**Ad-hoc pragmatic implicatures among Shipibo-Konibo children in the Peruvian
Amazon**

Martin E. Fortier

Institut Jean Nicod, Department of Cognitive Studies, Ecole Normale Supérieure
Department of Philosophy and Social Sciences, Ecole des Hautes Etudes en Sciences Sociales
PSL Research University

Danielle Kellier

Department of Psychology, Stanford University

María Fernández Flecha

Department of Humanities, Pontificia Universidad Católica del Perú

Michael C. Frank

Department of Psychology, Stanford University

Abstract

Pragmatic reasoning – the ability to infer the intended meaning of an utterance in context – is one of the core aspects of language comprehension. Yet classic linguistic accounts of pragmatics may not apply as consistently in non-WEIRD (western, educated, industrialized, rich, democratic) contexts. Children’s ability to reason pragmatically increases across childhood in U.S. and European communities. Ad hoc (contextual) implicatures tend to emerge around age four, but this pattern has not been studied cross-culturally. We conducted a study of the development of ad-hoc implicatures in Shipibo-Konibo communities in the Peruvian Amazon – a culture with a holistic orientation that might be expected to lead to a decrease in the felicity of implicatures, inferences which typically lead restrictions on context. While 8–10 year-olds successfully made these implicatures, younger children did not, despite successfully understanding control trials. These findings suggest that ad-hoc implicatures are available interpretations, even in a community with different cultural expectations, but that their development may be more protracted.

Introduction

One of the most salient – and fascinating – aspects of human language is the ability of speakers to express a complex and subtle range of meanings that go beyond the literal semantics of their utterances. To take a classic example, a letter of recommendation that contains praise for penmanship and punctuality can still be damning based on its omission of certain important information (Grice, 1975). This kind of pragmatic reasoning – reasoning about a speaker’s intended meaning in a particular context – allows the flexible, social use of language to accomplish a wide variety of different goals (Grice, 1975; Clark, 1996; Goodman & Frank, 2016).

In the current study, we use ad-hoc implicatures – a specific pragmatic phenomenon – as a case study of the broader process of contextual reasoning about language. For example, in the letter of recommendation case, the pragmatic implicature is that the candidate is *not* intelligent or hard-working. Because such implicatures can be constructed even in very simple contexts, they can be a useful tool for studying developmental change in pragmatic inferencing ability (e.g., Papafragou & Tantalou, 2004; Stiller, Goodman & Frank, 2015; Horowitz, Schneider, & Frank, 2017). But to date this research has only been conducted in WEIRD – western, educated, industrialized, rich, democratic – contexts (Henrich, Heine, & Norenzayan, 2010). We extend this work by examining developmental change in ad-hoc implicatures in a non-WEIRD culture, the Shipibo-Konibo (SK) people of the Peruvian Amazon.

In the remainder of this introduction, we introduce questions about the cross-cultural universality of pragmatic principles, the current state of the developmental evidence, and the specifics of our investigation.

Gricean pragmatics across cultures

Grice's (1975, 1981) theory of pragmatics and implicatures is based on the idea that the meaning of a sentence derives from what the speaker intends to communicate. Despite its foundational impact in linguistics and psycholinguistics, the universal application of this intention-based approach has been criticized. For example, the "intentionalist" (or "mentalist") view of pragmatics may not apply in cultures in which the "opacity of mind" ideology prevails (Robbins & Rumsey, 2008). In such cultures, people are reluctant to speculate about other people's intentions, and the mind is purported to be opaque and not easily readable. In Samoa, making pragmatic inferences has been described as less about understanding the speaker's intentions than looking at the social and material consequences of utterances. The role of invisible mental states is downplayed while that of the visible outcomes of speech acts is highlighted (Duranti, 1984, 2014). Similarly, Danziger (2006, 2010) has observed that the "opacity of mind" prevailing in the Mopan Maya culture of Belize undermines the very notions of intention and lie. Mopan Mayas do not seem to make any distinctions between a false sentence intending to deceive the listener and a false sentence whose falsehood is non-intentional. What really matters in their eyes is that a false sentence does not accurately depict the world, regardless of what the speaker's intention was.

Several investigators have also questioned whether the specific "maxims" of cooperative communication outlined by Grice (1975) are in operation consistently across cultures.¹ Drawing upon data collected in rural Madagascar, Ochs (1976) suggested that the maxim of informativeness is not used as extensively in other contexts as it is in Western culture. Similarly, Harris (1996) and Le Guen (2018) have pointed out that in rural Egypt and in Maya Yucatec culture, speakers are not generally expected to comply with truthfulness. On

¹ Although this critique is posed in specifically Gricean language, we believe it applies equally to neo-Gricean accounts (e.g., Goodman & Frank, 2016).

the contrary, Le Guen remarks that Yucatec Mayas' default expectation seems to be that lies and deception are pervasive.

When anthropologists and linguists question the purported universality of Gricean accounts, however, they are not claiming that the people they have studied on the field *never* comply with cooperative norms. The claim is rather that *in some situations* in which we would expect compliance with these norms in a Western context, no such compliance is to be found. Yet despite this general interest in pragmatic norms across cultures, and the importance of measuring the degree of compliance with Gricean accounts, relatively little work in the cross-cultural context has made use of new experimental paradigms designed to study pragmatic behaviors in the lab (e.g., Noveck & Reboul, 2008). In particular, experimental measurement might help researchers understand the degree to which patterns of reasoning are truly infelicitous vs. simply less common.

Pragmatic development

The development of pragmatic abilities in childhood has been the focus of a deep literature. This work has examined a wide range of topics including the use of contextual, social, and discourse information (see e.g., Clark & Amaral, 2010) and the construction of common ground in word learning (for review, see Tomasello, 2000). A particular focal point – with important implications for our study here – has been the question of the degree to which children make Gricean implicatures (e.g., Noveck, 2000; Papafragou & Tantalou, 2004; Barner, Brooks, & Bale, 2011; Frank & Goodman, 2014). One line of this work has examined performance in lexical scales such as quantifiers (e.g., “*some* of the cookies” implicates “*not all* of the cookies”; Noveck, 2000). There is an emerging consensus that developmental issues in making such implicatures are related at least in part to knowledge of the individual scale members and their relationship to one another as alternatives (e.g., Barner, Brooks, & Bale, 2011; Horowitz, Schneider, & Frank, in press).

In contrast, an alternative line of work has tried to measure children's performance in tasks where the relevant pragmatic implicature is created from contextual alternatives (e.g., Papafragou & Tantalou, 2004; Stiller, Goodman, & Frank, 2015). These tasks have the advantage of using situations that are easily accessible to children, offering the possibility of capturing developmental changes in the ability to make pragmatic inference. In Stiller, Goodman, & Frank (2015), children were shown arrays containing three images, for example: [(1) a man], [(2) a man + glasses], [(3) a man + glasses + a hat]. They were then asked to help a puppet who said "My friend has glasses. Which one is my friend?". While the statement is literally true of both (2) and (3), on Gricean and other related accounts, an informative speaker would probably have said "hat" (or "hat and glasses") to describe (3). Thus, the puppet implicates pragmatically that (2) is his friend. In that study, children around 3.5 years old showed evidence of choosing (2) over the – presumably more interesting and salient – alternative (3).

Evidence from this study converges with data from a wide range of similar "ad-hoc" (contextually-created) implicature tasks that show evidence of success around four years of age (Horowitz, Schneider, & Frank, in press; Barner, Brooks, & Bale, 2011; Papafragou & Tantalou, 2004). But all of these studies have been conducted exclusively with Western populations, using convenience samples that typically reflect children recruited in WEIRD regions. Despite the simplicity of such tasks, and hence their suitability for translation across cultures and populations, little work has been done using them to investigate cross-population or cross-cultural differences in pragmatic inference.²

The current study: Ad-hoc implicatures, salience, and culture in the Shipibo-Konibo

The current study thus adapts the task described above from Stiller, Goodman, & Frank (2015) to investigate cultural variation in pragmatic development, specifically in the

² This pattern stands in contrast to work on quantification, which has made substantial progress cross-linguistically (Katsos et al., 2016).

Shipibo-Konibo (SK) people. The SK are an indigenous group living in the Peruvian Amazon, along the Ucayali River and its tributaries. They are mainly horticulturalists and fishermen (as well as occasional hunters), but are being increasingly integrated into the national Peruvian market economy. Although interactions with the Peruvian mestizo world – and even the Western world – are regular, SK culture remains very lively and still displays a strong identity.

Pragmatic inference in the SK has not previously been studied, but is of interest due to specific features of SK culture. While previous critiques of Gricean pragmatics across cultures have focused on the feature of “opacity of mind,” which is absent in Amazonia, we highlight another cultural feature that has been ethnographically reported to be present in Amazonia: a strong holistic prior (e.g., Walker, 2009). One major consequence of this prior is the reluctance to abstract a single entity from the web of entities it is intertwined with.

Holistic priors have been studied extensively by cultural psychologists. For example, in their study of the Menominee, a Native American culture of Wisconsin, Medin and colleagues have shown that when asked to sort fish, Euro-Americans did so by looking at the morphology or culinary merit of the fish, whereas Menominee mostly relied on ecological interactions the fish entertained with other components of the river ecosystem (Medin et al., 2006). This finding can be interpreted as supporting the idea that indigenous people are reluctant to isolate an entity from its broad environmental context. The holistic prior is also at play in the perception of foregrounds and backgrounds. When asked to describe the last memorable time they had fishing, Menominee participants, compared to Euro-American participants, use substantially more words describing the background and the context of the activity before actually mentioning the fish itself (Atran & Medin, 2008, Chapter 5). Interestingly, this perceptual preeminence of the background over the foreground has also been noted among East-Asians (Masuda & Nisbett, 2001, 2006). Finally, there is some initial

developmental evidence for holistic priors in Native American children. In one study, Menominee children were not willing to play with toy representations of plants and animals if a diorama realistically representing the background environment was not provided (Washinawatok et al., in press).

There is also evidence supporting the presence of holistic priors in Amazonian indigenous thinking. Ethnobiologists have stressed the prominence of relational and ecological models of animals and plants in Amazonian cultures (e.g., Lenaerts, 2004). For example, an animal is less defined by its intrinsic morphological properties than by its extrinsic features (its habitat, trophic position, interactions with other animals and plants, etc.). Even more to the point, it has been shown that SK adults learn multifactorial causality more easily and reliably than U.S. adults (Fortier, Wente, Fernández Flecha, & Gopnik, submitted). Specifically, when they have to guess whether one or multiple objects are required to activate a “blicket machine”, they are better than U.S. participants at detecting activation of the machine caused by multiple objects. U.S. adults are good at tracking unifactorial causal patterns but notably fail to track multifactorial causal processes (Lucas, Bridgers, Griffiths, & Gopnik, 2014). This finding thus speaks in favor of the holistic prior hypothesis: SK seem to conceive of objects of the world as being intertwined and extensively interacting together, whereas U.S. adults tend to contemplate them in isolation.

Could a holistic prior affect pragmatic inference? In the ad-hoc implicature described above (“glasses” used to refer to (2) [glasses and no hat] rather than (3) [glasses and hat]), there is a conflict between the salience of a particular referent (in this case, 3, which has two features) and the implicature that (2) is the speaker’s likely intended referent. One hypothesis is that young children’s difficulty in this paradigm stems from their difficulty overcoming the salience of (3) in favor of (2) (Yoon & Frank, submitted). Our proposal is that choice of (3) over (2) may vary across cultures, as predicted by the holistic prior. A listener who has a

strong holistic prior might ascribe more weight to salience—to the contextual fit and richness of referent (3)—and less weight to pragmatic inference.

We test this proposal by conducting a variant of the ad-hoc pragmatic inference task described above with a group of SK children (4-10 year-olds). In general, SK children have a routine that is a mix between more traditional activities and educational activities. They tend to spend about 3 to 4 hours a day at school (every morning). Teaching at school is bilingual and this is how they are first exposed to Spanish language, but they do not master the basics of Spanish before early adolescence. When they are not at school, children spend their time playing with peers, without being monitored by adults. They are also quite involved in the daily tasks of their household (caring for younger siblings, gardening in the family *chagra*, fishing, cooking, etc.). Doing so, they learn a great deal of skills. As in many other indigenous cultures, learning occurs simply “by observing and pitching in” (Rogoff, 2014) and without any formal teaching (Lancy, 2016). As a result, SK children seem mature and autonomous compared to the average Western child.

Testing SK children allows us to assess the strength of ad-hoc inference in a non-Western population. In addition, it allows us to test the specific hypothesis that we may see a greater weight on the salient alternative referent in children growing up in a culture with a holistic prior. In a pilot study, we tested SK children using the Stiller, Goodman, & Frank (2015) three-object paradigm described above. This paradigm proved to be difficult for young children, however (based on low performance even on control trials). As a consequence, in the present study, we used a simplified version of the paradigm that was designed for younger U.S. children and that involves computation of implicatures over two – instead of three – images (Yoon & Frank, submitted). Example stimuli are shown in Figure 1.

Figure 1. Example stimulus for a pragmatic inference (where the utterance would be “rice,” with correct answer on the left) / control-double trial (where the utterance would be “fish,” with correct answer on the right).

Methods

Participants

Our protocol received ethical approval from Pontificia Universidad Católica del Perú’s Institutional Review Board. Children were recruited in two SK neighborhoods of Yarinacocha, in the Pucallpa region of Peru, as well as in Bawanisho, a native community settled along the Ucayali River, 4 hours South of Pucallpa. Children were recruited either through their parents or through local schools. When recruited at school, consent for participation was collected from both the teachers and the parents; otherwise, only consent from the parents was collected.³ Data were collected from a total of 84 children, but 6 had no reliable age data associated and were excluded on this basis. The remaining 78 children were between the ages of 4 and 10 years old, with two exceptions who were older and were excluded from further analysis. Age of children was recorded as it was indicated by their DNI (Peruvian identity document). The 76 children in the final sample were split post-hoc into three two-year age groups for descriptive and visualization purposes. Sample composition is

³ Although all children were eager to participate in the experiment, we could not test all of them, because some parents feared that we might be *pishtacos* (organ and blood thieves) and were thus reluctant to have their children involved.

shown in Table 1. Female children were more likely to participate because male children tended to be away from the village slightly more often.

Table 1. Sample composition.

Age Group	Age (SD)	N	Male
4 - 6 year-olds	5.4 (.49)	11	3 (27%)
6 - 8 year-olds	7.1 (.50)	30	16 (53%)
8 - 10 year-olds	9.0 (.59)	35	13 (37%)

Stimuli

Our study had four trial types: *warm-up*, *control-single*, *pragmatic inference*, and *control-double*. Based on our earlier pilot study, we created a set of stimuli that were locally appropriate and that we believed would be easy for SK children to name (see repository for all materials⁴).

Warm-up trials consisted of 4 consecutive trials where a participant needed to choose between 2 images. Although the pair belonged to the same superordinate category, they did not share any highly salient features. Warm-up trials were a *flower* vs. a *hat* (baseball cap), a *dog* vs. a *chicken*, a *chair* vs. a *ball*, and a *jaguar* vs. a *peccary* (local wild pig).

The main block of trials in the experiment consisted of two control-single trials, two pragmatic inference trials, and two control-double trials. Control-single trials were, like warm-up trials, choices between two different images, but this time more closely matched (images from the same basic-level category that differed on some property). The control-

⁴ Materials are available at: https://github.com/langcog/amazon_pragmatics/tree/master/materials

single trials were a *black-and-white kene* (fabric square) vs. a *colorful kene*, and a *gringo* couple (pair of Caucasian adults) vs. *Shipibo-Konibo* couple (pair of SK adults).

In contrast, the base stimulus for both pragmatic inference and control-double trials was a pair of “containers” (e.g., *plate*; see Figure 1). Both containers shared one item (e.g., *rice* on the plate) and one had a unique item as well (e.g., *fish*). Items were *plates* with *fish* and *rice*, *motocarros* (vehicles) with *men* and *baskets*, *malocas* (traditional circular houses) with *trees* and *outhouses*, and *tables* with *plantains* and *aguaje* (moriche palm fruit). On pragmatic inference trials, the target word was the shared item (e.g., *rice*), with the intended referent being the container with only that item (e.g., the plate with *only rice*). On control-double trials, the target word was the unique feature (e.g., *fish*), with the intended referent being the container with both items.

We created four stimulus orders. Warm-up trials were given in a constant order, but trial type was counterbalanced for order in the six main trials. Target side was counterbalanced within each trial type. In addition, target item was counterbalanced across orders for the pragmatic inference and test trials (so that, e.g., *fish* was sometimes the shared item and sometimes the unique item). Similarly, the target word for warm-up and control-single trials was counterbalanced across orders.

Procedure

Children sat in front of the experimenter, whose hand was painted to look like a puppet. They were introduced to a fictional character called “Juanito” (the puppet) and were told that Juanito went for a walk and encountered different objects and people on his way. Juanito would next ask children if they could help him locate these objects on the two images displayed in front of them. For example, the experimenter would say: “Juanito encountered a plate.”⁵ The puppet standing for Juanito would then ask: “this plate has rice; can you show me

⁵ SK original version: “Juanitonin merai westiora rato.”

the plate?”⁶ Children would have to point either to the [plate + rice] picture or to the [plate + rice + fish] picture. In this case, the pragmatically correct response was [plate + rice].

Children were first presented with four warm-up stimuli: i.e., stimuli very easy to discriminate (e.g., [jaguar] vs. [peccary]), to familiarize them with the task. They were then tested in a counterbalanced order on: two “control-single” trials (e.g., [colored traditional fabric] vs. [black and white traditional fabric]); two “control-double” trials (e.g., [table + plantains] vs. [table + plantains + moriche palm fruit], after having been told that Juanito saw a table that has both plantains and moriche palm fruits); and two test trials (e.g., [table + plantains] vs. [table + plantains + moriche palm fruit], after having been told that Juanito saw a table that has only plantains).

The instructions were translated into SK by a certified translator and the translation was subsequently revised by two SK bilinguals who are used to working with children; the whole experiment was performed in SK. Two sample videos are provided in the Supplementary Materials⁷.

⁶ SK original version: “Nato rato riki arrozya; ¿Minki ea rato oinmati atipana?” The SK Research Assistant who performed the experiment introduced a slight procedural variation. Consistently with the procedure as just described, with some children, she used the puppet (i.e., she gestured with her painted hand as if the puppet was speaking) only to utter the final question: “can you show me the plate?” With some other children, on the other hand, the puppet was used both for the penultimate sentence “this plate has rice” and for the final question “can you show me the plate?” This slight procedural variation can be seen by comparing the two videos included in the Supplementary Materials. Importantly, what remained constant across children was that the first sentence (“Juanito encountered a plate”) was always uttered by the experimenter and the last one (“can you show me the plate?”) by Juanito.

⁷ Videos are available at: <https://nyu.databrary.org/volume/691>

Results

Figure 2. Proportion correct (or pragmatically consistent, in the case of pragmatic inference trials) responses, plotted by age group. Error bars show 95% confidence intervals, computed by non-parametric bootstrap.

Children's performance by age group across all trial types is shown in Figure 2.⁸ Across all age groups, children were at ceiling for warm-up and control-double trials, showing that they understood the task and were able to indicate the appropriate reference to the puppet. Both control-single and pragmatic inference trial performances were substantially lower, and close to chance except in the oldest age group.

To investigate the strength of the evidence that children were above chance on the pragmatic trials, we computed default Bayesian *t*-tests using the BayesFactor package

⁸ Data and analytic code for all reported analyses is available at https://github.com/langcog/amazon_pragmatics.

(Rouder et al., 2009) comparing children's mean responses to the null hypothesis of responding at chance. A first t-test revealed positive but relatively weak evidence for overall above-chance reporting across all children ($BF_{10} = 4.83$), but evidence was quite strong for 8-10 year-olds specifically ($BF_{10} = 266.49$).⁹ These tests therefore support the conclusion of above chance pragmatic responding in the oldest children.

Children showed a similar pattern of performance for control-single trials, with $BFs < 3$ for the younger two groups, but very strong evidence for 8-10 year-olds specifically ($BF_{10} > 10^{10}$). Why were children substantially weaker on control-single trials than control-double trials? We speculate that the items chosen ([Shipibo-Konibo couple] vs. [Gringo couple] and [colorful traditional fabric] vs. [black and white traditional fabric]) must have been more difficult for children given that the trials are uncomplicated comparisons (but we do not have independent evidence on this question). But by design, our key comparison is control-double trials, which use the same materials as pragmatic inference trials but ask about the unique feature, rather than the repeated feature. In contrast to the control-single trials, the evidence from these trials was clear: only the oldest children were able to perform the pragmatic inference, but all children performed well on the control-double trials that used the same stimulus items (see Figure 3).

To further investigate factors influencing children's performance, we fit a logistic mixed effects model with maximal random effects structure (Barr et al., 2013) using Bayesian inference via the brms package (Bürkner, 2016) using default priors and inference settings. The model specification included fixed effects of age (scaled and centered), trial type, and their interaction. It additionally included random effects of 1) trial type nested inside subject effects and 2) trial type, age, and their interaction nested inside stimulus type. Trial type was

⁹ Note that the choice of this age group for follow-up analysis is post-hoc and reflects the division of the data into discrete age groups after data collection was complete.

dummy coded and pragmatic trials were set as the intercept so that the coefficient on age could be interpreted as the age slope for these trials.

Pragmatic trials (the intercept) were close to zero in their mean estimate ($\beta = .54$ [-.41, 1.55]) and the coefficient CI overlapped with zero – thus, this result supports our caution in interpreting the overall evidence for above chance responding on pragmatic inference trials when averaging across the younger age groups. Confirming the visual impression shown above, warm-up trials and control-double trials were both substantially easier for participants than pragmatic inference trials, with coefficients larger and CIs not overlapping zero ($\beta = 6.65$ [1.16, 14.23] and $\beta = 3.35$ [0.14, 7.76], respectively). In contrast, control-single trials were numerically easier than pragmatic trials ($\beta = 1.11$ [-9.39, 12.19]) but there was high uncertainty in their coefficient estimate, consistent with our speculations about trial-level variability above.

The mixed effects model did not show developmental effects, due to item-level variation. Both main effects of age and interactions of age and trial type were relatively small, and confidence intervals were large and all included zero, suggesting that global developmental trends were small and/or inconsistent. Figure 3 shows individual item means for pragmatic inference trials and control-double trials. Visual inspection of these data suggest that, while the oldest age group was above chance for pragmatic inference trials in every single case, we also observed some item-level variation (likely due to the salience of the animate “man” target in the [motocarro + basket + man] item). This impression was confirmed by the substantial increase in model fit due to adding age by stimulus random slopes to the model (Bayes Factor for model comparison via bridge sampling $> 10^{10}$). In sum, our statistical findings allow us to conclude that the oldest age group was above chance in the pragmatic inference trials but suggest that there is some item-level variation in developmental change.

Figure 3. Proportion correct (or pragmatically consistent, in the case of pragmatic inference trials) responses, plotted by age group and experimental stimulus item. Error bars show 95% confidence intervals, computed by non-parametric bootstrap.

Discussion

How does pragmatic reasoning ability develop in children growing up in an indigenous Amazonian (and hence, non-WEIRD) culture? We used a simple ad-hoc implicature task adapted from previous work on pragmatic development to address this question in SK children. Although the younger children in our sample understood the task, they did not show the same patterns on the key pragmatic inference trials as has been observed in US samples. In contrast, 8-10 year-olds showed relatively robust above-chance performance. Although pragmatic inferences in our study were found substantially later in development relative to studies of children in the US and Europe (e.g., Barner, Brooks, &

Bale, 2011; Katsos & Bishop, 2011; Papafragou & Tantalou, 2004; Stiller et al., 2015), these findings nevertheless support the idea that ad-hoc pragmatic inferences occur in a wide variety of cultural contexts – even in those where norms regarding communication and informativeness may differ.

Although consistent with our prediction – later development due to a holistic prior – the interpretation of the developmental shift we observed is nevertheless ambiguous. It is possible that the conflict between a holistic prior and the pragmatic implicature resulted in the later emergence of the inference that we observed. We note however that such a conflict account would predict that younger children would be *below chance* in their responding – indicating salience-driven preferences (as observed for the youngest children in Yoon & Frank, submitted). We did not observe that pattern here though. To fully evaluate the hypothesis posed above (systematically testing the effect of holistic thinking on conversational implicatures) would require, first, to thoroughly quantify the degree of holistic thinking exhibited by children and adults across development, and next, to compare it to scores obtained in ours and other relevant paradigms.

Another possibility is that the developmental differences we observed relate to other differences in children’s language experiences. For example, they might experience fewer examples of pragmatic language use because more of their day-to-day language input is likely to come from peers rather than adults (Schneidman et al., 2012; Cristia et al., 2018). Such differences in input would result in differential familiarity with implicature and could create a more protracted developmental course. Many details in this hypothesis are underspecified, however. Even in U.S. contexts, the dependence of children’s pragmatic inferencing on specifics of their language input is not completely understood. The present design has several limitations that call for caution in the interpretation of our data and highlight the difficulty of cross-cultural research. First, in our paradigm, a fictional character (a puppet) was uttering

sentences and asking children to compute implicatures. While U.S. children are comfortable with this type of setting, it must be stressed that interactions with fictional characters are virtually nonexistent in SK culture and this feature likely rendered the paradigm more confusing. Performance in warm-up and control-double trials suggest that even younger children were able to answer simple questions, but they might still have struggled with the more complex and ambiguous test trials.

Second, some methodological questions also arise with regard to our stimuli. According to the salience hypothesis, the salience—or the richness—of the stimuli competes against conversational constraints. This hypothesis is somewhat different from the holism hypothesis: according to the latter, not any salient stimuli compete against conversationally relevant stimuli, but only those which are *realistically* salient. Future investigation of the cross-cultural pragmatics should attempt to tease apart the influence of salience from the influence of holism proper. Moreover, realistic salience can be found in distinct domains: some involving only natural items (animals, plants, inorganic materials, etc.) and others non-natural items (furniture, vehicles, buildings, etc.). It is worth noting that East Asians' holistic prior seems to apply to any kind of domain (Nisbett & Masuda, 2003), whereas Amerindians' holistic prior appears to apply first and foremost to the domain of naïve biology (Medin & Bang, 2014). The target images used in the present study did not include animals or plants depicted within their ecosystem. It remains an open question whether stimuli featuring realistic and biological salient items could effectively bias pragmatic inferences.

Finally, cross-cultural research should use a variety of paradigms and designs, not just one. Our results show that SK children's ability to compute ad-hoc implicatures is somewhat delayed as compared to U.S. and European children. This cross-cultural difference might reflect a deep cognitive difference (the same delay would be observed across different designs and paradigms) or might be an experimental artefact (because this specific task is too

unnatural and unfriendly). This question can only be answered by future research with both populations. As suggested by early critics of Grice, cross-cultural diversity in pragmatic inferences is never absolute: it is restricted to specific situations. The only way to test such subtle cross-cultural variations is to implement the richness of real-life pragmatic situations in a variety of experimental tasks.

Acknowledgments

We wish to thank Margina Sampayo Mori for her valuable help in data collection. We are very grateful to all the SK teachers and community leaders who made data collection possible – in particular: Percy Cruz Laulate, Petronila Franco Márquez, Arturo Inuma, Sario Cruz, Roberto Matios, Alejandro Ochavano, and Santiago Matios. Many thanks to Manuel Bohn and Joëlle Proust for their helpful feedback on the manuscript. MEF received funding from the France-Stanford Center for Interdisciplinary Studies, EHESS, and Fondation des Treilles. MCF was supported by NSF #1456077.

References

- Atran, S., & Medin, D. (2008). *The Native Mind and the Cultural Construction of Nature*. Cambridge MA: MIT Press.
- Barner, D., Brooks, N., & Bale, A. (2011). Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference. *Cognition*, 118(1), 84–93.
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013) Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255–278.
- Bürkner, P. C. (2016). brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, 80(1), 1–28.

- Clark, E. V., & Amaral, P. M. (2010). Children build on pragmatic information in language acquisition. *Language and Linguistics Compass*, 4(7), 445-457.
- Clark, H. H. (1996). *Using language*. Cambridge: Cambridge University Press.
- Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (in press). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, 10.1111/cdev.12974.
- Danziger, E. (2006). The Thought That Counts: The Interactional Consequences of Variation in Cultural Theories of Meaning. In N. Enfield & S. C. Levinson (Eds.), *Roots of Human Sociality. Culture, Cognition and Interaction* (pp. 259–278). Oxford/New York: Berg Publishers.
- Danziger, E. (2010). On trying and lying: Cultural configurations of Grice's Maxim of Quality. *Intercultural Pragmatics*, 7(2), 199–219.
- Duranti, A. (1984). Intentions, Self, and Local Theories of Meaning: Words and Social Action in a Samoan Context. *Center for Human Information Processing Technical Report*, 122, 1–22.
- Duranti, A. (2014). *The anthropology of intentions: Language in a world of others*. Cambridge: Cambridge University Press.
- Fortier, M., Wente, A. O., Fernández Flecha, M., & Gopnik, A. (Submitted). Abstract causal knowledge in Amazonia: Shipibo-Konibo horticulturalists learn multiple causality more readily than U.S. and Peruvian undergraduates.
- Goodman, N., & Frank, M. (2016). Pragmatic Language Interpretation as Probabilistic Inference. *Trends in Cognitive Sciences*, 20(11), 818–829.
<https://doi.org/10.1016/j.tics.2016.08.005>
- Grice, P. (1975). Logic and conversation. In P. Cole & J. Morgan (Eds.), *Syntax and Semantics. Volume 3: Speech Acts* (pp. 41–58). New York: Academic Press.

- Grice, P. (1981). Presupposition and conversational implicature. In P. Cole (Ed.), *Radical Pragmatics* (pp. 183–198). New York: Academic Press.
- Harris, R. (1996). Truthfulness, conversational maxims and interaction in an Egyptian village. *Transactions of the Philological Society*, 94(1), 31–55. <https://doi.org/10.1111/j.1467-968X.1996.tb01176.x>
- Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33(2-3), 61–135.
- Horowitz, A. C., Schneider, R. M., & Frank, M. C. (2017). The Trouble With Quantifiers: Exploring Children's Deficits in Scalar Implicature. *Child Development*. <https://doi.org/10.1111/cdev.13014>
- Katsos, N., & Bishop, D. (2011). Pragmatic tolerance: implications for the acquisition of informativeness and implicature. *Cognition*, 120(1), 67–81. <https://doi.org/10.1016/j.cognition.2011.02.015>
- Katsos, N., Cummins, C., Ezeizabarrena, M. J., Gavarró, A., Kraljević, J. K., Hrzica, G., ... & Van Hout, A. (2016). Cross-linguistic patterns in the acquisition of quantifiers. *Proceedings of the National Academy of Sciences*, 113(33), 9244-9249.
- Lancy, D. (2016). Playing With Knives: The Socialization of Self-Initiated Learners. *Child Development*, 87(3), 654–665. <https://doi.org/10.1111/cdev.12498>
- Le Guen, O. (2018). Managing epistemicity among the Yucatec Mayas (Mexico). In J. Proust & M. Fortier (Eds.), *Metacognitive Diversity: An Interdisciplinary Approach*. Oxford/New York: Oxford University Press.
- Lenaerts, M. (2004). *Anthropologie des Indiens Ashéninka d'Amazonie: Nos sœurs Manioc et l'étranger Jaguar*. Paris: L'Harmattan.
- Lucas, C., Bridgers, S., Griffiths, T., & Gopnik, A. (2014). When children are better (or at least more open-minded) learners than adults: Developmental differences in learning

- the forms of causal relationships. *Cognition*, 131(2), 284–299.
<https://doi.org/10.1016/j.cognition.2013.12.010>
- Masuda, T., & Nisbett, R. (2001). Attending holistically versus analytically: comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology*, 81(5), 922–934.
- Masuda, T., & Nisbett, R. (2006). Culture and change blindness. *Cognitive Science*, 30(2), 381–399. https://doi.org/10.1207/s15516709cog0000_63
- Medin, D., & Bang, M. (2014). *Who's asking? Native science, western science, and science education*. Cambridge MA: MIT Press.
- Medin, D., Ross, N., Atran, S., Cox, D., Coley, J., Proffitt, J., & Blok, S. (2006). Folkbiology of freshwater fish. *Cognition*, 99(3), 237–273.
- Nisbett, R., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences*, 100(19), 11163–11170.
<https://doi.org/10.1073/pnas.1934527100>
- Noveck, I. (2000). When children are more logical than adults: Experimental investigations of scalar implicature. *Cognition*, 72(2), 165–188.
- Noveck, I. & Reboul, A. (2008). Experimental pragmatics: a Gricean turn in the study of language. *Trends in Cognitive Science*, 12(11), 425–431.
- Ochs, E. (1976). The Universality of Conversational Postulates. *Language in Society*, 5(1), 67–80.
- Papafragou, A., & Tantalou, N. (2004). Children's Computation of Implicatures. *Language Acquisition*, 12(1), 71–82. https://doi.org/10.1207/s15327817la1201_3
- Robbins, J., & Rumsey, A. (2008). Introduction: Cultural and Linguistic Anthropology and the Opacity of Other Minds. *Anthropological Quarterly*, 81(2), 407–420.

- Rogoff, B. (2014). Learning by Observing and Pitching In to Family and Community Endeavors: An Orientation. *Human Development*, 57(2–3), 69–81.
<https://doi.org/10.1159/000356757>
- Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian t-tests for accepting and rejecting the null hypothesis. *Psychonomic Bulletin & Review*, 16, 225-237
- Shneidman, L. A., & Goldin- Meadow, S. (2012). Language input and acquisition in a Mayan village: how important is directed speech?. *Developmental science*, 15(5), 659-673.
- Stiller, A. J., Goodman, N. D., & Frank, M. C. (2015). Ad-hoc Implicature in Preschool Children. *Language Learning and Development*, 11(2), 176–190.
<https://doi.org/10.1080/15475441.2014.927328>
- Tomasello, M. (2000). The social-pragmatic theory of word learning. *Pragmatics. Quarterly Publication of the International Pragmatics Association*, 10(4), 401-413.
- Walker, H. (2009). Baby hammocks and stone bowls: Urarina technologies of companionship and subjection. In F. Santos-Granero (Ed.), *The Occult Life of Things: Native Theories of Materiality and Personhood* (pp. 81-102). Tucson: University of Arizona Press.
- Washinawatok, K., Rasmussen, C., Bang, M., Medin, D., Woodring, J., Waxman, S., ... Faber, L. (In Press). Children's Play with a Forest Diorama as a Window into Ecological Cognition. *Journal of Cognition and Development*.
<https://doi.org/10.1080/15248372.2017.1392306>
- Yoon, E., & Frank, M. (Submitted). Developmental Gains in Speed and Accuracy in the Processing of Ad-Hoc Implicatures.