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COMMENTARY

What does the public think about language science?

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Despite the long tradition of using the scientific method to study language, there is a widespread, if largely anecdotally based, feeling among language scientists that the general public does not perceive language to be a classic object of scientific study. The goal of the current study was to investigate this notion. We report the results of three experiments conducted in informal science learning environments that: (i) confirm the public thinks of science and language as fundamentally different objects, and (ii) show there are some areas of language science that are more readily accepted as science than others. Our results also suggest that high-impact demonstrations of core linguistic phenomena may be used to encourage people to recognize that language can be, and often is, an object of scientific study. Although the public has an incomplete understanding of the study of language, we argue that the strong humanistic approach with which the public associates the study of language can be seen as an opportunity to broaden participation in science.*

Keywords: informal science, language science, public perception

1. Introduction. Although a basic understanding of science is an important part of everyday life, public understanding of science in the United States is notably low, and even lower among women and individuals in minority groups (Funk & Goo 2015). In response to this, scientists are turning their efforts to public outreach. One challenge to successful public outreach efforts is that although people may lack knowledge about a domain, they are not typically blank slates. That is, they often hold various misconceptions about a domain that can make learning its core concepts difficult (e.g. Gil-Perez & Carrascosa 1990, Yates & Marek 2014). The goal of the current study is to investigate whether the public holds one key misconception about the study of language, namely, that language is an object that cannot be studied using the scientific method.

Linguists and other types of language scientists have long employed the scientific method to ask questions about language. They (we) study language systematically, with evidence-based theories that are regularly revised based on rigorous observations and experimentation. The Linguistic Society of America markets itself as ‘Advancing the scientific study of language since 1924’ (https://www.linguisticsociety.org/), and many research programs and other activities in the field are funded by the National Science Foundation, one of the premier science-funding organizations of the United States.[1] For practitioners in the field, there is no question that the scientific method is a core tool for studying language.

Moreover, this approach to studying language has yielded a treasure trove of results that have expanded our understanding of the human mind and brain (Friederici et al.

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[1] At the time of this writing, the NSF was providing over $46,000,000 in funding through the Linguistics program of the Behavioral and Cognitive Sciences (BCS) division of the Social, Behavioral, and Economic Sciences (SBE) directorate. Up-to-date information can be found here: https://www.nsf.gov/awardsearch/advancedSearchResult?ProgEleCode=1311&BooleanElement=ANY&BooleanRef=ANY&ActiveAwards=true&#results.

2017, Gentner & Goldin-Meadow 2003, Pullum 2018), improved educational practices (Norris & Ortega 2000, Seidenberg 2013), improved the quality of life for individuals with hearing impairments (Robinshaw 1995) and language difficulties (Conti-Ramsden et al. 2001, Garraffa & Fyndanis 2020), and enabled many components of our modern technological world (Bender 2013, Mitkov 2004). To put it mildly, language science has been a success.

Nevertheless, there is a widespread, if largely anecdotally based, feeling among language scientists that the general public does not perceive language to be a classic object of scientific study. Instead, linguists are seen primarily through a humanities lens, with the emphasis on good writing, the rhetoric of arguments, and learning about other languages and cultures. Importantly, there is a genuine tradition of studying language in this way that goes back at least to Aristotle (Janko 1987), and this tradition remains strong in many academic departments, especially those, like English and foreign languages, that are humanities-based.

If it is the case that the general public views the study of language as being irrelevant to science, there are several potential negative consequences for the field. The humanities and the sciences are often perceived culturally as being in competition with each other (Snow 2012 [1959], Tuana 2013), and currently, the sciences are winning. Science, Technology, Engineering, and Mathematics (STEM) are a priority for national funding (Handelsman & Smith 2016) and for educational programs (Krishnamurthi et al. 2013). At the university level, STEM departments are on a stronger footing than humanities departments in terms of faculty pay (Jaschik 2016), grant funding (Caplan-Bricker 2013, Gibbons 2019), and in many cases student enrollments (American Academy of Arts & Sciences 2015, National Student Clearinghouse Research Center 2015). Additionally, STEM-related careers are higher paying and expected to grow at higher rates than non-STEM-related careers (US Bureau of Labor Statistics Occupational Outlook Handbook database: https://www.bls.gov/ooh/). To the extent that language is perceived as outside of the STEM domain, it runs the risk of being overlooked for resources; just as worrisome, it runs the risk of being overlooked by talented students who are interested in STEM careers but do not see language as something that can be studied in that way.

However, there may also be some potential advantages to the dual status of the study of language. For example, at the national level, linguistics departments have achieved gender parity among their students (Linguistic Society of America 2020), an uncommon property for most STEM departments. As previous research has found that women tend to choose humanities and social science majors and career paths more frequently than men do (who tend to gravitate more toward STEM fields) (Aud et al. 2010), the humanities gloss that many ascribe to the study of language may contribute to the field's ability to attract a more diverse set of students.

Any attempt to leverage interest in the humanities side of language into promoting the STEM side of language science will, however, have to contend with the true range of approaches to the study of language. Language is not a topic area that falls neatly into disciplinary bins, and it is investigated by researchers in multiple STEM fields (including physics, medicine, computer science, and psychology) as well as multiple humanities fields (including literature, foreign languages, and comparative studies). Linguistics departments—the one type of department devoted specifically to the study of language—are variably considered to be humanities or STEM, depending on the university. It is quite possible, therefore, that the multiplicity of ways that language is studied are not perceived as being part of any kind of unified endeavor, as the term 'language science' suggests. Leveraging interest among the subdomains of language science could be stymied if people do not perceive them to be connected to each other.

The goal of the current study is to investigate the public perception of the study of language. Is it in fact the case that language is perceived more through a humanities lens than a scientific lens? And to the extent that it is, can this perception be changed? More pointedly, can people's perceptions of language or their interest in language be leveraged to broaden participation in science?

We approached these questions through three experiments. In experiment 1, we asked one group of members of the general public to recall favorite memories about language, and a second group to recall favorite memories about science. By comparing these open-ended responses, we were able to verify that participants' notions of language and science draw on—for the most part—very different kinds of experiences. One important difference was that many favorite science-related memories involved doing semi-structured activities focusing on specific phenomena; nothing similar was seen in memories about language. We return to this idea in our general discussion (§6) and consider how to engage people with such kinds of activities focusing on aspects of language.

In experiment 2, we sought to quantify interest in science and language among the general public: to what extent do people have a positive attitude toward each of these domains and an interest in further engagement with them? We found that people had generally positive attitudes about language (although not quite as positive as their attitudes about science), that some subdomains of language were viewed more positively than others, and that participants' gender had only a very mild effect on attitude.

In experiment 3, we asked about people's perceptions of whether different language topics can be studied in a scientific manner. Even if language does not spontaneously evoke a scientific discipline, it may still be the case that people are open to thinking about language—or some subdomains of language—scientifically, when prompted. Our results supported the idea that perceptions of subdomains of language exist on a scientific continuum.

Finally, we examined the relationship between interest in language and the appreciation that language can be studied in a scientific manner. Finding a connection from an increased interest in language (or a subdomain of language) to an increased understanding of how language can be studied scientifically would support the idea that there is a potential pathway for people who like language in general to move toward language as a STEM field. As we show here, the connection between language interest and its scientific study is tenuous at best. In the general discussion, we explore how embracing the dual nature of language as both a humanities and a science subject can benefit the field, and how these contrasting aspects might be incorporated into the kinds of structured activities that are recalled as positive science memories.

2. Experiment 1: memories of language and science. The goal of experiment 1 was to investigate how people spontaneously think about language and compare that to how they think about science. Previous experiments looking at 'epiphany' moments suggest that people can recall important incidents in their past by focusing on a specific topic area (Ballantyne et al. 2011, Green 2016). Genuine epiphany moments refer to times that had a lasting impact on long-term behaviors and career choices. Since one of our interests is in how to channel people's interest in language into a potential career studying it, we used this approach to enable us to see if individuals recalled memories, either for language or for science, that influenced their life more generally. We used a between-subjects design with two conditions to discourage people from trying to compare/contrast their memories. Thus, approximately half of the participants were asked to recall a science memory, and the other half were asked to recall a language memory. Further, since one of the potential outcomes of this program as a whole is to attract a more diverse set of individuals to study STEM by leveraging their interest in language, we examined whether participants' gender influenced their recollections of language or science.

2.1. Participants. Participants were recruited at two events designed to appeal to a broad cross-section of individuals: a free fair at a local science museum and a special evening at the museum where admission tickets were offered at a discounted rate. Groups were approached at these events and asked to fill in one of the brief memory survey sheets. As noted above, each person filled in only one sheet, so provided only a language memory or a science memory. No formal attempts were made to control who was assigned to which condition, although members of a single group were encouraged to fill in sheets for different conditions.

A total of 236 adults and seventy children participated, and they were roughly equally divided by condition and gender. Race/ethnicity data were not collected for this study. In the science memory condition, 105 adults (ages: 18–69, mean = 36.8; fifty-six women, forty-nine men) and forty-two children (ages: 5–17, mean = 10.9; twenty-nine girls, thirteen boys) participated. In the language memory condition, 131 adults (ages: 18–72, mean = 36.6; eighty-seven women, forty-four men) and twenty-eight children (ages: 5–17, mean = 11.9; sixteen girls, twelve boys) participated. The level of education of the adults in both groups was very similar, and very high: 73% of the adults in the language condition and 77% of the adults in the science condition either were in the process of earning a BA/BS degree or else had already earned that degree or a more advanced one. Similarly, both conditions had similar numbers of adults with jobs in a STEM profession (broadly including jobs in medical, engineering, or research professions): 21% of participants in the language condition and 28% of participants in the science condition. Only a small number of individuals listed careers that were clearly connected to language (e.g. Spanish teacher, interpreter, speech-language pathologist)—four in the language condition and two in the science condition.

2.2. Design, stimuli, and procedures. Potential participants were approached at public events and asked to fill in a brief survey for a research study. The surveys were provided on half-page-sized notepads. The color of the paper was different for the two conditions to facilitate efforts at getting a roughly balanced sample. Participants (or their parents, for children) consented orally, and they returned their filled-in surveys to opaque boxes placed nearby.

All of the surveys contained the same four demographic questions (age, gender, level of schooling, and current job). The written instructions on the top of each survey were the following, with the word *language* or *science* varying depending on the condition: 'Do you remember a time when you were excited about language/science? Do you remember a time when you learned something interesting or cool about language/science?.' Participants who requested clarification were read the prompt and told to write down whatever their gut reaction was to the question. Most participants wrote their own answers, but in a few cases (primarily younger children) research assistants wrote down orally provided answers.

2.3. Coding. The responses were transcribed verbatim. The final codes used for analysis can be seen in Appendix A, but they were developed through an iterative emergent coding process. First, it was determined that most of the responses were brief (one sentence or less) and identified a single fact or incident. This central element was termed the GENERAL FOCUS of the response, and in the initial iteration of coding, the authors (and one research assistant) read through the entire set of responses and suggested classification groupings for the general focus. Through discussion, preliminary definitions for the proposed classifications were created and the responses were coded. This preliminary coding was then reviewed by the team. We revised the coding definitions to more precisely capture each category and augmented them to ensure that a maximal set of responses were coded.

The final set of general focus codes consisted of eight coding levels: Identity (for memories about personal identity), Activities (for memories about participating in a structured activity), Recreation (for memories about unstructured activities done for enjoyment), Class (for memories about formal classroom experiences), Place (for memories highlighting a distinctive setting), Accomplishment (for memories about successful learning and application of knowledge), Event (for memories about a specific impactful event), and Content (for responses that were not memories but merely recounting of relevant content information).

During the coding process, two additional codes emerged that appeared to be independent of the general focus code: LOCATION and SOCIAL PERSPECTIVE. The location code was used to identify where the episode recounted in a memory occurred, and four levels were used: School (for formal school settings), Extra-curricular/Informal learning locations (for semi-structured learning spaces outside of formal school settings), Life (for settings in one's everyday life), and Work (for places of employment). Location overlapped in some respects with general focus, but was largely orthogonal to it. For example, a school location was part of memories of favorite classes, but it was also part of many memories focusing on activities and accomplishments; conversely, memories focusing on specific activities sometimes mentioned a school setting, but others mentioned informal learning locations (such as museums) or general life settings (such as the backyard). The greatest conceptual overlap between the two sets of codes involved the general focus code of Place. This code was used when the general focus of the memory was in fact a location; for example, a trip to Mount St. Helens was inspirational for one person's science interest.

The social perspective code was wholly orthogonal to the other codes. It was noted during the early iterations of emergent coding development that some of the memories were resolutely focused on the writer ('I'-language), while other memories mentioned the role of other people. This information was ultimately coded with reference to whether first-person singular pronouns were used (First person) or other individuals were mentioned explicitly (Others).

Finally, there were a small number of responses that contained multiple sentences and were more complex. Any responses that contained multiple levels of a category were coded as being both. For example, the language memory response 'Grew up in a bilingual family—loved the day I could share in conversation' was coded as expressing two general focus codes: Identity (the person's language background is important for describing their family) and Accomplishment (the person mentioned pride in a language-related ability).

The final coding definitions were used by two coders (one who had participated in the development of the codes and one who had not) to code the full set of responses. For the focus codes, these two coders agreed on 70.6% of the codes, yielding a kappa score of 0.664 (*SE* = 0.029), which is considered 'substantial' agreement. For the location codes, they agreed on 86.6%, yielding a kappa score of 0.81 (*SE* = 0.027), which is considered 'almost perfect' agreement. For the social perspective codes, they agreed on 95.7%, yielding a kappa score of 0.93 (*SE* = 0.018), which is also considered 'almost perfect' agreement. All disagreements between the two coders were resolved by discussion.

2.4. RESULTS. The type of memory being recalled—either science or language—was the independent variable of interest: Do people write about different things when asked to reflect on their experience with science compared to language? The three coding categories (general focus, location, and social perspective) were analyzed with separate chi-square tests. Adults and children were analyzed separately; however, as there were many fewer child participants and they encompassed a wide age range, we treat the adult analyses as primary. Table 1 shows how children's and adults' memories were coded across all of the categories.

	ADULTS		CHILDREN	
CATEGORY & LEVELS	LANGUAGE	SCIENCE	LANGUAGE	SCIENCE
GENERAL FOCUS				
Identity	13	13	2	0
Activity	0	29	1	15
Recreation	12	14	2	5
Class	36	12	8	12
Place	17	15	0	7
Accomplishment	19	3	6	1
Event	12	2	2	0
Content	23	13	0	7
Other	12	7	9	1
LOCATION				
School	37	33	10	18
Extra-curricular/ILL	1	18	0	7
Life	34	7	0	2
Work	8	7	0	0
Unspecified	53	43	19	17
SOCIAL PERSPECTIVE				
First person	59	38	19	11
Others	35	26	3	13
Nonspecific	37	41	6	18

TABLE 1. Number of participant memories that fell into each of the coding categories. Levels where there was a significant difference between language and science values have been highlighted. Because of the number of cells with no memories for children in the general focus and location categories, no post-hoc comparisons were made on those data.

Separate chi-square analyses were conducted for each general category of coding for each age group. For the general focus category, there was a significant overall difference in focus for the two kinds of memories among adults: $\chi^2(8, N = 254) = 60.12$, $p < 0.001$. Post-hoc comparisons (Bonferroni corrected for multiple comparisons to $p < 0.003$) showed that the specific focus category levels that differed between the conditions were Accomplishments, Classes, and Events (favoring language) and Activities (favoring science). The remaining categories were statistically equivalent across the two domains. Children's general focus responses also significantly differed by domain ($\chi^2(8, N = 76) = 38.69$, $p < 0.001$). However, 72.2% of the children's cells had expected counts of fewer than five, making post-hoc examinations of the individual category levels somewhat suspect. Nevertheless, just as with adults, Accomplishments and Events both were more prevalent in the language condition, while Activities were more prevalent in the science condition. Unlike adults, responses focusing on classroom experiences were equivalent for the two domains.

For the location category, there was a significant overall difference in focus for the two kinds of memories for adults: $\chi^2(4, N = 243) = 33.41$, $p < 0.001$. Post-hoc comparisons (Bonferroni corrected for multiple comparisons to $p < 0.006$) showed that the specific levels that differed between the conditions were Life (favoring language) and Extra-curricular/Informal learning locations (favoring science). The remaining categories were statistically equivalent across the two domains. Children's location also significantly differed by domain: $\chi^2(3, N = 73) = 8.31$, $p = 0.04$. For this category, 50% of the children's cells had expected counts of fewer than five, again making post-hoc examinations of the individual category levels somewhat suspect. Nevertheless, just as with adults, Extra-curricular/Informal learning locations were more prevalent in science responses. By contrast, the one level that was more prevalent for language responses was 'Unspecified'.

For the social perspective category, there was no significant overall difference for the two kinds of memories for adults: $\chi^2(2, N = 254) = 3.2$, $p = 0.202$. Adults did slightly favor the use of first person in their memories overall, but their preferences were equivalent across the domains. Children's social perspective responses, however, did significantly differ by domain: $\chi^2(8, N = 69) = 13.06$, $p = 0.001$. Post-hoc examination of the individual category levels showed that children used more first-person singular pronouns in their language responses and were more likely to mention other people in their science responses; the use of nonspecific responses was statistically equivalent across the domains.

Finally, additional chi-square analyses were run on each memory domain separately, using gender as an independent variable. These analyses revealed no significant differences between the gender groups for either adults or children for any of the three coding categories.

2.5. Discussion. When people reflect on their most notable experiences with language and science, in many respects they come up with quite different things to talk about. Language memories are dominated by classroom experiences that (for some) lead to mastery in the real world. The classrooms that people are largely focused on are in fact foreign language classrooms—a full 49% of adults' responses (and 68% of children's responses) in the language domain mentioned a non-English language by name. The connection to mastery was evident in the general focus codes, where adults often mentioned specific events where they used a foreign language (e.g. 'When I was able to ask for something in a foreign country (Italy) in Italian & they understood me') or a time when they demonstrated competence with a foreign language (e.g. 'Recently on a visit to Costa Rica. I knew Spanish words before, but to actually get to speak it there made it more interesting for me. Now I want to experience foreign languages more'). Another way that the responses focus on personal abilities for language can be seen in the children's favoring of first-person singular forms ('I' etc.) in their language memories. Moreover, the fact that many of the language responses mentioned nonschool and nonwork locations (e.g. 'I recently traveled to Japan … ', 'I currently work on learning Japanese. I watch anime + study karate, where my instructor sometimes uses Japanese words') reinforces the idea that language is seen as something that is used in the real world.

By contrast, the dominant type of science memory centers on some kind of specific activity, often done in school or in a semi-structured environment such as a camp or a museum. These activities included things like traditional science class demonstrations (e.g. a frog dissection) and fun science demonstrations (e.g. 'We did an egg drop experiment in elementary school. Each student had to create something to hold the egg and drop from roof of gym. The goal was to not have the egg crack'; 'Building a reflector telescope with a group of fellow students in high school, including sanding lens'). Moreover, the fact that children preferentially included mention of other people and used first-person plural pronouns in their science memories suggests that they see these science activities as non-individualistic exercises (e.g. ' … We looked at an owl throw up').

Despite these differences—language as foreign language mastery and science as fun activities—there were also some commonalities in the ways that people recollected the two domains. Both domains inspired several people to relay a favorite factoid from the domain (e.g. ' … my professor introduced the "Southern"/"Louisiana" language that was heavily based on French and Spanish'; 'Last week I read about a spider who mothers its babies, it even brings them food'). Thus, people appear to see both domains as containing a range of interesting phenomena to learn about. Moreover, both science and language feature in people's personal identities. In the language domain, the identity statements were most often connected to being bilingual or being from a multilingual family (e.g. 'When I was little my mom would speak to us in Spanish. Now I'm learning it in school so I can communicate better with my grandparents'). In the science domain, the identity statements were usually connected either to the person's profession (e.g. 'Everyday @ my work in AeroSpace Defense! I <3 science') or to general attitude statements (e.g. 'I am often excited about science. I hope for a way to more efficiently create, store & transfer energy'). Indeed, the few memories that clearly embodied real epiphanies fell into the identity category (e.g. 'Researching science fair project ideas in 6th grade, I started learning about different types of bridges. This eventually led me to a career in civil engineering'). Overall, therefore, both domains are clearly important to many people in ways that go beyond being simply topics one studies in school.

Additionally, the general conceptions of these two domains as revealed by the recollections do not differ in any way by gender or particularly by age: men and women, boys and girls all show very similar patterns. One potential caution in the results is that although we explicitly targeted events designed to attract a socioeconomically diverse audience, in point of fact most of our participants were highly educated. But with that limitation in mind, the sense in which the domains of language and science differ for this task are equivalent for a range of individuals, and likely reflect broadly held societal attitudes.

One possible concern with this study is the fact that there is a category mismatch between the terms we used: 'language' is the object of study of language science, while 'science' is the name for an approach to studying something. It is possible that people's responses depended primarily on the difference in emphasis (object of study vs. method of study). Moreover, it does seem plausible that people would have provided different memories if asked to recall a favorite memory about 'nature' or the 'solar system'. We could imagine more personal experiences being mentioned (e.g. walks in the woods, stargazing on a camping trip) rather than the structured activities that were prominent for science (e.g. frog dissections and NASA camp). Finding the paths that make science feel more personal is an interesting line of investigation that could potentially also help broaden participation in science.

However, while the concept of science might be made more personal, we find it far less likely that there is a straightforward way to ask people to spontaneously recollect more science-oriented approaches to language. In recently conducted work in our lab (Wagner et al. 2022), we asked participants to explain what they thought a linguist did. The dominant responses centered on foreign languages: linguists either learn many languages themselves or teach languages to others. Very few people mentioned any examples of the kind of scientific work that many linguists regularly engage in. Further, as we show in experiment 3 below, when directly asked about the scientific nature of topic areas, our participants consistently rated language topics as less amenable to scientific study than topics within the fields of botany and genetics. More generally, we note that we chose the terms 'science' and 'language' because they are broad terms, very familiar to most people, and identify a core concept we were interested in. The fact that they yielded different memories suggests that, at some very general level, these two concepts invoke different ideas.

In sum, when asked to generate memories about language and science, people tend to mention different things. Language is seen as a tool used in the real world to communicate with other people, while science is often remembered in the context of a fun activity. One way to encourage people to think of language as something that can be studied scientifically may therefore be to introduce them to fun, science-like activities that demonstrate core results from language science. Additionally, previous research (Kang et al. 2019) has found that informal science activities can foster a personal STEM identity, which contributes to ongoing STEM involvement. Given that this study also found that language memories often invoke statements about personal identity, we see language science activities as potentially offering a useful tool for encouraging people to link their language and STEM identities.

3. Experiment 2: measuring interest in language and science. Experiment 1 showed that language and science evoked very different kinds of memories, thus supporting one of our initial premises, namely, that language is not considered to be a canonical part of STEM. Our next step was to determine if there was a difference in interest (or fascination) between the two domains, and if so, whether that difference depended on any systematic demographic properties. Previous work has found that there are large gender disparities between the number of men and women choosing specific college majors and career paths: women are more likely to choose humanities and the social sciences, while men tend toward engineering, math, and physical sciences (Aud et al. 2010). This gap exists despite evidence that there is no gender gap in aptitude for STEM-related abilities (Turner & Bowen 1999). Instead, it appears that there are gender differences in attitudes toward science that may contribute to the gender disparities (Hill et al. 2010). For example, in one study of sixth graders' attitudes toward science, girls were more likely than boys to rate science as difficult to understand (Jones et al. 2000). Interestingly, the same study found that girls indicated a strong interest in a language-related topic (animal communication systems), and language continues to be an area of focus for women into the college years, when they are more likely than men to choose a major in English, communications, or foreign languages (Aud et al. 2010). Thus, girls (and women) are interested in language even if they do not recognize that it can be studied scientifically and therefore may be well positioned to benefit from exposure to language science.

In experiment 3, we take up the question of whether a person's interest in language and/or science might influence their appreciation that language can be studied in a scientific manner. However, experiment 2 asks more simply whether certain categories of people are more interested in language compared to science or vice versa.

In this study, we used an established scale from the Activation Lab to assess participants' interest (or as the scale terms it, 'fascination') in science (Chung et al. 2016). No equivalent scale exists for assessing interest in language science, so we adapted the Chung et al. scale to create the language fascination scale. However, as we discuss below, our initial piloting of this scale suggested that participants might be more comfortable with a measure that invokes specific subareas of language rather than language as a general construct. Thus, we also created and used the SPECIFIC LANGUAGE AREA FASCINATION SCALE, which was a further modification of Chung et al. 2016. The value of administering the specific area scales in addition to the general language scale is that they allowed us to probe the extent to which participants' attitudes depended on different concrete domains. One possibility is that participants' interest in different subdomains may not be similar to their interest in language as a whole, and moreover, participants may have quite different attitudes toward language depending on the specific subdomain being probed.

3.1. PARTICIPANTS. There were 660 participants in total, including 495 adults (ages: 18–83, mean = 32.8; 314 women, 181 men) and 155 children (ages: 3–17; mean = 11.8; ninety-eight girls, fifty-seven boys). All participants were recruited, and completed the survey, at a local science center, and roughly a quarter of participants (28%) were part of families holding memberships to the museum. The children's education levels were commensurate with their age; the adults were highly educated overall: 59% had completed a BA or higher degree, and an additional 37% had earned their high school diplomas. The racial/ethnic breakdown for adults and children was extremely similar and was as follows: 79% white, 7% African American, 5% multiracial, 4% Asian, and 2% Hispanic. The remaining 3% chose not to respond. An additional sixty-one participants were recruited but not included in the final sample because they did not complete the full survey (including all portions reported in experiment 3 below).[2]

3.2. INSTRUMENTS. We administered the SCIENCE FASCINATION SCALE created by the Activation Lab (Chung et al. 2016). This instrument is short, consisting of just eight statements for which participants indicate the frequency of their engagement, their overall attitude, and their agreement with various statements. It is primarily designed to be used with children between the ages of ten and fourteen, but our preliminary piloting with the scale showed that adults found it to be quite sensible.

This scale served as the basis for the development of our parallel language fascination scale. Our first attempt involved a simple translation of the science fascination scale into language terms. Specifically, we substituted the word *language* for the word *science* as the topic area, *communication* for *nature* as the overarching domain of study, *words* for *objects* as a specific element that is studied, and *linguists* for *scientists* as the people who study the area. In addition, the science fascination scale assumed that the participant had done some kind of activity involving science in the past—a reasonable assumption given the results noted in experiment 1. However, as experiment 1 also makes clear, such an assumption is not warranted for language, so we modified two of the items to focus on learning about language rather than doing work on it. The final version of the language fascination scale is shown in Table 2.

Initial piloting with our language fascination scale revealed that many participants requested clarification of what we meant by 'language' and 'communication', even though the same participants never requested clarification about what was meant by 'science' or 'nature' in the science fascination scale. We note that there is nothing intrinsically more abstract or vague about 'language' relative to 'science'—both terms are

[2] An additional ten participants did complete the survey but were omitted from the analyses because they did not identify as either male or female. These ten individuals identified in a range of ways (nonbinary, fluid, transgender, refusal to specify), which meant that they did not constitute a coherent gender group collectively, and there were not enough individuals in any one category to make the gender analyses including them interpretable.

ITEMS	RESPONSE SCALE
I wonder about how communication works.	Never—Once a Month—Once a Week—Every day
In general, when I learn about language, I …	Hate it—Don't like it—Like it—Love it
In general, I find language …	Very boring—Boring—Interesting—Very interesting
After learning something really interesting about language, I look for more information about it.	NO!!—No—Yes—YES!!
I need to know how words work.	NO!!—No—Yes—YES!!
I want to read everything I can find about language.	NO!!—No—Yes—YES!!
I want to know everything about language.	NO!!—No—Yes—YES!!
I want to know how to do everything that linguists do.	NO!!—No—Yes—YES!!

TABLE 2. The language fascination instrument.

quite broad and encompass a diverse set of activities. Being interested in language could involve an interest in dialect, poetry, or how computer voices work; being interested in science could involve an interest in flowers, atoms, or diseases. Nevertheless, participants' reactions suggested they did not have a single, unified category that encompassed the range of things that language scientists study. Or, if they did, 'language' was not a useful way to label it.

To address this issue, we developed the SPECIFIC LANGUAGE AREA FASCINATION SCALE, which asked participants to rate three statements about specific subareas of language science. We piloted ten areas of language encompassing a wide range of research: computer voices, hearing difficulties, poetry/song lyrics, dialect, language acquisition, animal language, language games, slang, grammar, and foreign language learning. The final version of the instrument examined the areas of POETRY & SONG LYRICS, SLANG, LANGUAGE ACQUISITION, and LANGUAGE GAMES. These four were chosen because they led to very little confusion among participants and collectively represent a broad set of different domains of language. For each specific area, participants read three statements: one relating to a general positive attitude, one to a desire to learn more about the area, and one to a desire to actively engage with the area. Participants were asked to rate their level of agreement along a four-point scale: strongly disagree, disagree, agree, strongly agree. The full scale can be found in Appendix B.

Following the validated practices for the science fascination scale (Chung et al. 2016), each level on each of the scales was assigned a numerical value from 1 to 4 such that higher values indicated increased frequency/interest/engagement/agreement. The scores were averaged across all items within a scale and could range from 1 to 4. Scores above 2 (the midpoint) indicated an overall positive level of interest and engagement, while scores below 2 indicated an overall negative level of interest and engagement.

3.3. PROCEDURE. Participants were recruited on the floor of a local science center. Verbal consent was obtained from adult participants, and verbal parental permission was obtained for child participants. All instruments used were presented on an iPad, using Google forms and a secure Wi-Fi connection. Participants held the iPads themselves and were allowed to complete the form at their own pace. Experimenters remained nearby to answer questions and to troubleshoot any technical difficulties. For some younger children, parents were allowed to assist by reading the questions and pressing the buttons, and an experimenter assisted in this way for some children. All participants completed three sets of surveys in the following order: (i) a basic demographic survey, (ii) the science and language interest surveys reported in experiment 2, and (iii) the nature-of-science surveys reported in experiment 3. The full suite of surveys took approximately twenty minutes to complete, and the overwhelming majority of recruited participants completed all portions (as noted above, those who did not were excluded from analysis). Participants did not receive any incentives to participate (beyond a sticker saying 'I did language science today!').

3.4. Results. The mean values for all three fascination scales broken down by gender and age group can be seen in Figure 1. The first analysis compared the responses to the established science fascination scale to the responses to our parallel language fascination scale. Following the recommended guidance from the creators of the science fascination scale (Chung et al. 2016), we ran a general linear model with participant age group (child vs. adult) and gender (male vs. female) as between-subjects independent variables, the domain of the scale (science vs. language) as a repeated-measure within-subjects variable, and the fascination scores (the average value across all items on the scale) as the dependent variable.

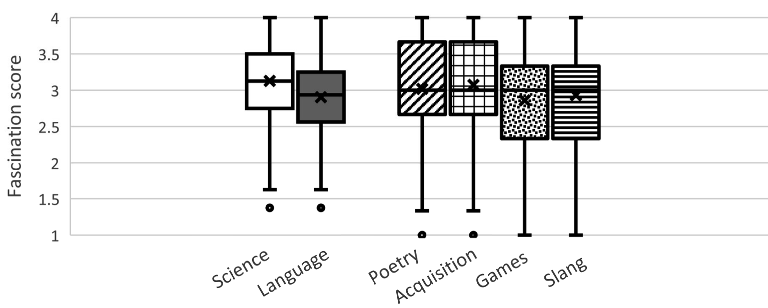

Figure 1. Box-and-whiskers plot of all the fascination instruments used. The scales range was to 4, with higher scores indicating greater levels of fascination. Science fascination was significantly higher than general language fascination. Across all six scales, the significance ordering was the following: science = acquisition > poetry/lyrics > general language = slang > games.

The model found a moderate main effect for the domain of fascination ($F(1, 646) = 68.34$, $p < 0.001$, partial eta$^2 = 0.096$), with participants showing higher overall scores for science fascination over language fascination. The model found a main effect with a small effect size for age group ($F(1, 646) = 5.31$, $p = 0.022$, partial eta$^2 = 0.008$) and no overall effect for gender ($F(1, 646) = 0.54$, $p = 0.45$). Additionally, there were no significant interactions among any of the variables, including no significant interaction between domain and gender ($F(1, 646) = 2.67$, $p = 0.1$), indicating that the overall higher interest level in science relative to language was shared equally between males and females in this sample.

The next set of analyses examined whether there were differences in fascination level among the specific subareas of language, and how those compared to the general language fascination score. A general linear model was run with participant age group (child vs. adult) and gender (male vs. female) as between-subjects independent variables; the subareas of language and general language were entered as repeated-measure within-subjects variables (General language vs. Poetry vs. Language acquisition vs. Games vs. Slang), and the fascination scores (the average value across all items on the scale) as the dependent variable.

The model found no significant difference between children and adults as a main effect ($F(1, 643) = 0.89$, $p = 0.35$) and found a main effect for gender with a small effect size ($F(1, 643) = 8.45$, $p = 0.004$, partial eta$^2 = 0.013$). Moreover, there were no significant interactions within the model. There was, however, a moderate-sized main effect of specific subarea of language ($F(4, 643) = 10.45$, $p < 0.001$, partial eta$^2 = 0.061$).

Post-hoc *t*-tests were conducted to further understand how language area mattered for the levels of fascination. Ten paired *t*-tests (Bonferroni corrected to an alpha level of 0.005) were conducted, comparing general language fascination and the four language areas (i.e. General language vs. Poetry vs. Language acquisition vs. Games vs. Slang) to each other. These tests showed that the subareas of Poetry and Language acquisition were statistically equivalent to each other and received significantly higher scores than the General language fascination measure, and than the subareas of Games and Slang. The subarea of Slang was statistically comparable to the General language measure and higher only than the Games subarea. The Games subarea received a score that was significantly lower than every other subarea, including the General language area. In short, participants were most fascinated by poetry and language acquisition and least fascinated by the use of language in games. Fascination with slang was intermediate and equivalent to general language fascination.

3.5. Discussion. This study probed the general public for their interest in, or fascination with, both science and language. The first main result was that our participants found science to be more fascinating than language overall. Contrary to the previous literature (Aud et al. 2010, Hill et al. 2010, Jones et al. 2000), our result held equally for both genders. This may be explained partly by the location of testing. A science center is likely to attract visitors who are pro-science, regardless of gender.

Gender effects among subcategories were also small and should thus be interpreted with some caution. Nevertheless, we did find that females provided higher ratings than males for all of the language scales. Moreover, inspection of the means showed that Language acquisition generated the highest ratings from women (significantly higher than their fascination with science: $t(313) = 3.83$, $p < 0.001$). For no subareas of language did boys or men provide higher ratings than they did for science. We did not predict that women might have a special interest in language acquisition, but we speculate that this result reveals how life experiences may shape interests. For example, many of the adult women in our sample were mothers of young children (reflecting the family-oriented nature of our museum setting) who are currently watching language acquisition happening within their own families.

More generally, the differences in responses between the general language fascination scale and the specific language subarea scale suggest that there may be some real differences in the way that language scientists conceptualize language and the ways that the public does. For example, language acquisition is a core topic within linguistics and language science, but given that interest in language acquisition is stronger than interest in language as a whole, it appears that this subarea is not what first comes to people's minds when they are asked to reflect on language. Casting the result more positively, language acquisition may be a particularly fruitful topic area for engagement, as people find it more fascinating than some other domains of language.

Interestingly, there was one subarea of language that had fascination scores equivalent to the general language fascination scale: slang. We find it notable that slang is one of the few subfields of language science that receives wide coverage in the popular press. Indeed, promoting new words is an annual ritual among dictionary publishers, as well as the American Dialect Society (see https://www.americandialect.org/woty). Our piloting efforts suggested that people may lack a general category of language science; these results point to the possibility that the study of slang terms may serve as the primary representation of language science for many people. However, this particular experiment included only four subdomains, so we cannot make strong claims about how different areas of language may relate to people's general understanding of language.

Finally, we note that although people indicated a higher level of interest in science than language overall, the scores themselves were all very much in the positive range. The rating scales themselves were scored from 1 to 4, and therefore any score above a 2 is on the positive side; looking at Fig. 1, it is clear that most of the language interest scores were actually close to 3, which is firmly at the positive end of the scale. Even language Games, which was judged the least fascinating subarea of language we queried, received a mean overall score of 2.86. This level of positivity is very similar to what was found in experiment 1 and may reflect the general stance of the kind of people who are willing to participate in research studies in science centers.

4. Experiment 3: can language be studied scientifically? The previous two experiments demonstrate that people have distinct notions of the study of language and of science and that, at least among visitors to a science center, science is viewed as more interesting. In this study, we ask to what extent people are willing to explicitly endorse the idea that one could study language scientifically. Even if this is not people's spontaneous way of thinking about language, maybe it is still something that makes sense to them.

What does it mean to study something scientifically? Our guiding principle, drawn from the National Science Teaching Association (https://www.nsta.org/nstas-official-positions/nature-science; see also Lederman 1992), is that science is a process for generating new information. A wide variety of principles and concepts have been proposed as key components of the scientific method, including some sweeping notions about how the process works (e.g. our current scientific understanding is tentative and can be revised on the basis of evidence, and evidence is generated by interrogating the world; see also Kuhn 1962), more specific notions about subcomponents of the process (e.g. the difference between laws and theories, the difference between inventions and discoveries), and some notions about how scientists go about their business (e.g. scientists are objective and logical, scientists are creative, scientists are influenced by their cultural background).

To assess people's estimation that a domain could be studied scientifically, we focused on three components from the nature-of-science literature that captured core elements and could also be described quickly in easy-to-understand language. We first asked whether people believed there was something new yet to be discovered in the domain. This question aimed at the core idea of tentativeness: the possibility of new discoveries suggests that what we currently know is incomplete (and also potentially changeable). We next asked how likely participants thought it that different kinds of people would discover new things in the domain. We focused our analysis on participants' assessment of whether a scientist was the type of person who investigated a particular domain. Our third question asked participants how they thought someone would go about discovering new things in a domain. For this question, we again focused our analysis on participants' assessment of whether a controlled experiment—a distinctive aspect of science—was an appropriate method for investigating the domain.

In experiment 2, we found that not all subfields of language science are equally interesting to people, and it seemed likely that not all subfields would be perceived as equally scientific in nature. After all, some elements of language are studied within traditional STEM departments and medical schools (e.g. hearing, including hearing speech sounds), while others are studied within humanities and even fine arts departments (e.g. poetry). We therefore investigated four different topics studied by language scientists. Topics were used as the unit of evaluation in this experiment (as opposed to names of academic departments, such as Linguistics or English) because, following the insight from experiment 2, we wanted to keep the judgments focused on something concrete and specific. Poetry and grammar were chosen because they are typically associated with the humanities, while hearing was chosen because it is typically associated with STEM. Our fourth area was dialect, which we chose because it is stereotypically associated with linguistics as a field. We also recognized that science is not a monolith any more than language science is, and therefore also chose two very different topics that are canonically thought of as being studied scientifically: genetics and sunflowers.

If language is genuinely not considered to be something that can be studied scientifically, then we hypothesize that there will be a sharp difference between how people rate the language topic areas and the canonical science areas: there should be less new to discover about language topics, scientists should be less likely to study them, and experimental techniques should be less likely to be used. However, given the variability found for interest in experiment 2, we also anticipated that there might be real differences in the ways people perceived the different language topic areas. Our expectation was that the topic of hearing would be perceived as more scientifically oriented than poetry or grammar, but the status of dialect is a more open question. To the extent that linguistics itself is perceived as a science, then a stereotypical linguistic topic area should be perceived as scientifically oriented.

4.1. Participants. The participants in this study were the same as those in experiment 2.

4.2. Materials and procedures. The procedures in this study were the same as those in experiment 2. The instruments reported here were presented to participants after those reported in experiment 2. For this study, participants responded to three ratings scales for each of the six topic areas. The topic areas were always presented one at a time in the following order: dialect, hearing, poetry, grammar, sunflowers, and genetics.

For each topic area, participants were given a single sentence description of the area (shown in Appendix C) and were asked to indicate on a five-point scale whether there was anything new to be learned about this area. Next, participants were asked: ‘Is this the kind of person who could discover something new about X’, and were presented with four types of people to rate on a five-point scale: ‘scientist’, ‘linguist’, ‘anyone with an interest in [topic area]’, and a specific expert practitioner in the area (‘English teacher’, ‘newspaper editor’, ‘songwriter’, ‘doctor’, ‘gardener’). Finally, participants were asked: ‘If someone wanted to discover new things about X, would they … ’, and were presented with four methods of investigation (observation, experiments, surveys, asking an expert) to be rated on a five-point scale. Each point on the ratings scale was converted to a number from −2 (strongly disagree) to +2 (strongly agree). Thus, the positive/negative valence of a score reflected agreement/disagreement, and the absolute value of the score reflected the strength of the opinion.

The full set of materials (and associated results) can be found in our supplementary materials, available on the Open Science Framework (https://osf.io/j7ty6/). For the current analyses, we focused on a subset of our questions that were geared specifically toward a science orientation, namely, whether it is possible to discover something new about a topic area, whether scientists are the ones who would make those discoveries, and whether they would do so by conducting controlled experiments. Table 3 shows the questions (as instantiated by the hearing-impairment topic) that were analyzed for this paper.

Some people have problems with their hearing, either because they are born unable to hear or because they develop hearing difficulties as they get older					
Is there anything new to discover about hearing difficulties?					
	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
Is this the kind of person who could discover something new about hearing difficulties?					
Scientist	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
If someone wanted to discover new things about hearing difficulties, would they …					
Experiment in a lab (e.g., controlled tests)	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree

TABLE 3. The science orientation questions from the survey, as they were instantiated for the hearing-impairment topic area.

4.3. RESULTS. Prior to conducting each analysis, we created an omnibus model that included age group (children vs. adults) and gender (male vs. female) in addition to the target question. For all three questions, none of these models found a significant main effect for these demographic factors or a significant interaction term involving them. They were therefore omitted from the remaining analyses.

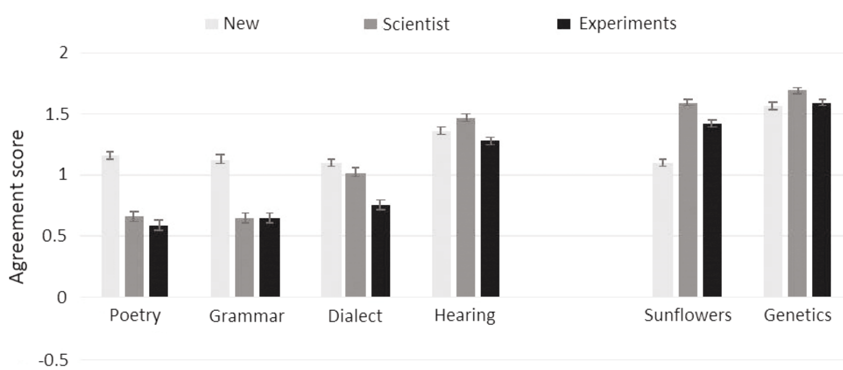

FIGURE 2. Mean ratings for the three scientific questions for all topic areas. The scale ranges were −2 to + 2, with higher scores indicating greater levels of agreement.

4.4. POSSIBILITY OF DISCOVERY. The first analysis examined whether there was anything new to be discovered for each domain. Figure 2 shows the mean agreement ratings across the domains for the discovery question. Further detail on this question can be seen in Figure 3, which shows the breakdown by response selection for each topic area. As can be seen, the mean score for all domains was above 1, indicating that participants agreed that there was something new to be learned about every topic area. A comparison of the mean scores showed, however, that there were some differences in the strength of this agreement. A general linear model using topic area as the independent variable and the discovery rating as the dependent variable found an overall difference ($F(5, 619) = 50.39$, partial eta^2 = 0.075). Post-hoc comparisons using the least significant difference measure and an alpha level of 0.003 showed that the genetics topic area received higher ratings than all other areas. In addition, the hearing topic area received higher ratings than the remaining areas (including sunflowers). All other areas received equivalent ratings.

4.5. AGENTS OF DISCOVERY. The next analysis looked at whether a scientist was someone participants thought would be able to discover new things in each domain.

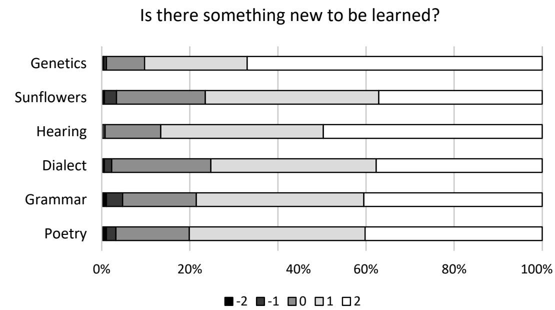

FIGURE 3. Percentage of participants who provided each scale response for the 'possibility of discovery' question. The colors on the figure go from black (−2, indicating strong disagreement) to white (+2, indicating strong agreement).

Figure 2 above shows the average ratings for each topic area, and further detail on this question can be seen in Figure 4, which shows the breakdown by response selection for each topic area. A general linear model using topic area as the independent variable and the scientist rating as the dependent variable found a main effect of topic area ($F(5, 631) = 272.19$, $p < 0.001$, partial eta$^2 = 0.3$), and post-hoc analyses found differences between almost every topic. Genetics received the highest scientist ratings, significantly higher than even sunflowers. Sunflowers received significantly higher scientist ratings than hearing, which in turn received significantly higher scientist ratings than dialect, which in turn received significantly higher scientist ratings than poetry and grammar. Ratings for poetry and grammar were equivalent and were the lowest scientist ratings across all categories. We can thus identify a clear ordering for how likely participants think scientists are to discover things for these topics: genetics > sunflowers > hearing > dialect > poetry/grammar.

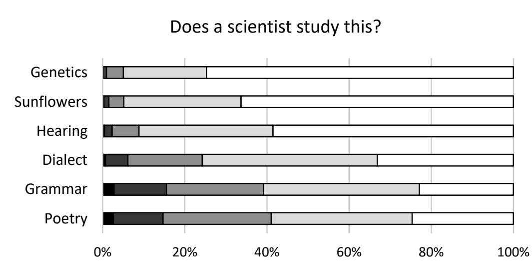

FIGURE 4. Percentage of participants who provided each scale response for the 'agents of discovery' question. The colors on the figure go from black (−2, indicating strong disagreement) to white (+2, indicating strong agreement).

4.6. METHOD OF DISCOVERY. The next analysis looked at whether each topic area can be investigated via controlled experiments, a method canonically associated with doing science. Figure 2 above shows the average ratings for each topic area, and further detail on this question can be seen in Figure 5, which shows the breakdown by response selection for each topic area. A general linear model using topic area as the independent variable and the experiment rating as the dependent variable found a large main effect of topic area for this method ($F(5, 622) = 211.9$, $p < 0.001$, partial eta$^2 = 0.254$). Post-hoc analyses showed that poetry, grammar, and dialect all received significantly lower ratings for this method (and they were all equivalent to each other). The remaining topic areas were each significantly different from the others: hearing received significantly higher ratings than the remaining language topics, sunflowers received significantly higher ratings than all language topics, and genetics received ratings significantly higher still.

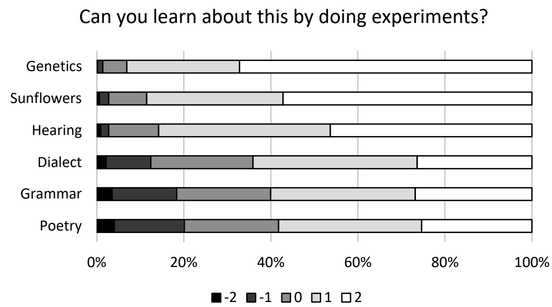

FIGURE 5. Percentage of participants who provided each scale response for the 'method of discovery' question. The colors on the figure go from black (−2, indicating strong disagreement) to white (+2, indicating strong agreement).

4.7. DISCUSSION. As with experiment 2, most of the ratings in this experiment were quite positive. Recall that the scale ranges from −2 to +2 and that any rating above 1 indicates an endorsement of the statement. Thus, participants were generally open to the idea that there were new things to be discovered about all of the topic areas. However, when it came to the question of whether scientists would be the ones discovering new things, or whether they would be using controlled experiments to do so, there were significant drops in agreement for all of the language areas. The language topics were not, however, a homogeneous set: poetry and grammar were seen as least likely to be studied by scientists using experiments, dialect fared slightly better, and hearing fared slightly better than that (though it was still deemed less likely to be studied by scientists using experiments than the topic areas of sunflowers or genetics).

Given the differences found among these linguistic subfields, we feel it is worth pointing out that all of the language topic areas we investigated do indeed have scientific traditions of study—even those the public deemed less science-oriented. There is an extremely robust literature using experimental techniques to look at how humans produce and understand various elements of their grammar (e.g. Traxler & Gernsbacher 2011), and various dimensions of poetry (metaphor, meter, etc.) have also been examined through experimentation (e.g. Kiparsky & Youmans 2014, Palmer & Kelly 1992). The fact that the public does not think of grammar and poetry as objects of scientific study does not, of course, mean that language scientists do not study them that way—it means only that the public does not know.

5. DOES FASCINATION MAKE LANGUAGE MORE SCIENTIFIC? Because experiments 2 and 3 were run with the same individuals, we can use these data to ask a question about individual differences: What is the relationship between a participant's interest in language science and treating language topics as something that can be studied scientifically? If interest in language leads to greater acceptance of language topics as open to scientific study, then we have grounds for believing that it is possible to leverage an interest in language into interest in pursuing STEM opportunities more generally.

To investigate this question, we created a composite SCIENCE ORIENTATION score, which was composed of the average rating across the three variables reported for experiment 3. We correlated the science orientation scores for the four language topic areas with participants' language scores from experiment 2. We were concerned, however, that a simple correlation would reveal only whether a participant was more (or less) likely to use the top (or the bottom) of the ratings scale across the entire experimental session. We therefore also included participants' science fascination scores in the analysis as a control factor.

First, we calculated the correlation between the science orientation scores and both the language and science fascination scores. These values can be seen in Table 4. As expected, there are broad correlations across the experiment in how individuals used the rating scale, as all of the factors correlated positively with each other.

	POETRY	GRAMMAR	DIALECT	HEARING	GENETICS
Science fascination	0.204	0.203	0.301	0.243	0.230
	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
Language fascination	0.265	0.263	0.317	0.233	0.216
	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
Z-value	1.330	1.300	0.358	−0.217	−0.303
p-value	0.093	0.096	0.360	0.410	0.380

TABLE 4. Correlations between science orientation score and language fascination and science fascination scores. Pearson's R reported. Correlation between language fascination and science fascination = 0.246, $p < 0.001$.

But if language fascination is critically driving a science orientation in language areas, then the correlation between the two should be stronger than the correlation between science fascination and science orientation. To determine if this is so, we used the comparison of correlations for a dependent samples test (Lenhard & Lenhard 2014). For this test, we calculated the correlation between the language and science fascination scores: they are also positively correlated with each other (Pearson's R = 0.246, $p < 0.001$). Their correlation value served as a baseline comparison, and the correlation values for the science orientation scores were standardized relative to it. We set the standardization so that stronger correlations between science orientation and language fascination would be set to positive. Thus, the positive standardized *Z*-value for poetry's science orientation (1.33) indicates that the correlation between it and language fascination was stronger than between it and science fascination; by contrast, the negative *Z*-value found for hearing (−0.217) indicates that the correlation between it and language fascination was weaker than the one found between it and science fascination. The standardized *Z*-values are normally distributed, and the *p*-values indicate the probability of finding that standardized value. As can be seen in Table 4, although our results go in the hypothesized direction for poetry, grammar, and dialect—that is, the correlations between science orientation in these areas and language fascination are higher than between these areas and science fascination—the size of the difference is not significant. It appears, therefore, that increased interest in language does not strongly predict one's perception of language topic areas as being more science-oriented in general.

6. GENERAL DISCUSSION. We investigated a piece of conventional wisdom in the language science field, namely, that the public perceives language from a humanities perspective and not a scientific one. The results of these studies largely confirm this opinion, widely held among language scientists. When asked to recall an experience involving language (experiment 1), people focused on foreign language mastery, but when asked to recall an experience involving science, they focused on structured activities demonstrating science phenomena. People's spontaneous impressions of language are quite different from their responses to science. Moreover, in a more structured task (experiment

3), participants were less willing to endorse core elements of the nature of science in connection with language topics relative to the more traditional objects of scientific study, genetics and sunflowers. Thus, people appear to find it less likely that scientists would discover new things about language topics or that they would use controlled experiments to investigate them.

These results supporting the conventional wisdom are tempered, however, by the fact that it is unclear that a unified concept of 'language' exists for many of our participants as an overarching domain of study. Indeed, even some language scientists agree that language in this sense is ill-defined (Friederici et al. 2017). In the piloting stage of experiment 2, participants expressed confusion about what we meant by both 'language' and 'communication', and experiments 2 and 3 found that participants' attitudes—both those involving their interests and those about scientific orientation—varied depending on the specific topic area of language being queried. For example, experiment 2 found that adult women found science to be more interesting than language overall, but found the specific area of language acquisition to be more interesting than science. Further examples of variation in experiment 3 found that the topic of hearing impairments was rated significantly higher than other language areas for general science orientation and that even the topic of dialect had a significantly higher science orientation than the topics of grammar and poetry.

Since some areas of language science are recognized as falling under the domain of STEM, we might ask how one could shift a person's thinking about those that are not seen in this way from a humanities perspective to a more scientific one. The results from experiment 1 point to a possible approach: people link science with structured and semi-structured activities that have a clear focus and a hands-on component. Science is something that is demonstrated for them (and with their participation) through controlled activities. By contrast, language is something that one takes classes in—usually foreign language classes. However, language provides ample opportunities for the kinds of demonstrations commonly done for canonical science topics. Indeed, introductory linguistics classes regularly make use of the same kind of structured/semi-structured demonstrations of aspects of language that people seem to link with science. For example, most classic findings from the field can be turned into an inquiry-based learning activity. Indeed, our lab has created activities of this kind based on phenomena such as the McGurk effect (Tiippana 2014), the use of various word-learning strategies (Bloom & Markson 1998), shallow sentence processing (Park & Reder 2004), and the Mayan hieroglyphic writing system (Houston 1988). We refer the interested reader to our website for some videos featuring these activities and guidelines for using them to engage with the public: https://u.osu.edu/thebln/language-outreach/.

These activities follow the essential insights found in the science activities mentioned in experiment 1 (such as the 'egg-drop' experiment) and are guided by the principles put forward by the National Academy of Sciences (Bell et al. 2009). Our language activities do not attempt to present cutting-edge research, but instead seek to excite individuals by showing them a core result from the field in an interesting and entertaining way that allows for a sense of personal discovery. Among other things, they allow individuals to see a scientific approach to language.

There is an existing tradition of bringing linguistics into K–12 classrooms (Denham & Lobeck 2010, Honda & O'Neil 2017), where it is well appreciated that language lends itself to doing inquiry-based and problem-based investigations that can promote the idea of the scientific study of language (Bateman 2019, Ginsberg et al. 2011). Our own experiences, however, involve using linguistic activities and demonstrations in the context of informal learning spaces. Bringing these activities to science museums and other public-science events can help shift broader public perceptions. Previous work has shown that informal learning in museum settings can generate interest in and excitement for science (Anderson et al. 2007, Fenichel & Schweingruber 2010, Şentürk & Özdemir 2014). The studies reported here show that science museum visitors have largely positive memories about language experiences (experiment 1), show high levels of interest in language phenomena (experiment 2), and recognize that some areas of language study are related to science (experiment 3). Moreover, ongoing work in our lab suggests high levels of engagement with these activities in a science museum setting (Baker et al. 2019). Taken together, these results suggest that public outreach efforts focusing on high-quality language demonstrations are likely to influence how the public views language science.

One challenge to infusing science museums with language phenomena is that science museum staff may, like the general public, also fail to view the language sciences as part of their core mission. There are at least two ways to address this. First, as our data indicate, some fields of language study are more readily viewed as STEM fields. Starting with demonstrations in those areas opens the opportunity to talk about other areas of study. For example, hearing-related phenomena are already considered to draw on canonical STEM fields such as physics and biology, yet understanding how we interpret what we hear is critically dependent on traditional language science areas such as phonetics, syntax, semantics, and sociolinguistics. Second, while science museums may not be inherently interested in language sciences, they are interested in broadening their appeal and diversifying their audience. Because language science has the potential to appeal to a somewhat different audience, inclusion of language science activities can align with a science museum's broader goals. For more information about integrating language science in a science museum setting, see Wagner et al. 2015.

While we have argued that there is a popular notion that language is not studied scientifically, it is important to note that many areas of language study (poetry and grammar most notably, among those we investigated) do have a strong tradition of scholarship that does not involve the scientific method. Our point is not that our participants (or anyone else) are fundamentally wrong to think of some language topics as being studied outside of the scientific context. Our point is that this conceptualization of language—including language topics such as poetry and grammar—is incomplete. We wish to suggest that this incomplete understanding is a potential opportunity that could be leveraged to encourage individuals who do not readily identify with science to consider STEM as an option. Much research has indicated that women and some racial and ethnic minorities have a lower interest in STEM fields and tend to favor humanistic pursuits (Aud et al. 2010, Hill et al. 2010, Jones et al. 2000). The fact that some language topics are perceived as being primarily studied in a nonscientific manner may help explain why the field of linguistics has been more successful at attracting women and non-white scholars than other STEM fields (Charity Hudley et al. 2020). The strong tradition of using humanistic approaches means that linguistics has a leg up on attracting students who do not readily identify with STEM. Engaging these students with topics that are already of interest to them and showing them that a scientific approach can be taken with that topic may motivate students to engage in a deeper understanding of language science, thus increasing their science identity. Future work in our lab is aimed at understanding how the development of a more complete understanding of the study of language may be used to facilitate broader participation in STEM.

Taken together, the results of these three studies confirm a popular notion among linguists that the public at large does not view the study of language as being relevant to the sciences. Importantly, our data also suggest that public outreach efforts aimed at high-impact demonstrations of core linguistic phenomena may be successful at shifting the public's understanding of language science. However, we also suggest that in addressing this core misconception about the study of language we do not attempt to recategorize the study of language as being fundamentally a question of science, but rather make efforts to broaden the understanding of the study of language to include BOTH humanistic and scientific approaches, as this wider understanding of the subject has broader appeal. While it is important to increase the number of women and minorities in STEM-related careers, given the importance of science in everyday decision making, it is equally important to encourage those not in STEM-related fields to strongly identify with science. We argue that language science's deep connection to both science and humanities traditions makes it well suited for broadening participation in science in this way.

Appendix A: Coding categories, definitions, and examples used to code participants' memories in experiment 1

Category & levels	Definition	Example response
General focus		
Identity	Memories that affected the person's identity	*When I was younger I wanted to be a writer. Every time I read something new, I was amazed about how different people described different things.*
Activity	Memories where the person participated in a specific activity primarily for learning or teaching purposes	*I've always been excited about science! Making a potato gun with my physics teacher in high school*
Recreation	Memories where the person participated in an unstructured activity for their own enjoyment.	*I remember watching the space shuttles launch as a kid!*
Class	Memories about taking a class to learn something	*When I was learning German in college. I enjoyed the challenge of learning a new language.*
Place	Memories highlighting a specific locale that is not a school or place of employment	*I really enjoyed learning sign language & we got to go to the Ohio colony to practice.*
Accomplishment	Memories where the person successfully learned, applied, or used a skill, ability, or previous knowledge	*When I learned to roll my 'r'. I had been trying in Spanish classes so long!*
Event	Memories about a specific event that sparked life-long or long-term change	*When I was 26 and developed an illness, I started reading Harry Potter. It renewed my interest in language & reading.*
Content	The response provides relevant information but provides no context about how they acquired it	*I learned about how the moon rotates. [Includes illustration.]*
Other	For items that were not classifiable with the other codes	*Latin. Credo in unum Deum.*
Social perspective		
First person	The first person (singular) is explicitly used but nobody else is mentioned	*I speak Russian, so that's interesting!*
Others	Other people are explicitly mentioned	*I was really excited about language because we were learning Spanish in class.*
Nonspecific	Used when no people are explicitly mentioned	*Going to COSI and the hands on. — Solid, liquid, gas. COSI is so cool.*

(Table continues)

CATEGORY & LEVELS	DEFINITION	EXAMPLE RESPONSE
LOCATION		
School	A classroom or formal school setting is mentioned or implied	*Yes, 8th grade—studying constellations.*
Extra-curricular/ ILLs	A structured learning space is mentioned, including camps, museums, or school-related (but not classroom-based) environments	*Yes. Yes. Going to space camp.*
Life	Locations are specified that are not designed to be explicitly educational or employment-related	*I always loved science! I started as a little boy who was fascinated by the colorful rocks in the neighbor's driveway. I'm still a rock hound—a science fan*
Work	The person's place of employment	*When I started a new job and I didn't understand them. So I went to my boss and ask her to teach me how to talk to them.*
Unspecified	No location is mentioned or easily inferable	*Learning & reading new words. Reading books & discovering new words & meanings.*

Appendix B: The specific language area fascination scale

Participants were told to indicate how much they agreed with each statement using this scale: strongly disagree, disagree, agree, strongly agree.

GENERAL STATEMENT	POSITIVE ATTITUDE?	DESIRE TO LEARN MORE	DESIRE TO ENGAGE
Many **poems and songs** use language rhythms and rhymes in creative ways.	I like listening to/ reading poetry and song lyrics.	I want to learn everything about how language can be used creatively.	I would like to write poems and song lyrics.
New words, such as **slang words** and technical words, are being created all the time.	I like finding out what the latest slang words are.	I want to learn everything about how new words get into the language.	I would like to create new slang words myself.
Young children learn their language by the time they enter elementary school.	I like hearing young children talking.	I want to learn everything about how children are able to learn language.	I would like to spend time interacting with young children learning their first language.
There are lots of **games that involve language play**, including board games like Scrabble and Boggle and word games such as Pig Latin or just making up bad puns.	I like playing these kinds of language games.	I want to learn everything about how language is used in these games.	I would like to create language games.

Appendix C: Description sentences for the six topic areas, along with the the topic represented

	TOPIC DESCRIPTION
Dialect	People in different parts of the country often pronounce words differently and use different words altogether.
Hearing	Some people have problems with their hearing, either because they are born unable to hear or because they develop hearing difficulties as they get older.
Poetry	Many poems and songs use language rhythms and rhymes in creative ways.
Grammar	All languages have rules and patterns (this is known as grammar).
Sunflowers	Sunflowers are able to follow the movement of the sun across the sky from east to west.
Genetics	Lots of people's physical characteristics come from the combination of their genes.

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