social identity appears to be a factor that contributes to determining \( c \), which in turn determines the interpretation; as a result, pressing all this information in the same mold would fail to capture this relationship. Second, as noted above, we’re not just dealing with one potential new addition to \( c \), but have to allow for two new ingredients (the speaker’s and hearer’s social properties) to interact in the way that they shape the setting of something like a precision parameter. In light of these considerations, we see richer models of contextual information, which provide separate representations for different components of the context (e.g., dynamic models such as Farkas and Bruce 2010; or game-theoretic models such as Burnett 2017, 2019),\(^{19}\) as a more viable alternative for incorporating persona effects on meaning resolution. This especially applies to the need to represent interlocutors’ personae and relevant properties separately from, but along with their evolving propositional commitments, and thus adequately handle the different types of perspective-related information relevant to the exchange of propositional information.

### 5.2 Personae, stereotypes and sociolinguistic processing

Our findings further illuminate the study of sociolinguistic cognition, enriching previous work focused on exploring how speaker information shapes language processing (§3.1 for discussion). We would like to focus on two takeaways in particular.

First, our findings provide a novel, and first, illustration of the role of personae for semantic interpretation, showing that the role of these constructs in language processing extends well beyond the phonetic and syntactic domain. Second, our results show that the effect of speaker persona on imprecision resolution crucially interacts with social properties of the comprehender. In particular, with respect to the specific hypotheses we considered (see §3.4), they provide evidence against Hypothesis 2A, and align with Hypothesis 2B. Effects of speaker-persona are especially impactful on the linguistic behavior of language users who do not identify with this persona, as opposed to language users who do. This speaks against the direct production-perception link between pragmatic behavior and pragmatic interpretation that motivated Hypothesis 2A, which predicted that comprehenders embodying a particular persona have fine-grained knowledge about generalizations and expectations related to this persona’s linguistic behavior, with the consequence that they should be especially likely to recruit this knowledge when processing utterances by speakers similar to them. By contrast, our pattern of results supports Hypothesis 2B, which was motivated by findings from the sociolinguistic literature showing that social information cued via stereotypical links between forms and social categories exclusively affected participants’ responses when

\(^{19}\)An advantage of game-theoretic approaches is that they have already been successfully deployed to capture both pragmatic reasoning/semantic indeterminacy (see Lassiter and Goodman 2015; Goodman and Frank 2016 among many others) and the signaling of social meanings. However, as far as social meanings are concerned, these endeavors have primarily focus on social information conveyed in the sound domain, leaving the challenge open as to how this information effectively interacts with meaning interpretation at the descriptive level. We see this as an exciting avenue for future research.
they did not see themselves as targeted by the stereotype at stake (See §3.4 for details).

Looking ahead, two outstanding issues remain. One concerns what specific motivation drives the interplay between speakers’ and comprehenders’ identities observed in our study. Two prominent possibilities emerge from the literature. The first is that participants identifying with the speaker (consciously or unconsciously) selectively block the stereotypical association from affecting their response choices, most plausibly to fend off potential negative evaluations of their shared stereotype. 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 stereotypes impact their behavior. This line of thought would be consistent with patterns from the previous sociophonetics literature, such as the observation that participants can resist, or altogether inhibit, convergence towards the interlocutor when it comes to linguistic features that are embedded in stigmatized stereotypes (Babel 2010; Walker and 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, non-descript language users, both from a linguistic and a social perspective. Alternatively, the interaction between speaker persona and participants’ identification could reflect different degrees of having to rely on stereotypes, as suggested by Wade (2020) to capture the different propensity of Southerners and Non-Southerners to converge towards Southern-labeled speech that lacked actual Southern features (see §3.4). Applied to our case, it’s possible that the socio-indexical association between personae and precision tracks real-world patterns of numeral usage at best loosely, and ultimately inaccurately – as is indeed the case for most ideological representations of speech (see Gal and Irvine 2019 for further discussion). Respondents strongly identifying with the speaker then simply may have more and richer experiences with the relevant type of speaker, making stereotypical information less relevant. By contrast, respondents who identify less with the speaker may have less access to information drawing on actual usage, and thus rely on stereotypical information more heavily. We think that these considerations set up a promising hypothesis space that should be explored in future work using more fine-grained psycholinguistic methods to investigate the cognitive processes involved in juggling different sources of information in language comprehension.

The second lingering question revolves around whether the effects found in our study are primarily driven by Nerdy or Chill speakers, or equally by both. As noted in §3.1, our contrastive approach does not directly let us distinguish between these possibilities. However, stating the effects in such contrastive terms – by establishing a connection between contrasts in meaning interpretation and contrasts at the level of social identity – actually aligns well with a key notion in sociolinguistic and anthropological theory, namely that social constructs such as personae do not exist in isolation, but are interpreted relative to a broader system of distinctiveness (Irvine 2001; Eckert 2019). They inherently evoke, and cannot therefore be fully divorced from, possible other constructs that could have materialized in the context instead. Nerdy and Chill persona can be seen as forming one such opposition; but other contrasts that similarly affect (im)precision resolution likely exist – e.g., perhaps between Nerdy and a “young professional” persona, to cite an example of social type that received attention in the sociophonetics literature (D’Onofrio 2018). What matters is that for any such pairing, the contrasts would be best construed as part of a distinctive pattern, thereby moving away from attempts to pin the effects on one vs. the other, and instead seeing them as part of a larger meaningful opposition.

Above and beyond these issues, we believe that finding that persona effects are modulated by comprehenders’ identity lends further support, coming from a novel empirical domain, to an idea
central to sociolinguistic theory: that the social dimension of meaning is inherently intersubjective, fluid, and both speaker- and listener-dependent (Agha 2005; Eckert 2008; Campbell-Kibler 2008; Levon 2014 among many others). It thus reinforces the notion that social meanings cannot be construed as static bits of content merely reflecting speakers’ identity. Rather, they result from a dynamic interpretation process shaped by a listeners’ own affiliation and identification with the social categories embodied by the speaker.\(^{20}\) An important further source of information affecting participants’ responses to note in this context is the social profile of the addresses in the presented dialogues, i.e. Rachel and Eva, who ask the question that the speakers answer using a numeral. In our study, the two interlocutors differed in gender but shared social characteristics, creating dyads that were homogeneous in terms of persona but not in terms of other demographic features. While this was kept constant across the two speaker identity conditions, an obvious question is whether, and how, different combinations between these properties would have affected respondents’ behavior. Especially intriguing, in terms of future research, is which of two possible alternative behaviors are observed if the dyads contained mismatching personae, e.g., with a nerdy speaker addressing a chill addressee (or vice versa). One alternative would be that participants posit some sort of accommodation or convergence to take place – i.e., that nerdy speakers are taken to describe quantities more similarly to how chill ones do, and vice-versa, resulting in mitigation – or possibly neutralization – of our persona effects. The opposite possibility would be that a conversation between divergent personae might be construed as leading to strengthened patterns of identity differentiation on the part of the speaker, translating into an amplified speaker persona effect. Together with a possible re-combination of the participants’ genders, we see these steps as important to gain a more comprehensive understanding of how other social factors might factor into the overall meaning resolution process.\(^{21}\)

In conclusion, we take the parallels between previous work on sociolinguistic cognition and our findings as pointing to the need for a more comprehensive perspective on the making and interpretation of meaning across different domains of language use. In particular, the similarities in effects of social information on pragmatic interpretation and phonetic processing offer a richer, multifaceted perspective on the role of social information in language comprehension, highlighting an avenue of future work that we see as both important and exciting in the study of language.

### 6 Conclusion

We presented experimental data showing that the social persona embodied by the speaker, in interaction with participants’ own related social properties, impacts precision thresholds adopted for numeral interpretation. Taken together, these findings open up novel perspectives on the study of meaning at the interface of semantics, pragmatics and sociolinguistics, hopefully inspiring further empirical and theoretical explorations of interactions between these dimensions in future research.

\(^{20}\)A related point is that the observed speaker-comprehender interaction further strengthens the point made in §3.1 that the notion of a neutral baseline is theoretically problematic, as assessing the extent to which a participant identifies with a supposed neutral persona becomes both difficult and conceptually besides the point: if no one identifies with this neutral persona, then investigating an interaction of the relevant sort is no longer is possible; but if some participants were to identify with this persona, that would show that it is not socially neutral, since these participants necessarily bring into the picture a constellation of substantive, distinctive social properties.

\(^{21}\)We thank two anonymous reviewers for pushing us to consider this point.
References


Appendix

Each version of the experiments can be accessed online via the following link:

- Nerd: https://farm.pcibex.net/r/pKefQR/
- Chill: https://farm.pcibex.net/r/WSRZXM/

"Becky and Tyler are looking for a venue for an event"

Figure 12: Filler item

Main Analysis with Secondary Trait included  While we established that the secondary traits are not in any way directly related to whether participants identify with the persona of the character they encountered, one may nonetheless find it of interest whether the relate at all to response choice behavior. Figure 13 illustrates the relationship between Secondary Trait and covered box choice rates by speaker persona. To test for potential statistical effects, a supplemental analysis added Secondary Trait (and its interaction with persona) to the main model reported in §4.6. The output from that model is included in Table 6.

<table>
<thead>
<tr>
<th>Level</th>
<th>Coeff.</th>
<th>SE</th>
<th>z-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.35</td>
<td>0.28</td>
<td>1.29</td>
<td>0.20</td>
</tr>
<tr>
<td>Persona</td>
<td>-0.93</td>
<td>0.49</td>
<td>-1.88</td>
<td>0.06</td>
</tr>
<tr>
<td>Predominant Trait</td>
<td>-0.01</td>
<td>0.90</td>
<td>0.08</td>
<td>0.94</td>
</tr>
<tr>
<td>Secondary Trait</td>
<td>0.03</td>
<td>0.08</td>
<td>0.39</td>
<td>0.69</td>
</tr>
<tr>
<td>Predominant Trait*Persona</td>
<td>0.48</td>
<td>0.18</td>
<td>2.72</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Secondary Trait*Persona</td>
<td>-0.31</td>
<td>0.17</td>
<td>-1.77</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Table 2: Mixed-effects models summary for Persona and participants’ traits.
Most importantly for our central concerns in the paper, the interaction between Predominant Trait and Persona remains significant and virtually unchanged; similarly, the effect of Persona remains, though slightly smaller and with only marginal significance (but note that this is reporting the effect at the 0-point of the centered trait scale, corresponding to 5.5; so both the effect and its significance will increase at the lower end of the scale). The only way in which the Secondary Trait might matter is that there is a marginal interaction with Persona, reflected in the trend of the two lines in Figure 13 differing in their slope. Importantly, this interaction goes in the opposite direction, suggesting that, while predominant and secondary traits are not correlated, there is at least some partial opposition between them in the way in which the affect participants’ response behavior. In any case, our main point based on the interaction of Predominant Trait and Persona remains unchanged when we include Secondary Traits into our model.

Figure 13: COVERED responses by speaker Persona and secondary trait

**Population differences** While not central to the question we’re concerned with, the fact that we drew participants from two distinct populations raises the question whether there may be any differences in patterns across the, e.g., because the distribution of relevant participant properties might be different. Due to the reduction in power that comes with looking at roughly half the participants, the analytical approach above was not feasible due to convergence issues in the models. As an alternative, we therefore proceeded to adopt a categorical approach to the analysis of participants’ identity. Relying on the median, each respondent was assigned to one of the following categories: Higher Predominant Trait rating (>population median) vs. Lower Predominant Trait rating (≤population median).

Figure 14 illustrates the rate of COVERED responses for Persona and Predominant Trait category across the two populations. A visual inspection of the graphs suggests that Persona and Predominant Trait interact similarly across the two groups, aligning with the general pattern unveiled for the entire data set: in both cases, we observe a higher rate of COVERED responses with Nerdy than with Chill speakers for participants with a lower Predominant Trait rating – that is,
participants whose identification with the speaker stereotype is lower. This observation is also substantiated by the outcome of separate mixed-effects logistic regressions run on each population, with Persona and Predominant Trait rating category as our predictors.\textsuperscript{22} Across both populations, a significant interaction between Persona and Predominant Trait category was found (Prolific $\beta=-2.02; \text{se}=0.96; p<0.05$; College undergraduates: $\beta=-2.06; \text{se}=1.00; p<0.05$).\textsuperscript{23}

In sum, across the two populations, we found the same interaction between Persona and Predominant trait discussed in §4.6, showing that the two populations behave relatively consistently. While there may be slight differences in result patterns, despite the likely differences in the make-up of the two populations, the effect central to our interpretation of the data comes through in both, suggesting it is a robust and replicable effect.

\textsuperscript{22}We centered our predictors; this effectively corresponds to sum-coding, with slight deviation in values due to some imbalances across the various cells of our design.

\textsuperscript{23}In addition, we found a significant main effect of Persona for the Prolific population, but not for the college undergraduates one (Prolific $\beta=-1.08; \text{se}=0.48; p<0.05$; College undergraduates: $\beta=0.60; \text{se}=0.49; p=0.22$).