Contributions of pragmatics to word learning and interpretation

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1.   Introduction

A key feature of human language lies in the fact that the overall meaning of an utterance

typically goes beyond the literal meaning of the individual words and the way the words

combine within that utterance. Even a simple sentence such as "It's too high" contains

referential ambiguity ("it"), underspecification ("too high" for what?), and may convey different

things depending on context (e.g., it can be an informational statement or an indirect request for

help). Within linguistic theory, this property of natural language is captured by the distinction

between semantic, literal meaning and pragmatic, contextually derived meaning (see also

Hacquard, this volume; Schwarz & Zehr, this volume). The underlying assumption behind this

distinction is that some aspects of meaning are encoded in our mental lexicon or the

compositional rules that allow the contents of the lexicon to be combined (i.e., semantics), while

other aspects of meaning are derived contextually through inferential reasoning processes (i.e.,

pragmatics).

Many theoretical accounts of the semantics-pragmatics interface treat pragmatic

interpretation as a species of intention recognition, since hearers try to reconstruct what the

speaker meant by uttering a sentence. For instance, on Grice's theory of pragmatics (Grice

1957, 1975), hearers expect speakers to be cooperative actors who follow rational

conversational rules. Cooperative speakers are expected to make conversational contributions

that are truthful (Maxim of Quality), relevant (Maxim of Relation), clear (Maxim of Manner)

and as informative as required by the purpose of the conversational exchange (Maxim of

Quantity). Deviations from these communicative principles give hearers reasons to think that

the speaker intended to convey meaning beyond the conventional meaning of the words in the utterance, thus giving rise to pragmatic inference (e.g., in the example "It's too high", the Maxim of Relation would yield different interpretations of the utterance depending on whether the speaker and hearer had been discussing the price or the location of a toy). Subsequent theoretical accounts reinterpreted and modified aspects of the Gricean framework (Carston 1995; Chierchia, Fox, & Spector, 2009; Gazdar 1979; Horn 1972; Levinson 2000; Noveck and Sperber 2007; Sauerland 2004; Sperber and Wilson 1986/1995; Van Rooij and Schulz 2004) but preserved the foundational idea that interpreting utterances (and other non-linguistic communicative acts) relies on the ability to "read the mind" of others and understand their intentions and beliefs.

From a psychological perspective, these accounts suggest that pragmatic reasoning relies on a form of theory of mind, the capacity to recognize that others have belief states that differ from one's own (Baron-Cohen, Leslie and Frith 1985; Wimmer and Perner 1983). Furthermore, tracking the belief states of others during communication requires people to identify what information is shared (or not) with their conversational partners, a psychological construct referred to as *common ground* (Clark and Marshall 1981; Stalnaker 1970). Experimental evidence to date confirms the idea that adult comprehenders flexibly integrate information about the speaker's beliefs in interpreting language in context (Bergen and Grodner 2012; Breheny, Ferguson, and Katsos 2013; Brown-Schmidt, Gunlogson, and Tanenhaus 2008; Fairchild and Papafragou 2018; Heller, Grodner, and Tanenhaus 2008; Nadig and Sedivy 2002; Tanenhaus et al. 1995).

For the child learner, as for more mature communicators, pragmatic mechanisms along the broad lines described by Grice can be important for bridging the gap between what words

and sentences mean and what the speaker intended to communicate by uttering them in a specific context. In addition, since the meanings of words and sentences themselves are initially inaccessible to the young child, pragmatic mechanisms of intention recognition could be used to discover word meaning. For example, by assuming that the speaker is being cooperative, the child can conclude that a novel label uttered by a speaker is relevant to the present exchange, informative, unambiguous and truthful. Within the developmental literature, however, the nature and extent of children's ability to engage in rich pragmatic reasoning when interpreting the meaning of (new) words and sentences have traditionally been topics of considerable debate. In the case of word learning, general (associationist) learning accounts propose that children learn words by associating sounds (words) and perceptual stimuli (objects in a scene) without necessarily or constantly engaging in social-pragmatic considerations (e.g., Locke 1690/1964; Piaget 1952; Smith 2000; Vygotsky 1978; Werker et al. 1998). A different research tradition takes the view that children learn new words through pragmatic inference by actively consulting the speaker's mind and trying to figure out what was meant (e.g., Baldwin 1991, 1993; Bloom 2000; E. Clark 2007; Diesendruck and Markson 2001). Similarly, in the case of language interpretation, some researchers propose that children have limited ability to use pragmatic computations to derive intended but 'unsaid' aspects of meaning (and therefore appear egocentric or literal; Epley, Morewedge, and Keysar 2004; Piaget, 1952), while others attribute much greater pragmatic sophistication to young learners (Clark and Amaral 2010; Tomasello, 2000; cf. Grigoroglou and Papafragou 2017).

In this chapter, we review the available empirical evidence to evaluate the role of pragmatics in how children acquire and contextually interpret the words in their language. To advance the state of the art, we present and synthesize currently disparate sets of experimental

findings across a variety of pragmatic tasks and phenomena. We organize the chapter in terms of two major themes. In the first half of the chapter, we assess the extent to which young children use pragmatic mechanisms to build a mental lexicon (i.e., to learn new words). In the second half, we discuss the extent to which children use pragmatic inference to employ their mental lexicon (i.e., to interpret known words). Although these two areas of research have developed largely independently from one another and have produced findings that often appear contradictory, we take an integrative approach that highlights the commonalities of the mechanisms underlying children's pragmatic reasoning across these two domains despite inherent differences across phenomena of varying cognitive and linguistic complexity. To preview our conclusions, we find evidence for rich and massive effects of pragmatic reasoning in both domains. This evidence suggests continuity in pragmatic reasoning, whereby foundational aspects of the rich pragmatic system at work in adults are already in place in early stages of language development.

2.   Building a lexicon: Pragmatics in word learning

A fundamental question in the study of language is how young children acquire the meaning of words. Since children are not born knowing the meaning of individual words in their language, vocabulary acquisition is, at least in part, environment driven. However, the exact properties of the environment that allow children to form mappings between words and their referents have puzzled thinkers for centuries (see Bloom 2000; Gleitman and Trueswell, this volume, for discussion).[1] As alluded to already, two prominent views have been developed to explain word

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[1] Here, we focus on the "easy" case of learning words for concrete objects. The problem becomes even more complex once we consider words that refer to entities or events that are not directly observable in the physical world (e.g., abstract nouns, mental state verbs, logical connectives, etc.; cf. Crain, this volume; Gleitman and Trueswell, this volume.).

leaning. On one view, word learning is considered an associative process between perceptual stimuli (Locke 1690/1964; Piaget 1952; Smith 2000; Sloutsky et al. 2017; Vygotsky 1978; Werker et al. 1998). For example, children growing up in an English-speaking environment learn the word "table" by associating the sound segment [ˈteɪbəl] with the piece of furniture immediately available to them in the environment when the label is uttered. This view has been attractive because it is parsimonious: if word learning depends on the contingency between an auditory stimulus (i.e., a label) and the visual stimulus that happens to be in focus of the child's attention, it is no different than other types of (non-linguistic) learning that rely on simple cognitive mechanisms of attention and memory.

On an alternative, pragmatic view, children learn new words through pragmatic inference by actively trying to figure out the speaker's referential intention (e.g., Baldwin 1991, 1993; Bloom 2000; E. Clark 2007; Diesendruck and Markson, 2001). For instance, children learn the word "table" because they understand that the speaker, by using that particular label, intended to refer to a specific piece of furniture and no other. Although both the associationist and the pragmatic views assume that word learning happens in cases of referential clarity, where uttering a label coincides with the child's attention on a particular object, they differ in whether this coincidence is incidental or the result of interpreting the speaker's intention. Specifically, on the pragmatic view, early word learning seems to be guided by children's ability to pick up on several observable social cues in the environment that make speakers' intentions recoverable. These include information provided by the speaker herself (e.g., body orientation, direction of gaze, touching, pointing etc.), as well as information provided by the communicative context, as experienced by the child in conjunction with the speaker (e.g., information shared in physical

compresence or in prior engagement with the speaker). In the next sections, we review multiple strands of empirical evidence to adjudicate between these two perspectives.

2.1. *Pragmatic sensitivity in early word learning*

Several pieces of evidence support the view that, even at its early stages, word learning is not merely a process of associating a sequence of sounds (a word) to a perceptual stimulus (an entity in a scene) but rather a process of reconstructing a speaker's communicative intention. A first piece of evidence comes from work demonstrating that, from a very young age, children treat signals that are presumed to have communicative value as privileged for learning compared to other, non-communicative signals. For instance, 6-month-old infants are more likely to treat language-like sounds (i.e., novel words) as conveying information about a speaker's intentions compared to non-communicative sounds (e.g., a cough; Vouloumanos, Martin, and Onishi 2014; see also Martin, Onishi, and Vouloumanos 2012; Vouloumanos, Onishi, and Pogue 2012). A second piece of evidence comes from the fact that infants can assign reference to absent entities: already at 12 months children resolve ambiguous requests (e.g., "Can you give it to me?") by assuming that the speaker refers to an object that was witnessed in a previous interaction with them but is absent at the time of the request (Ganea, 2005; Ganea and Saylor 2007; Osina, Saylor, and Ganea 2017; see also Bohn et al. 2018). Thus, even at very early stages of development, children do not make superficial associations between the sound of a word and a perceptual stimulus in their environment but actively consider a speaker's communicative intention when trying to interpret what a speaker says.

Perhaps the most direct piece of evidence against associationist accounts comes from the observation that children monitor the speaker's direction of gaze and actively use gaze

information in word learning situations (e.g., Baldwin 1991, 1993; Baldwin et al. 1996; Bloom 2000; Koenig and Echols 2003). This ability arises at around 12 months of age and continues to develop during the second year of life (Pruden et al. 2006; Vaish, Demir, and Baldwin 2011; Yurovsky and Frank 2017). In a classic demonstration (Baldwin 1991), 18- to 19-month-old children were given a novel toy to play with while another toy was placed inside a bucket in front of the experimenter. The experimenter then provided a label while looking at either the toy that the child was manipulating or the toy inside the bucket. If word learning relied on simple associations between a string of sounds and an object that happened to be in the child's focus of attention, children should have associated the experimenter's label with the toy that they happened to be playing with at the moment of naming, regardless of where the experimenter was looking. Children, however, made the label-to-toy mapping only when the experimenter was looking at their own toy but not when she was looking at the toy in the bucket.

Finally, longitudinal studies of child-caregiver dyads underscore the importance of tracking the speaker's direction of gaze and engaging in joint attention for vocabulary development: individual differences in children's ability to engage in joint attention before their first birthday predict their vocabulary size later in development (Brooks and Meltzoff 2005; Carpenter et al. 1998; Tomasello and Farrar 1986; see also Bottema-Beutel 2016, for a meta-analysis). Importantly, however, the mere presence of joint attention does not guarantee successful word learning. Analyses of naturalistic infant-parent interactions demonstrate that it is the (very fine-grained) timing of the presentation of all the relevant information that crucially restricts learners' hypotheses about potential meanings of a given label (Trueswell et al. 2016; see also Gleitman and Trueswell, this volume, for discussion). Overall, the present evidence suggests that social-pragmatic cues such as joint attention are powerful learning mechanisms for

early word learning (on the availability of such cues in moments of actual word learning 'in the wild', see Trueswell et al. 2016).

2.2. Using common ground in word learning

In addition to the mechanisms outlined above, children around their second year begin using more sophisticated sources of information about a speaker's naming intentions. These sources include information shared in common ground with a speaker. Common ground with an interlocutor can be established with various types of experiences and it can include perceptual information shared by interlocutors who are physically co-present in the same environment, linguistic information shared by interlocutors engaged in the same conversation or general information shared by members of the same community (Clark and Marshall 1981). Establishing common ground with a communicative partner is essential for word learning. For instance, in one study, 15- to 20-month-old children did not learn new words when the labeling came from a disembodied voice outside the testing room: in the absence of a visible, physically co-present speaker, children did not consider this as an act of naming (Baldwin et al. 1996).

Other evidence shows that, during word learning, children consult information shared with a speaker in prior discourse. In one demonstration, Akhtar, Carpenter and Tomasello (1996) showed that 24-month-old children used discourse novelty to infer the meaning of a novel word. In this study, children and adults played with three novel objects (which remained unnamed during the playing session). These objects were later placed inside a box, along with a fourth, new (novel) object. The adults displayed excitement about the contents of the box and provided a novel label. Children assigned the label to the new object (rather than the older ones), thus assuming that the new label referred to the newly introduced object. Interestingly,

children formed this mapping even when the object was new only to the speaker but not to themselves (see also Horowitz and Frank 2015; Sullivan et al. 2019). Later work challenged the role of social-pragmatic reasoning in this context: 18- to 28-month-olds drew the same conclusions even when novelty did not arise from common ground with the speaker (i.e., from remembering that an object was new for the speaker) but from a contrast in the perceptual context (i.e., from noticing that the new object was introduced in a perceptually more salient or distinct setting compared to the older objects; Samuelson and Smith 1998). In response to this challenge, further studies found that the effect of perceptual context was subject to social cues: children did not learn labels for objects in perceptually distinct settings unless they considered the setting to be intentional rather than accidental (Diesendruck et al. 2004). Thus social-intentional considerations built over interactions with a partner affect word learning (on the development of this ability, see also MacPherson and Moore, 2010; Tomasello and Haberl 2003).

Finally, children use contrastive inferences (or *mutual exclusivity*) to narrow down word meanings in ways that might invoke common ground. Specifically, children as young as 12 months tend to assume that a novel word refers to an object for which they do not have a name (Golinkoff, Hirsh-Pasek, Bailey and Wenger 1992; Graham, Poulin-Dubois, and Baker 1998; Halberda 2006; Markman, Wasow and Hansen, 2003; Merriman and Bowman 1989). For instance, if a child is presented with two objects, one familiar (e.g., a book) and one unfamiliar (e.g., a kaleidoscope), and a speaker uses a novel label to refer to one of the two objects (e.g., "Do you want to check out the kaleidoscope?"), the child infers that the speaker is referring to the unfamiliar object (i.e., the kaleidoscope). A prominent account of mutual exclusivity links it to a pragmatic mechanism guided by Gricean considerations of what the speaker said compared

to what the speaker could have said but did not (see Clark 1990). Early support for this pragmatic view came from evidence that preschoolers suspend mutual exclusivity inferences when labels are offered by non-native or unreliable speakers, presumably because they tie such inferences to the profile of the speaker (Diesendruck 2005; Diesendruck, Carmel, and Markson 2010). However, this conclusion was later challenged by the observation that mutual exclusivity is not affected by the speaker's context-specific knowledge: across different studies, children (and adults) draw mutual exclusivity inferences irrespectively of whether the speaker was present or not during the introduction of novel labels (Diesendruck and Markson 2001; Srinivasan et al. 2019; see also de Marchena et al. 2011). Although these two findings appear to contradict each other, they can be reconciled under the assumption that mutual exclusivity for words may be a pragmatic process, albeit one that does not require highly specific considerations of other people's mental states (as in classic common ground adaptations) but simply relies on generic considerations of what is conventional within a linguistic community (a different, broader type of common ground; cf. also de Marchena et al. 2011). This conclusion is in accordance with the position that pragmatic computations of common ground operate at different levels of specificity and echoes findings from other domains showing that children adapt differently to varieties of common ground in production (see Grigoroglou and Papafragou 2019; Moll and Kadipasaoglu 2013).

2.3. *Word learning and speaker belief*

A particularly strong test of social-pragmatic accounts to word learning comes from studies asking whether children learn words by considering the speaker's knowledge when such knowledge contradicts their own. In this line of research, children are asked to learn new words

from speakers with a false belief in tasks similar to the ones used in developmental literature to study children's theory of mind in non-communicative situations (e.g., see Baron-Cohen, Leslie and Frith 1985; Buttelmann, Carpenter and Tomasello 2009; Hamlin et al. 2013; Király et al. 2018; Onishi and Baillargeon, 2005; Wimmer and Perner 1983). In one study (Southgate, Chevallier, and Csibra 2010), 17-month-olds saw an experimenter place two novel objects in two boxes and leave the scene. While the first experimenter was away, a second experimenter entered the scene and switched the location of the objects. Then the first experimenter returned, pointed to one of the boxes and offered a label for its content (e.g., "There's a sefo in the box"). The experimenter then opened both boxes without looking inside, and asked children to retrieve the named object (e.g., "Can you get the sefo for me?"). The majority of children searched inside the box that the experimenter had *not* pointed at, thus demonstrating an understanding of the speaker's referential intention despite her false belief).

Despite these early successes, other studies demonstrate failures on versions of this basic paradigm with children younger than 5 (Carpenter, Call and Tomasello 2002; Houston-Price et al. 2011). For instance, in one study (Papafragou et al. 2017), 3-, 4- and 5-year-old children watched one character place a novel object inside a box and then leave the scene. While the first character was away, a second character entered the scene and replaced the object in the box with a different novel object. Then the first character returned and named the content of the box using a novel label (e.g., "blicket"). Children were then presented with the two objects and were asked to identify the object that the label applied to ("Which one is the blicket?"). Only 5-year-olds reliably passed the task. Furthermore, children's performance closely matched performance in an equivalent false belief task that did not involve word learning (cf. Carpenter et al. 2002; *pace* Happé and Loth 2002).

At present, there is considerable discussion about the interpretation of these and similar results (e.g., see Kulke, Johannsen, and Rakoczy 2019; Poulin-Dubois and Yott 2017; Powell et al. 2018; Rubio-Fernandez and Geurts 2013; Southgate 2019, for discussions about infants' and preschoolers' performance in non-verbal theory of mind tasks). Notice that the kinds of studies reviewed above, even though similar, are not methodologically identical: for instance, infants in Southgate et al. (2010) were asked to actively participate in the task and provide an action-based response to the experimenter's use of a new label (i.e., by helping the speaker find the object she had in mind as part of the task) but in Papafragou et al. (2017) children were asked to observe interactions between different characters and provide an explicit judgement of which object the label picked out (i.e., by pointing to the object they thought the speaker had in mind in a subsequent experimental phase) . It is possible, therefore, that the discrepancy in the study findings connects to a broader pattern in the literature whereby infants have been shown to have an "implicit" awareness of others' false beliefs (e.g., Buttelmann et al. 2009; Knudsen and Liszkowski 2012; Hamlin, Ullman, Tenenbaum, Goodman and Baker, 2013; Onishi and Baillargeon 2005; Southgate, Senju and Csibra 2007; Surian, Caldi and Sperber 2007; Träuble, Marinović and Pauen 2010) but preschoolers before the age of 5 often fail in false belief tasks where an experimenter asks for "explicit" (verbal) responses about others' mental states (e.g., Bartsch and Wellman 1995; Perner, Lang, and Kloo 2002; Wimmer and Perner 1983; Wellman, Cross and Watson 2001). Alternatively, given task differences in infant and preschooler studies, it is possible that infants' successes do not reflect a rich understanding of the content of others' belief states but a (cognitively simpler) awareness of what events were co-experienced (or not) with other people, which could suffice for a wide range of infant theory of mind tasks (see Powel et al. 2018; Southgate 2019, for discussion). For instance, it seems that theory of mind

successes with infants replicate in tasks where an agent maintains contact with an object or event but fail to replicate in tasks where this contact is abrupted (e.g. Poulin-Dubois et al. 2013; Surian et al. 2007; Sodian and Thoermer 2008; Yott and Poulin-Dubois 2016; see Powell et al. 2018, for discussion).

Even though this topic remains unsettled, a prominent explanation for the pattern of results in the literature attributes the older children's difficulty in false belief tasks to the implementation of the ability to track mental states within specific tasks rather than to inability to consult false beliefs *tout court* (e.g., Scott and Baillargeon 2017; Rubio-Fernandez and Geurts 2013, among others). Within the context of word learning, two additional lines of research support this conclusion. First, in a study investigating the acquisition of mental-state verbs such as *think* and *believe*, children younger than 5 tracked other's false-belief states and used them to constrain the meaning of unknown verbs (Papafragou, Cassidy and Gleitman 2007). Specifically, 4-year-olds (and adults) were more likely to correctly guess that a novel verb in a sentence (e.g., "Matt gorps that his grandmother is under the covers") referred to an agent's mental state when the agent held a *false*, as opposed to a true, belief (e.g., when someone other than Matt's grandmother was hiding under the covers). Papafragou et al. (2007) concluded that false beliefs are more noteworthy or pragmatically salient compared to true beliefs and therefore more likely to promote mental verb conjectures (cf. also Hacquard and Lidz 2018). For present purposes, the very sensitivity to false beliefs in the context of word learning is an important finding.

Second, independent of false belief contexts, young children are known to consult a broad set of speaker properties in deciding what a novel word means: 3-4-year olds suspend word learning when interacting with speakers who express uncertainty about the referent of a

novel label, overtly display ignorance of familiar labels or are generally unreliable (e.g., Birch, Vauthier, and Bloom 2008; Jaswal and Neely 2006; Sabbagh and Baldwin 2001; Koenig and Harris 2005; Koenig and Woodward 2010; Sabbagh and Shafman 2009; Scofield and Behrend 2008; Sobel and Corriveau 2010). In these tasks - unlike classic false belief contexts - it is the conversational history of the speaker that offers cues to their mental state. These results naturally fit within a social-pragmatic framework of word learning but are harder to reconcile with an associationist account of how word forms are linked to word meanings.

2.4.   *Pragmatic and discourse principles in word learning*

Finally, there is evidence for the role of general pragmatic and discourse mechanisms during word learning. One powerful such mechanism is the assumption that speakers are following Gricean maxims – for instance, they want to be informative in context. In one study (Frank and Goodman 2014), 3- and 4-year-old children and adults were presented with a task where they had to identify the referent of a novel label (e.g., "a dinosaur with a dax") by only relying on context. Context in this task involved two identical characters (e.g., dinosaurs): both characters had one feature in common (e.g., a bandana) but one of them had an additional feature (e.g., a headpiece). By assuming that the speaker was informative, both young learners and adults inferred that the novel label referred to the unique feature (i.e., the headpiece). Later work demonstrated that such general expectations of informativeness can be combined with other, social sources of information (i.e., common ground shared with a speaker) to guide inferences about the meaning of words (Bohn, Tessler, and Frank 2019).

Inferences about the meaning of novel words can also be drawn from general assumptions about discourse coherence. Just as the meaning of words can be inferred by their

syntactic environment (e.g., Brown 1957; Gilette, Gleitman, Gleitman and Lederer 1998; Landau and Gleitman 1985), discourse structure can also be informative for word learning. For instance, in a recent study (Sullivan et al. 2019), 2- to 6-year-olds and adults were asked to guess the meaning of novel words when these were presented within temporal and causal discourse structures (e.g., "One animal handed the baby to the other animal [and/because] the baby started crying in the *talfa*'s arms"). It was found that children (4-year-olds and older) and adults successfully identified the target referent (giver/receiver) for the novel labels (see also Horowitz and Frank 2015; Sullivan and Barner 2016 for similar findings).

Taken together, the studies reviewed so far suggest that young children draw inferences about the possible meaning of a word in context based on a variety of social-pragmatic – as opposed to simply associationist - cues (e.g., a speaker's direction of gaze, presence or absence during an event, prior conversational exchanges and history). Furthermore, even in the absence of such cues, children can use general pragmatic principles and discourse properties to delimit the set of potential meanings for a newly encountered word.

## 3.	Using the lexicon: Pragmatics in early language comprehension

Even after children acquire the semantic meaning of a word in their native language, they need to confront the fact that the same word can be understood differently depending on the context. Thus, to become mature communicators, children have to be able to bridge the gap between word meaning and the meaning that a speaker intended to communicate by using a word in a specific conversation (cf. Grice, 1975; Sperber & Wilson 1986/1995). As in the case of word learning, a crucial question is how children develop this ability and whether they recruit similar mechanisms as adults in understanding what others say. Recall that some researchers propose

that children have limited ability to use pragmatic computations to go beyond what the speaker has said (and therefore appear mostly egocentric or otherwise literal; Piaget, 1957; Epley et al. 2004), while other commentators grant children more sophisticated abilities (e.g., Tomasello, 2000; Grigoroglou and Papafragou 2017 for overviews). Here we assess these proposals focusing on two pragmatic phenomena that have attracted wide attention in the developmental literature: reference and (quantity) implicature.

3.1. Reference comprehension

A foundational aspect of communication involves understanding how different types of expressions are used to pick out objects and other entities in the world (e.g., "the red pen", "the pen", "it"). On classic theoretical models of reference, the interpretation of referential expressions largely depends on expectations of informativeness (Grice's maxim of Quantity), constrained by assumptions about what information is shared or not with a conversational partner in common ground (Clark and Marshall 1981). For instance, the utterance "Give me the pen" is easy to interpret if there is a single pen in the scene but confusing in case there are multiple pens (unless the hearer can identify based on visual cues, prior discourse or other common-ground knowledge which pen the speaker has in mind). Psycholinguistic evidence confirms that adult comprehenders take into account the information shared in common ground with a speaker when resolving such referential ambiguities (e.g., Heller, Grodner, and Tanenhaus 2008; Tanenhaus et al. 1995; Nadig and Sedivy 2002). Of interest is whether children's interpretation of ambiguous referential expressions is guided by speaker-oriented assumptions.

Experimental paradigms designed to investigate reference resolution in children typically create a knowledge mismatch between a speaker and the child comprehender by manipulating the objects that a speaker can or cannot see. For example, participants in the task are presented with a box with different compartments, containing different objects. Crucially, the contents of one (or more) of the compartments is visible only by one of the participants. In critical trials, the speaker produces an utterance which is ambiguous from the child's perspective (e.g., "Pick up the duck", when the child can see two ducks) but unambiguous from the speaker's perspective (i.e., the speaker can only see one duck). In such trials, if children take into account the speaker's perspective in interpreting the request, they should reach for the object that is visible to both themselves and the speaker. In eye-tracking experiments, 5- to 6-year-olds (and to some extend 3-year-olds) interpret such ambiguous requests from the perspective of the speaker by quickly looking at and reaching for the mutually visible object (Nadig and Sedivy 2002; Nilsen and Graham 2009; see also Morisseau, Davies, and Matthews, 2013).

In other circumstances, children's (and adults') ability to rapidly integrate information about the speaker's perspective in reference interpretation is hindered. For instance, given a somewhat more complex visual array of objects, 4- to 12-year-old children and adults initially ignored the perspective of the speaker and looked at the object visible only to themselves (Epley et al 2004; see also Wang et al. 2016). Importantly, in this study, although adults eventually recovered from their initial egocentric bias, children largely did not (Epley et al. 2004). In fact, even in an earlier eye-tracking study where children successfully considered the speaker's visual perspective, they were slower to integrate this perspective compared to adults (Nadig and Sedivy 2002). Other studies demonstrate that children's perspective-taking in reference

resolution continues to develop well into preschool years and adolescence and only gradually becomes adult-like (Dumontheil, Apperly and Blakemore 2010; Wang et al. 2016).

Taken together, these findings suggest that one needs to draw a distinction between having an appreciation of others' mental states and using this ability in communicative situations that require integration of multiple sources of information, including an interlocutor's perspective, visual context, linguistic complexity, etc. (Grigoroglou and Papafragou 2017; Nilsen and Fecica 2011; Lin, Keysar, and Epley 2010). On this view, differences in children's performance across referential communication tasks (and across developmental time) do not necessarily involve children's ability to represent others' perspective but rather the capacity to integrate perspective information with other types of information (e.g., the child's own perspective, visual information from context, linguistic complexity of utterances etc.). In this light, seemingly small differences among tasks may produce significant discrepancies. For instance, the fact that children's performance was overall better in Nadig and Sedivy (2002) compared to Epley et al. (2004) can be attributed to the fact that Epley et al. used a more complicated visual array and, within this array, the underspecified descriptions applied better to the referent that was visible only to the child, such that suppressing one's own perspective was harder than in the Nadig and Sedivy study. Furthermore, in Nadig and Sedivy's task, children were repeatedly reminded throughout the experiment that the speaker could not see what they did, thereby scaffolding the maintenance of visual perspective information in memory.

Echoing earlier discussion in the context of word learning, we conclude that children appreciate the referential perspective of their communicative partner very early, but the implementation of this ability depends on demands of different tasks. Two additional pieces of evidence support this conclusion. First, in individual children the ability to align with the

speaker's visual perspective when resolving reference correlates with inhibition (i.e., the ability to suppress one stimulus in favor of another; Nilsen and Graham 2009). Second, in reference resolution tasks where maintaining speaker-specific information does not involve contrasting one's own visual perspective with the speaker's, children are highly likely to consult the speaker's profile. For instance, 3- and 4-year-olds are sensitive to a speaker's action constraints (e.g., whether she has her hands empty or full) when they interpret referentially ambiguous requests (Collins, Graham, and Chambers 2012). Relatedly, 4- and 5-year-olds (but not 3-year-olds) use the speaker's emotional perspective (e.g., sad vs. happy tone of voice) to guide reference resolution (Berman, Chambers, and Graham 2010; San Juan et al. 2017).

3.2.   *Implicature comprehension*

Successful communicators routinely calculate components of speaker meaning that are conveyed without being explicitly stated. For example, when hearing the utterance "Some of the butterflies flew away", one can easily infer that not all of the butterflies flew away, although this inference was not part of the literal meaning of the utterance. Similarly, the utterance "John's mother was very sick" invites the inference that John's father was not. These examples are instantiations of quantity (or scalar) implicatures (Grice 1975; cf. also Sperber & Wilson 1986/1995), a type of conversational inference that arises when the speaker violates informativeness by using an informationally weaker expression (*some* vs. *all*; *mother* vs. *mother and father*) and expects the hearer to understand that the speaker is not in an epistemic position to offer the stronger term (see Horn 1972, 1984; Hirshberg 1985; Levinson 1983, on different definitions of informational strength; see also Schwarz & Zehr, this volume). As in the case of reference, a key requirement for calculating quantity inferences is the ability to access and

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reason about relevant lexical alternatives (i.e., expressions that the speaker could have uttered to be more informative but did not). A second key requirement is to evaluate how much the speaker knows (more knowledgeable speakers are more likely to use a weaker term to implicate that the stronger term does not hold). In accordance with broad Gricean accounts, adult comprehenders take into account speaker-specific information, including speaker knowledge, alongside informativeness expectations when processing quantity implicatures (Bergen and Grodner 2012; Breheny, Ferguson, and Katsos 2013; Fairchild, Mathis and Papafragou, in press; Fairchild and Papafragou 2018).

A relatively small set of studies to date has asked whether children integrate speaker knowledge and informativeness in implicature computation (Hochstein et al. 2014; Barner et al. 2018; Papafragou, Friedberg, and Cohen 2018; Kampa and Papafragou 2020). In one such study (Papafragou et al. 2018), 4- and 5-year-old children watched two videos, where two almost identical agents ("twins") performed the same action (e.g., colour a star). In one video, an observer witnessed the whole event; in the other video, the observer fell asleep halfway through the action and only watched part of the event. At the end, children heard either a strong or a weak statement (e.g., "The girl coloured all/some of the star") and had to attribute it either to the fully knowledgeable or to the partially knowledgeable observer. Results showed that 5-year-olds were able to attribute informationally strong statements to knowledgeable observers and informationally weak statements to partially informed observers, but 4-year-olds could not reliably link the observer's (i.e., speaker's) epistemic state to the informational strength of different statements. The 4-year-olds' performance improved only when the epistemic component was removed (cf. also Barner et al. 2018; Hochstein et al. 2014).

A further study using a simple paradigm inspired by the literature on referential communication demonstrated that even 4-year-olds can integrate speaker knowledge in calculating implicatures (Kampa and Papafragou 2020). In this study, 4-year-olds, 5-year-olds and adults saw pairs of pictures showing the same person sitting across a table behind a two-compartment box with identical objects (e.g., a spoon and a bowl). In one picture, the person in the picture could see the contents of both compartments in her box (e.g., both the spoon and the bowl) but in the other, she could only see the content of one compartment (e.g., only the spoon). Participants heard either a strong statement (e.g., "I can see a spoon and a bowl") or a weak statement (e.g., "I can see a spoon") and had to choose the box that the speaker was talking about. At age 4, children were highly successful in matching weak statements to the pictures where the person had limited access to the contents of the box (e.g., she could only see the spoon), and, by age 5, they were entirely adult-like. Extensions of this method showed that children could use similar reasoning when the communicator used a drawing of either a single object (a spoon) or two objects (a spoon and a bowl) instead of an utterance to identify the intended box (Kampa and Papafragou subm.). Thus, children apply expectations of informativeness in combination with speaker knowledge to instances of both linguistic and non-linguistic communication, as predicted by pragmatic accounts (Grice 1975; Sperber and Wilson 1988/1995; cf. also Gweon et al. 2014).

Despite these successes, as decades of earlier developmental research show, children face persistent limitations in deriving quantity inferences in more open-ended contexts. For instance, when presented with logically true but under-informative descriptions of events (e.g., "Some of the horses jumped over the fence", when all of the horses had jumped over the fence), 5-year-olds are massively more likely (Foppolo, Guasti, and Chierchia 2012; Guasti et al. 2005;

Chierchia et al. 2001; Pouscoulous et al. 2007; Noveck 2001; Papafragou and Musolino 2003; Barner, Brooks, and Bale 2011; Huang and Snedeker 2009) to accept such descriptions compared to adults (Papafragou and Musolino 2003; cf. Noveck 2001; Foppolo, Guasti, and Chierchia 2012; Guasti et al. 2005; Barner, Brooks, and Bale 2011). Children's difficulties persist even in online processing tasks that do not require explicit felicity judgements (Huang and Snedeker 2009). Children's performance improves in judgment tasks that provide training in pragmatic infelicity (Foppolo et al. 2012; Papafragou and Musolino 2003), or offer more nuanced response options (Katsos and Bishop 2011). Notice that, unlike the studies on quantity inference and speaker knowledge reviewed earlier (and the referential communication tasks that inspired them), most of the felicity judgment tasks testing comprehension of quantity implicature do not involve conversational exchanges with an interactive addressee who intends to convey a quantity implicature (often the speaker is a 'silly puppet' who only unintentionally produces an infelicitous utterance). A further difference is that, unlike the studies reviewed in the beginning of this section (and most referential communication paradigms), children are asked to evaluate an utterance in the absence of specific information about what is relevant in the task.

In sum, children's failures in a long line of felicity judgment tasks in which they have to reject what (from an adult's perspective) is an under-informative utterance are plausibly due to a failure to reason about the goals of the task (i.e., what is a relevant alternative to what the speaker has said), especially when there are no clear indication of what these goals are and no genuine interlocutor. In direct support of the role of relevance, 5-year-olds compute quantity implicatures when more informative lexical alternatives are highly accessible, but only if these alternatives are relevant to the probable goal of the task (Papafragou and Skordos 2016).

Furthermore, in simple tasks where quantity inferences are used for a clear conversational goal (e.g., to identify a referent) and relevant lexical alternatives are highly salient, even children younger than 4 compute quantity implicatures (Stiller, Goodman, and Frank 2015; Kampa, Richards, and Papafragou 2019).

4.   Conclusion

In this chapter we surveyed a rich set of experimental evidence demonstrating the role of social-pragmatic mechanisms in very young children's lexical development. This evidence suggests that infants with limited linguistic knowledge use a variety of social-pragmatic mechanisms to identify possible meanings for newly encountered words. Similarly, children use pragmatic reasoning to constrain potential contextual interpretations of known words (e.g., when resolving referential indeterminacy, or drawing conversational implicatures). Thus, from the perspective of the young learner, pragmatic mechanisms have a role both in constraining hypotheses about what newly encountered words mean, and in contextually enriching the linguistic-semantic meaning of known words during a conversation. Perhaps most importantly, children's pragmatic computations seem to rely on a pragmatic architecture that flexibly integrates information about properties of the speaker with a developed set of expectations about how rational communicators should talk (Grice 1975; Sperber and Wilson 1985/1996), thereby suggesting continuity with major components of the adult system.

At the same time, this chapter has highlighted several limitations in children's reliance on pragmatics to acquire and use their lexicon. For instance, even though preschool-aged children frequently consider the perspective of the speaker across several phenomena, the ability to do so consistently and to adult levels of sophistication undergoes significant development. As

a result, learners can be inconsistent in their ability to consider the speaker's knowledge (e.g., Epley et al., 2004; Hochstein et al. 2014; Papafragou et al. 2017, 2018), fail to compute some pragmatic inferences that adults routinely derive (e.g., Noveck 2001; Huang and Snedeker 2009), and might show strikingly different responses in what appear to be close variants of the same task (e.g., Nadig and Sedivy 2002; Epley et al. 2004). We have suggested that these limitations emanate from difficulties implementing fundamental pragmatic mechanisms across different contexts, and not from pragmatic insensitivity. This idea is further supported by the fact that general cognitive limitations in children correlate with pragmatic performance (Matthews et al. 2018), and that even adults' pragmatic performance deteriorates under cognitive load (e.g., see Horton and Gerrig 2005; Wardlow Lane and Ferreira 2008). Learners overcome these limitations as they become capable of inferring common ground or referential intent from less overt cues across different phenomena such word learning (e.g., Papafragou et al. 2017), reference resolution (e.g., Nilsen and Graham 2009) and scalar implicature (e.g., Stiller et al. 2015; Kampa and Papafragou 2020).

To be sure, the picture of pragmatic development presented here is highly selective and needs to be broadened in several respects. First, for simplicity's sake, we have examined the processes of acquiring and contextually interpreting the words in one's language as distinct processes, but naturally, both processes operate in tandem in language acquisition: in most word learning studies we described, children are figuring out the meaning of a novel noun as they solve a referential question (how to choose an object among many possible referents for a new name). The true task for learners is thus how to extract the semantics of a word from its pragmatically enriched interpretations as these interpretations shift more or less dramatically across contexts of use. Second, in the present review we have focused exclusively on lexical

comprehension, but it is clear that similar issues arise in lexical production. Indeed, recent work has suggested that pragmatic pressures such as informativeness shape children's use of the lexicon in production, often in strikingly similar ways cross-linguistically (Bannard, Rosner, and Matthews 2017; Grigoroglou, Johanson, and Papafragou, 2019). Third, we have sampled only a few of the many pragmatic phenomena actively being investigated in the literature, and mostly included examples from studies on typically developing English speakers (see Grigoroglou and Papafragou 2017; Matthews, Biney, and Abbot-Smith 2018, for additional examples). A fuller picture of pragmatic development needs to broaden the empirical basis under discussion and include learners from a wider variety of communities and backgrounds.

As this chapter showed, one of the biggest challenges in studying the contribution of pragmatics to children's acquisition and use of the lexicon is inferring the state of the learner from variable, often contradictory patterns of pragmatic performance. Moving forward, we suggest two main directions that could be pursued to address this challenge. First, the field needs more specific linking assumptions between formal models of semantic-pragmatic representations and the specific demands of individual psycholinguistic paradigms used to study pragmatic abilities across children of different ages and adults. Such an integrated approach can help elucidate the nature and growth of the pragmatic system, as well as bridge the mostly separate research traditions now studying early word learning and pragmatic interpretation in preschoolers and older children (e.g., for notable examples see de Marchena et al. 2011; Srinivasan et al. 2019, on mutual exclusivity; Kampa & Papafragou, 2020, on implicature). Furthermore, computational models paired with behavioral methods can tease apart the variables, assumptions and computations that comprise word learning and interpretation at the semantics/pragmatics interface (e.g., see Bohn et al. 2019; Frank & Goodman 2014).

Second, and relatedly, it is important for the field to move towards an investigation of how the same pragmatic principles apply across diverse linguistic phenomena. For instance, the principle of informativeness is an underlying assumption guiding inferences across a variety of phenomena in both word learning and interpretation but has been examined mostly within limited, individual phenomena such as sensitivity to discourse novelty in word learning (e.g., Akhtar et al. 1996), referential communication (e.g., Nadig & Sedivy 2002), or scalar implicature (e.g., Noveck 2001). It would be interesting to see how this assumption (or other similarly broad pragmatic principles) is implemented across different linguistic phenomena and even in non-linguistic communication (see Kampa et al., 2019).

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