The role of audience design in an emerging language system: Evidence from a novel signaling paradigm

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The evolution of human language is informed by rapid development across many cognitive abilities. Some of these abilities have been evaluated via novel signaling experiments in which conventional signals are restricted (e.g., Sulik & Lupyan, 2018). Across four experiments, we tested whether knowing interpersonal information, operationalized here as partner age, affects signaling outcomes. We developed a word list with contemporary meanings to determine whether signalers consider age information when generating clue words for specific partners. When informed of a partner's age (i.e., 18-25 or 40-60) at the task's onset, we found some audience design evidence (Expt. 1), supporting its potential role in language evolution. When provided with frequent and disruptive reminders of a partner's age, signalers capitalized on this information more often (Expt. 2-3). Testing signalers' clues, however, did not yield more success for receivers guessing target words which were produced to be age-specific (Expt. 4).

1. Language Evolution

Humans' capacity for language is thought to have emerged within a suite of cognitive abilities (Pinker, 2010). For instance, language depends on a memory network that stores semantic information which, in turn, supports the conceptual categorization that language offers (Gong & Shuai, 2015). Such interdependencies, however, enhance the difficulty of unraveling the phylogenetic order in which various abilities evolved. Decoding this order is crucial for determining conditions that support emergence of a full-fledged language system. A recent set of ideas has focused on the importance of forming communicative intentions (Scott-Phillips, 2014). Within this context, we explore audience design as a potential prerequisite for language evolution.

1.2. Measuring Language Evolution: Novel Signaling Paradigm

Methodological innovations in experimental semiotics have contributed to new insights concerning the cognitive underpinnings of human communication (see Galantucci et al., 2012, for a review). One approach, pioneered by Scott-Phillips et al. (2009), is the *novel signaling* paradigm in which participants are tasked with

conveying meaning to a partner without the ability to communicate via conventional means. This work allows insight into the conditions that could support language's emergence in an environment where conventional signals were not available. For example, with the goal of persuading a partner to move a stimulus to a target region, a conventional signal would be to simply say "move the [stimulus] to [target region]." However, when such explicit signals are forbidden (e.g., in remote contexts), conveying an intention proves significantly more difficult. However, Scott-Phillips et al. found that pairs could achieve success by assuming 'default' conventions that could function as a type of common ground.

Expanding on this work, Sulik and Lupyan (2018) explored the nature of perspective-taking in a novel signaling task. In their study, partners were assigned to either a signaler or receiver role. Signalers read a target word (e.g., *bank*) with instructions to elicit the target word from the receiver. Crucially, signalers were permitted to produce exactly one (non-target) word to signal the target. Thus, signalers could rely on conventional signals (i.e., words) in the task, but those signals were novel in use. Targets were selected for holding either symmetric or asymmetric semantic relationships with their most salient associates. The word *bank*, for example, is asymmetric in that its most frequent associate is *money*; however, *money*'s most salient associate is *cash,* not *bank*. To elicit a guess of *bank*, then, a better approach is to select a clue with *bank* as a strong backward associate (e.g., *teller*). This imbalance allowed the authors to investigate how signalers consider their partners' perspectives during novel signaling, reasoning that signalers who are more attuned to their partners' perspectives should produce clues that increase the likelihood of guessing the target.

In Sulik and Lupyan's (2018) initial experiment, signalers struggled to produce helpful clues for asymmetric targets. In subsequent experiments, however, the authors constrained the signal (by providing signalers with a list of clue options) or the common ground (by sharing that list with receivers), resulting in better performance. These findings suggest that, in environments where access to a conventional signal is restricted, representing an interlocutor's mental state may be an important prerequisite for communication (see Tomasello, 2008). Using this paradigm to tease out the processes that undergird humans' capacity for language invites further exploration of the various abilities that support language.

2. Testing Audience Design

Here, we adapted Sulik and Lupyan's (2018) work to test whether certain aspects of *audience design* could enhance communicative success on a linguistically restrictive task. Audience design occurs when speakers adjust utterances to a specific audience to facilitate comprehension (H. H. Clark & Murphy, 1982), and speakers frequently rely on interpersonal cues when determining their referential choices, such as whether an addressee is a native speaker (Bortfield & Brennan, 1997), or a novice or expert (Isaacs & H. H. Clark, 1987). Age is another salient cue that speakers regularly consider, tailoring speech for both children (E. V. Clark & Estigarribia, 2011) and

elderly adults (Hummert et al., 1998; Kemper, 1994). Thus, knowing an interlocutor's age could influence communicators to produce age-sensitive signals.

Recognizing relevant social characteristics not only influences modern language use, but may support humans' capacity for communication more generally (Seyfarth & Cheney, 2014). Early humans evolved linguistic capabilities within social contexts in which distinguishing members and tracking individual histories was likely highly valuable. Non-human primates, for comparison, display behaviors that suggest an awareness of partner-specific history associated with enhancing fitness and offspring survival (Rosenbaum et al., 2016; Silk, 2007). Thus, individualized behaviors toward conspecifics plausibly included acts of direct communication in early humans, which could be considered precursors of audience design. Such personalized interactions reflect a broader network of cognitive abilities that allow for reasoning about others' mental states, essential for establishing a language system (Scott-Phillips, 2014).

Here, we test whether knowledge of a partner's age improves communication in a novel signaling task. Because the paradigm restricts conventional signals, signalers must forge new ways to represent their intentions, illustrating circumstances similar to ones with which early humans contended. Considering interpersonal information under these conditions would support an account of language evolution in which the ability to engage with audience design is a critical and potentially necessary feature.

2.2. *Experiment 1: Audience Design in a Novel Signaling Task*

We recruited 23 Northwestern students from an intro psychology class (avg. age: 19) to serve as signalers. Participants were monolingual English speakers who completed the task online via Qualtrics software. For each of a series of target words, signalers produced a single (non-target) clue word to elicit a guess from their partners of the target, replicating Sulik and Lupyan (2018). Participants were (falsely) informed that the partner (who did not exist) would complete the task later, so no feedback would be provided. Critically, at the task's onset, signalers were informed that the partner was a native English speaker from the U.S. belonging to one of two age groups: 18-25 or 40-60. The partner's age group was randomly assigned between-subject with the expectation that signalers would produce clues tailored for someone in that age range.

Signalers were presented with a list of 40 words in random order. Upon reading each word, they were asked to type a clue word into a textbox for their partner. Twenty of the 40 words were used by Sulik and Lupyan (2018)—i.e., words with either symmetric or asymmetric primary associates—and the other 20 were critical words that held "contemporary" meanings. These contemporary words are recently popularized homonyms (e.g., *tea*) which carry both classic meanings (e.g., the beverage) and modern meanings that have recently emerged in youth vernacular (e.g., gossip). Our goal was to test whether signaler behavior differed between the two partner conditions, predicting that those assigned to older partners would be more likely to produce clues with traditional meanings, while those assigned to younger partners would be more likely to produce clues with contemporary meanings, a pattern

indicative of audience design. Moreover, we expected this pattern because our participants were peers to younger partners, suggesting a loosely shared inventory of cultural knowledge, including neologisms.

Sulik and Lupyan (2018) analyzed responses by evaluating clues' forward and/or backward association strength relative to the target based on Nelson et al.'s (2004) Free Association Norms corpus. However, contemporary meanings were unavailable in existing norms and responses could not be analyzed by association strength. Rather, we coded clues categorically as either traditional, contemporary, or some other meaning[1]. If the partner's purported age range had any bearing on these responses, then the contemporary words should have been more likely to elicit a contemporary response for younger partners than for older partners.

Overall, clue word production suggested that signalers engaged in audience design. A mixed effect logistic regression assessed the likelihood of producing a contemporary clue given a contemporary target[2]. The model revealed an effect of partner's age on clue production, with signalers assigned to younger partners producing contemporary clues for critical targets more often (17.9% of trials) than those assigned to older partners (12.7%), $b = 0.37$, $p = .049$. This effect suggests that access to a partner's age influences the production of signals in a novel signaling task.

2.3. *Experiment 2: Boosting the Effect of Audience Design*

In Expt. 2 we enhanced the salience of the partner's age to account for participants who may have overlooked age in Expt. 1 (which appeared only at the task's onset). We recruited 30 more undergraduates (avg. age: 18.33) and replicated Expt. 1's materials and procedure. The critical change in Expt. 2 was providing signalers with continuous access to partners' demographic information, On-screen reminders appeared alongside each target: "Reminder: Your partner is [18-25/40-60] years old, speaks English, and resides in the U.S." The age reminder corresponded to participant's randomly assigned age condition.

On-screen age information enhanced signalers' engagement of audience design relative to Expt. 1. Analyzing the critical contemporary words, a mixed effect logistic regression model revealed that signalers produced more clues corresponding to contemporary meanings when assigned to a younger partner (22%) than an older partner (13%), $b = 0.49$, $p = .001$; suggesting that continuous access to age encourages audience design more explicitly in contexts where conventional signals are restricted.

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[1] Sulik and Lupyan's original words were not necessarily polysemous, so the analysis procedure only applies to contemporary words (which are of theoretical interest). Evaluating association strength for the original words, however, supports S&L's findings, a replication providing reliability for the paradigm.

[2] For Expt. 1-3, no trials/participants were removed prior to analysis; however, given the limited sample size, the full mixed effect model could not converge. The results reported here are from reduced versions of the model in which higher order effects were systematically removed until the model fit. In the summary (below; see Table 1), random effects are reported for the data aggregated across Expt. 1-3.

2.4. *Experiment 3: Audience Design Across Multiple Interlocutors*

In Expt. 3, we replicated our procedure using a within-subject design wherein signalers (n=26; avg. age: 19.08) provided clues to receivers from *both* age groups. The task occurred in-lab, though all other procedures were preserved. Participants were (randomly) assigned to a partner in one age group, and then halfway through the task informed that the partner had switched to someone in the other group, making age more evident. Contemporary targets were balanced across both partners.

Like Expt. 1 and 2, Expt. 3 continued signalers' trend of increasing influence of partner age as age was made more salient. A logistic mixed effect model supported the idea that addressing a younger partner produced more contemporary clues (27.7%) than an older partner (14.2%) for contemporary targets, $b = 0.75$, $p < .001$. Overall, Expt. 3 finds that switching partners fosters greater signal differentiation in the task.

2.5 *Summary: Experiments 1-3*

Taken together, Expt. 1-3 demonstrate audience design in novel signaling tasks with clues tailored to signaler's partner's age range. Evidence of audience design grew as age was made more explicit between experiments. To address sample size concerns, we implemented a logistic mixed effect model using data pooled across all three experiments (in which the basic procedure was the same). Participants produced 3-4 contemporary clues on average, with only 1 participant failing to produce any. The model revealed an effect of partner age, with contemporary meanings more likely to be produced for younger partners (22.6%) than older ones (13.3%), $b = 0.56$, $p < .001$. All results are summarized in Table 1:

Table 1. A summary of the logistic mixed effect models from Expt. 1-3

	N	Odds Ratio	CI	τ_{00} (subj.)	τ_{00} (item)	ICC
Expt. 1	23	1.44	1.00-2.07	0.05	10.90	0.77
Expt. 2	30	1.64	1.22-2.20	0.08	4.59	0.59
Expt. 3	26	2.12	1.54-2.93	0.03	8.17	0.71
Expt. 1-3	**79**	**1.76**	**1.45-2.13**	**0.13**	**6.52**	**0.67**

2.6. *Experiment 4: Receiving Signals*

In Expt. 4, we tested whether the signals (most frequent responses from Expt. 1-2, whether contemporary or not) were actually effective at eliciting guesses of the target. We recruited 47 students (avg. age: 18.77) to be receivers, randomly assigned

(between-subject) to read clues initially generated for either a younger or older partner. Because receivers matched the younger receivers' (and original signalers') age range, it was expected that clues generated for younger partners may prove more successful. The task occurred in-lab with receivers viewing clues on a computer and being prompted to guess the original target word. Participants were informed that clues had been generated by a previous signaler.

The task proved difficult overall (avg. success rate = 27.8%). A logistic mixed effect model revealed no evidence that receivers performed better given clues that were initially generated for a younger partner (27.2%) than an older one (28.3%), b = -0.04, p = 0.75. Thus, while Expt. 1-3 revealed evidence of audience design in a novel signaling task, the top clues produced in Expt. 1-2 were only moderately successful, with no apparent effect between clues generated for younger and older partners.

3. Conclusion

In Expt. 1-3, we find that signalers engaged in audience design by incorporating age-specific information during non-conventional signaling. Age information played a larger role in signaling when it was made more explicit, as the trends between experiments shows. Despite support for audience design, though, Expt. 4 reveals that clues tailored to younger partners did not improve success when shared with younger receivers. Still, access to interpersonal information appears to influence signaling when conventional signals are restricted. In a prelinguistic society, awareness of social information about one's partner could serve as a catalyst for conveying meaning. For instance, conveying a communicative intention may be realized by an enhanced understanding of an interlocutor's mental state and sociocultural background. However, there are limits to any far-reaching conclusions on this point. Specifically, this paradigm demonstrates how signalers generate alternatives when they lack access to conventional signal. In some aspects, this is a valid simulation of developing abstract linguistic representations *de novo*, but it is also limited in the sense that signalers (and their partners) have preexisting access to a fully developed lexicon. Nevertheless, when prevented from utilizing lexical knowledge conventionally, signalers could compensate by taking advantage of other cognitive skills, including access to stereotypical knowledge about the likely idiolects of individuals of a certain age range. Although audience design enhances standard language production, speculation about its importance in language's emergence remains plausible though ultimately unresolved.

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