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"Science is in everything, whether we realize it or not": using the IPA to encourage interest in the scientific study of language

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Abstract: One way to bring greater awareness to the fact that language can be, and often is, studied scientifically is to show people the scientific tools that linguists use to study it, such as the International Phonetic Alphabet (IPA). This project investigated how doing a common IPA activity might influence people's perceptions of language science and linguists. Adult visitors to a science museum (N = 117) participated in an activity in which they saw their name transcribed into the IPA and were guided to notice how it differed from the standard spelling, informed about some basic articulatory phonetics connected to the sounds in their names, and encouraged to think about the differences between sounds and letters more generally. Participants were then surveyed about what they had learned and their attitudes about language science. The results showed that most participants learned at least some of the core content material. More notably, the participants were more likely to believe that aspects of language such as poetry and dialects could be studied experimentally by scientists than a control group of adults who had not participated. These results demonstrate that even a brief intervention, if thoughtfully conducted, can shift attitudes towards the belief that language can be studied scientifically.

Keywords: International Phonetic Alphabet; public engagement; informal science learning; language science

1 Introduction

While linguists and other language scientists have been using the scientific method to study language for many years, much of the general public views language through a humanities lens, and imagines that language studies focus exclusively on topics centered on good writing and foreign language teaching. While such topics certainly are within the scope of linguistics, this perspective neglects a large portion of the field. And there are potential consequences to this neglect. For example, financially, science fields have higher funding priority nationally (Gibbons 2019; Handelsman and Smith 2016) and faculty in science-related departments are paid better than those in humanities departments (Jaschik 2016). Moreover, despite ongoing concerns about declining trust in scientists, scientists are still frequently relied on by many to provide informed opinions on a variety of complex topics relevant to society and governmental policies (Kennedy et al. 2022). Language is implicated in a range of important societal issues, such as how best to educate children who speak nonstandard dialects and how to integrate non-English-speaking immigrants into our communities. Being perceived as scientists helps those who study language gain respect and remuneration, as well as a voice in ongoing public debates.

One way to help shift how the public perceives language and linguists is to conduct public engagement that highlights the scientific approach to studying language. Previous work (Wagner et al. 2022) asked participants to reflect on a favorite memory concerning language or science. Participants asked to think about language frequently mentioned foreign languages and how they learned them in school, used them in other countries, or spoke them with their family members. Their recollections supported the view that people generally take a humanistic view of language. By contrast, participants asked to think about science frequently mentioned notable activities that they had done which were fun and interesting, many of them done in informal learning spaces such

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as museums. A suggestion made within that paper was that engaging with the public using activities modeled on fun science activities could help people start to think about language as something that could be studied scientifically.

Moreover, there is a body of scholarship that provides guidance about how to structure activities so that they lead to effective learning in informal science spaces. For example, a report from the National Research Council (Bell et al. 2009) laid out a set of six core learning goals which they call "strands"; these are listed, as paraphrased in Wagner and McKee (2023), in Table 1. Although one of the strands does focus on teaching specific content (Strand 2), the other strands emphasize providing a positive experience (Strand 1), and promoting an understanding of what science is, including hypothesis testing (Strand 3), reflecting on science as a way of thinking (Strand 4), and considering the tools used to generate knowledge (Strand 5). The final strand (Strand 6) emphasizes the fact that inspiring people to consider career options is part of the purview of informal science learning environments.

An additional source that has been inspirational for our own activity development is Fenichel and Schweingruber (2010). They focus on specific ways of conducting activities that facilitate learning, such as providing surprising new facts that can be juxtaposed with existing knowledge, and creating interactive situations that get individuals actively involved. We applied these insights about informal science learning to a language science activity that is commonly done by language scientists who engage with the public: creating name tags for people in the International Phonetic Alphabet (IPA).

Our group has used this activity for several years and anecdotally, it is popular with both adults and children, as well as with the students who conduct it. There are many potential ways to engage people with the IPA, and in Table 2, we lay out the core steps of our own demonstration and how they connect to the best practices from the informal science literature. We note that our version of the activity does not attempt to equally accomplish all of the potential informal science goals. However, like all the activities conducted by our group, it incorporates the critical goal of generating interest, which is necessary for maintaining attention in an informal learning space and includes multiple points where the participant is invited to interact with the material.

The goal of the current study was to see whether engaging with this IPA name tag activity would encourage people to think of language as something that can be studied scientifically. If people's perception of language is necessarily grounded in a humanities frame, then our activity should not influence their beliefs. However, if treating a language topic in the way that science topics are commonly treated – in a brief, hands-on activity that emphasizes science concepts – then this activity may broaden people's perspectives. Moreover, we not only asked whether people could learn about the IPA specifically, but we also asked whether a scientific perspective on language could generalize to a variety of different language topics.

Previous work done in the same venue (Wagner et al. 2022) had asked people to assess how a variety of different topics could be studied, including traditional science topics (genetics, botany) and a range of language-related topics including poetry, dialect, and audiology. Three critical rating scales focused on the specifically scientific nature of each topic: Was there something new to be learned about it? Did scientists study it? And could you use experiments to investigate it? Not surprisingly the traditional science topics received higher scores on

Table 1: The six strands of science education in informal contexts, based on Bell et al. (2009). The paraphrases used here take the perspective of the person conducting an activity.

Strand	Paraphrase
Strand 1	Generate interest and excitement
Strand 2	Celebrate scientific knowledge
Strand 3	Foster observations, explorations, and questions
Strand 4	Invite people to reflect on science as a process
Strand 5	Collaborate in using the tools of science
Strand 6	Encourage people to think of themselves as science learners and as potential scientists

Table 2: Layout of the IPA name tag activity and how it accomplishes various informal science goals.

IPA name tag activity step	Informal science goal	Explanation
Make a name tag with participant's name transcribed in the IPA.	Strand 1: Generate interest and excitement.	Using participants' own names make the activity personal, which is appealing. Moreover, the name tag serves as a souvenir to take home.
Ask participant to compare the English spelling of their name and the IPA transcription.	Strand 3: Foster observations, explorations, and questions. Juxtaposition, interactivity.	Participants are actively invited to make the comparison and their observations guide the conversation.
Choose one symbol from the name to focus on. Show where it sits in the IPA chart and explain the articulatory phonetics of the corresponding sound.	Strand 5: Collaborate in using the tools of science.	Illustrate how the IPA is a tool of science and how it represents a physical process leading to a sound.
Explicitly state our critical take-home message: *Letters are not sounds*. Note how the link between letters and sounds is simple for the IPA but complex for English.	Juxtaposition.	Participants are confronted with the difference between a tool they use in their everyday life (orthography) and a tool that linguists use (the IPA).
Ask participants to think about who might use the IPA and why it might be useful. Hints are provided as needed (e.g., "how could you write the sounds of a language you don't know?").	Strand 4: Invite people to reflect on science as a process. Interactivity.	Participants are invited to consider how the IPA is used to help linguists do their scientific work.
Ask participants to think about the relationship between letters and sounds in their everyday lives.	Strand 1: Generate interest and excitement. Interactivity.	Participants have the chance to talk about spelling problems, learning new languages, and other matters of personal interest.

these ratings than all of the language topics, but there was also variability among the language areas, with audiology receiving the highest science-like ratings and poetry receiving the lowest (dialect was intermediate). In this study, we used the same questions from that previous work and asked if the IPA name tag activity encouraged people to consider even topics such as poetry and dialect as those which could be scientifically studied relative to people who had not participated in the IPA name tag activity.

In brief, our specific research questions were the following:

(1) Does the IPA name tag activity engage participants' interest and get them excited?
(2) What do participants learn from the IPA name tag activity?
(3) Does the IPA name tag activity change participants' ideas about who studies language and how it is studied (i.e., do they see language as an object of scientific study)?

2 Methods

2.1 Participants

Participants were recruited at a local science museum. Three researchers wearing lab coats were positioned along a busy hallway and asked passing groups of museum visitors to participate in the IPA name tag activity. The activity was conducted on a cart in the same hallway. One adult member from each group was recruited to be the research participant and that person alone answered all the survey questions. The remaining members of the group participated in the activity but were not participants in the study itself.

A total of 117 adults participated (mean age = 39 years old, age range = 18–69 years; 87 female and 30 male). The majority (n = 92) of our participants identified as White, eight identified as Black, five as Asian, four as Hispanic/Latino, one as an Indigenous American, and seven as multiracial/multi-ethnic. Moreover, 109 participants indicated they were monolingual English speakers, and the remaining participants all spoke English well enough to engage with the activity. Participants were highly educated overall: 38 had post-college degrees, 50 had

college or related degrees, 24 had a high school diploma, and the remaining five either did not have a high school diploma or chose not to answer the question. However, most participants were not experts in language science. Only 25 had ever taken a linguistics class (although 101 had taken a foreign language class).

One potential concern with recruiting in a science museum is that participants will be a nonrandom sample of people particularly interested in science. This concern is unlikely to be the case with the current sample, because recruitment was conducted while the museum was hosting an exhibit on Marvel superheroes that drew a broad audience to the museum. Indeed, many participants in this study explicitly commented that they were going to the superhero exhibit and others were wearing superhero costumes or T-shirts suggesting that they were going there.

2.2 Procedure

Before beginning the IPA name tag activity, research participants gave their consent and answered basic demographic questions on an iPad. In addition, half the participants also completed the Language Fascination scale at this time (see below). The participant, along with his or her other group members, were then engaged with the IPA name tag activity. A single researcher (the first author) conducted the activity to keep it as consistent as possible. She followed the steps laid out in Table 1, although the order of the steps was occasionally modified in response to a participant's question or comment. A second researcher observed the interactions for fidelity and found that each step from Table 1 was completed between 93.2 and 100 % of the time. This researcher also observed the participants and recorded their behavior during the activity.

Following the IPA name tag activity, the participant completed a survey on an iPad about the experience. The first part of the survey consisted of four open-ended questions: What did you learn from this activity? What did you learn about language and/or about how language works? What did you learn about science and/or about how science works? What did you learn about how language is studied by language scientists? The second part of the survey (for those who had not already completed it) was the Language Fascination scale. This eight-item measure was developed in Wagner et al. (2022) and asks about participants' interest in language and communication. The third part of the survey was also drawn from Wagner et al. (2022) and asked participants to assess each of three topics within language science (poetry, dialect, and audiology) for its potential scientific qualities (each quality was rated on a four-point scale): participants rated their agreement with the statement, "There is something new to discover about [this topic]"; they indicated their agreement that different kinds of people – a scientist, a practitioner, a linguist, or an amateur – could study each topic; they indicated their agreement that discoveries about the topic could be made in various ways – through observation, conversations, asking an expert, or in a lab experiment. The final part of the survey asked participants to rate (on a four-point scale) whether the IPA name tag activity had changed their level of interest in language, their level of interest in science, their ideas about how language could be studied, and their ideas about who studies language. Participants were also asked to explain each of these ratings. Altogether, the session took about 15 min per group, with about 5 min being spent on the demonstration itself.

2.3 Coding

Open-ended responses in the survey were coded through an iterative, emergent process (Williams 2008). Once the core themes had been identified, all responses were coded by the first author for the embodiment of the themes. The second author coded 20 % of each of the codes to ensure reliability. In the few cases where there were discrepancies, they were resolved by the third author.

3 Results

3.1 RQ1: Does the IPA name tag activity engage participants' interest and get them excited?

We first considered whether this activity had met the primary goal of getting people interested and excited in the topic. During the activity itself, virtually all participants (97 %) showed some measure of enjoyment, including smiling and laughing. However, only 32 % of participants asked questions during the activity and only 39 % of participants made a connection to their everyday experiences (the final step in the activity). Thus, the overall level of engagement was only moderate while the activity was being carried out.

In our most direct survey measure of interest, participants indicated that the activity had increased their interest in both language (M = 2.9 out of 4) and science (M = 2.7 out of 4). Both of these scores are significantly above the mid-point of the scale (language increase $t(116) = 11.3$, $p < 0.001$; science increase $t(116) = 7.97$, $p < 0.001$). These ratings may be artificially high due to the overall positive atmosphere of the museum. However, they are backed up by qualitative explanations provided by participants, saying they were "interested to learn more about how pronunciation works" and "science is always going to be fascinating but stuff like this, when you are able to open your mind, makes it freshly fascinating." Indeed, 57 participants (49 %) provided comments indicating they thought they had learned something of value in the activity, 45 (38 %) explained how their interest in language had increased and 44 (38 %) mentioned ways that their interest in science had increased. Overall, therefore, the IPA name tag activity does engage people to a reasonable degree and participants generally report that it increases their interest in language and science.

3.2 RQ2: What do participants learn from the IPA name tag activity?

Our second research question was coded in an exclusively qualitative way based on participants' open-ended responses. We identified six key themes relating to the content of the activity. These themes are shown in Table 3, along with example responses that embody each theme and the number of participants who had responses embodying each theme.

As can be seen in Table 3, participants identified many of the key components of the activity, but few participants were able to fully articulate our core message that required them to combine those components. However, while only nine participants effectively aced the test, an additional 59 participants did mention both sounds and symbols, they just did not combine them in quite the way we wanted: for example, "It's a new way to write, and you can break down sounds." Thus, although a thorough understanding about the relationship between sound systems and their symbolic representations was rarely achieved in this short activity, many participants had learned relevant and important information about that relationship.

Table 3: The different things that participants learned about from the activity. The third column shows the number of participants (out of 117) who had responses embodying that theme. Note that individual participants could get credit for more than one theme.

Response theme	Example	*n*
Sounds: participant mentions sounds, pronunciation, phonetics, etc.	"Paying attention to where sounds happened in the mouth"	91
Writing: participant mentions writing, letters, alphabets, spelling, etc.	"A new way to write"	75
The IPA: participant explicitly mentions the IPA	"My name in International Phonetic Alphabet"	42
Critical message: participant explicitly notes that sounds are not letters	"Sounds are different than spelling"	9
International: participant mentions that the IPA is international, cross-language, "universal," etc.	"Can be used internationally"	38
Related fact: participant mentions a relevant fact that they learned distinct from the previous categories	"The periods represent syllables"	17

3.3 RQ3: Does the IPA name tag activity change participants' ideas about who studies language and how it is studied?

Finally, we asked whether engaging with the IPA name tag activity would increase participants' perception that language can be studied scientifically. Our primary measure for this research question was participants' endorsements on three science-oriented statements for three language topics (poetry, dialect, and audiology): there is something new to be discovered about this topic; scientists study it; one can learn about it through experimental lab studies. We do not have a within-subject change measure for these ratings (we did not administer the questions before and after the activity), but in Wagner et al. (2022) we did use the same task with an equivalent group of 540 adults (visitors to the same museum) who had not seen the IPA name tag activity (or any other language activity from our group). We treated these equivalent adults as representing the baseline for these items allowing us to make principled comparisons.

To verify that our baseline participants were similar to our current participants, we first compared the two groups on their Language Fascination scores. We found that the current participants had an equivalent interest in language (M = 2.86) to the baseline group (M = 2.93), $t(610) = 1.44$, $p = 0.15$. (Note that there was no difference in Language Fascination scores for current participants who took the scale before or after the activity, $p = 0.43$.) However, we did find a difference between participants who had just completed the IPA name tag activity and the baseline group for their science-oriented ratings of language topics. As can be seen in Figure 1, the science-oriented endorsements are higher for all questions for all three language topics for the IPA adults (white bars) compared to the baseline adults (gray bars). Moreover, those differences are significant for all questions

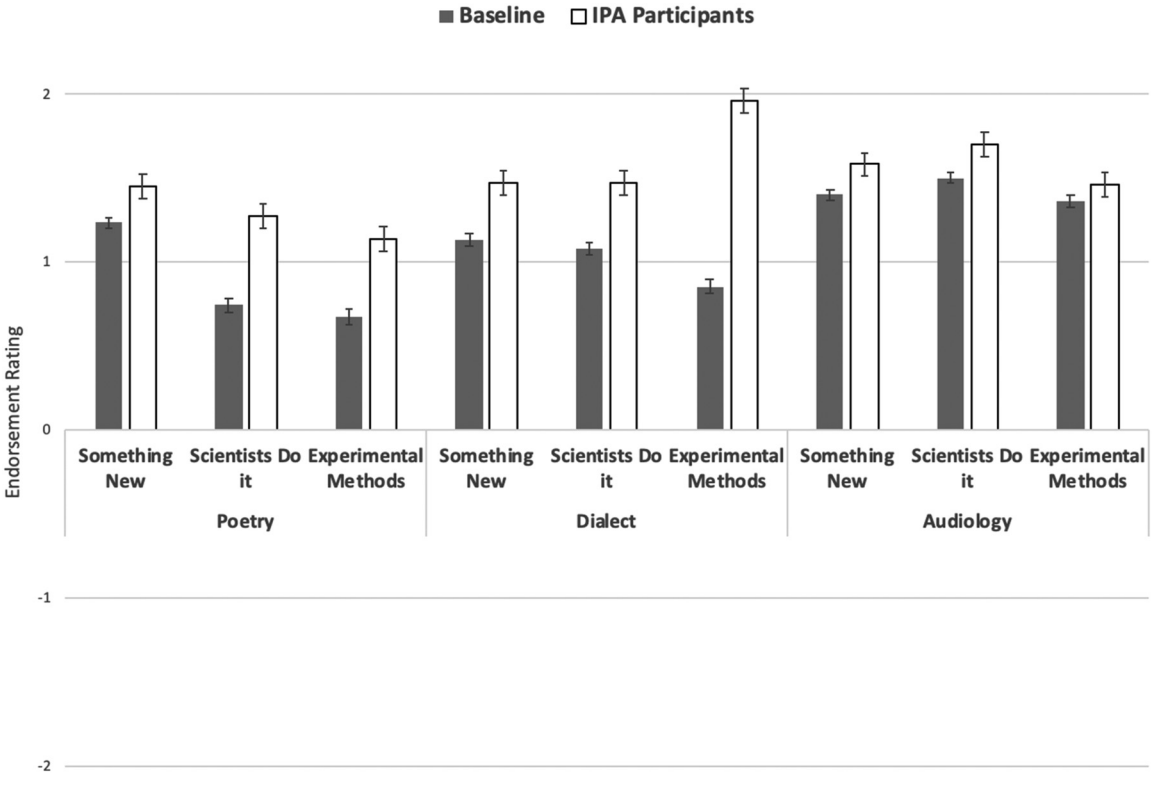

Figure 1: Mean endorsement ratings for three science-oriented statements for three language science topic areas. All differences are significant except for the endorsement of experimental methods for audiology. Poetry comparisons: Something new, $t(661) = 2.69$, $p = 0.008$; scientists do it, $t(661) = 11.88$, $p < 0.001$; experimental methods, $t(661) = 4.36$, $p < 0.001$. Dialect comparisons: Something new, $t(661) = 4.05$, $p < 0.001$; scientists do it, $t(661) = 4.6$, $p < 0.001$; experimental methods, $t(661) = 11.55$, $p < 0.001$. Audiology comparisons: Something new, $t(661) = 2.5$, $p = 0.013$; scientists do it, $t(661) = 2.69$, $p = 0.0073$; experimental methods, $t(661) = 1.28$, $p = 0.199$.

except for one audiology question (using experimental methods). We note that the audiology topic area had generated the highest levels of science-oriented endorsements in the baseline and participants in the current study had less room to improve upon them.

The qualitative results of the survey reinforce these findings. One participant stated: "It [the demonstration] reminded me how much I love this stuff … as a teacher, scholar, general nerd. I've always held that language is a living and evolving thing, and I hadn't really thought of poetry or lyrics as being studied by scientists as opposed to lit folks, so now I'm super curious about that field." Other participants (n = 18) explicitly stated that they learned "that linguists are scientists." Another participant said: "I guess it opens my mind to the types of scientists out there. I have heard of linguistics but never thought about what they do or how they study language." Other participants mentioned that they previously thought that linguists "just interpreted and translated." Therefore, these results indicate that whether participants had no idea what linguists did, or thought their work was simply related to translation and interpreting, a short linguistics demonstration has the power to open their minds to the scientific study of language.

4 General discussion

This study asked if we could interest the public with a language science activity (RQ1), teach them about language (RQ2) and broaden their perception of language to include thinking about it as something to be studied scientifically (RQ3). The results from our investigation with an IPA name tag activity suggest that all three of these goals were accomplished. For language scientists who are interested in public engagement, it is encouraging to see the effects that a short and relatively simple demonstration can have. Most participants expressed positive feelings about the demonstration, and the majority were able to identify at least one characteristic of the IPA. Importantly, we also found evidence that the demonstration increased endorsement of statements linking multiple areas of language study to the scientific method.

These encouraging results surely point to the power of informal linguistics education, but we want to highlight the fact that our activity was structured around best practices identified by specialists in informal science learning. Simply writing someone's name in the IPA likely would not have the same effect as our activity, which consciously aimed to incorporate multiple strands of science learning and emphasized interest and interaction. Experts in a content area, including language science, should be respectful of the expertise that exists in the informal educational domain: knowing what the IPA is does not mean that one knows the best way to inspire novices to want to learn more about it. But as this activity demonstrates, language science can instantiate informal science principles very effectively.

Finally, we note that one necessary side effect of encouraging participants to think about language as something that scientists can study is that we are implicitly encouraging them to think of the people engaging with them as the face of that science. We note that in response to the question about whether this activity had changed their idea about who studies language, one participant responded: "Not old men." Presumably engaging in a research study being conducted by three young women in lab coats was notable. While we must consider this particular response anecdotal, it is consistent with related work about what people learn from engagement experiences (cf. Righter et al. 2024). More generally, it highlights an important fact: representation matters. Whether we are representing language as something that scientists study or representing the diversity of humans that study language, we are showing the public what we think language science is.

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