Invention Stereotypes

Public Perceptions of Inventors & Their Work

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Executive Summary

When prompted to think about an occupation or social role, the spontaneous images people bring to mind often rely on normative representations and stereotypes. These images guide the inferences that people make about those who perform those jobs or roles, and have implications for public perceptions of, among other things, what experts in different areas look like as well as who gets to be seen as an expert on various topics. For example, when audiences are exposed to news stories about inventors, they typically approach these with the most available memory that they have of an inventor (cf. Shrum, 1995; Tversky & Kahneman, 1973), and this sets their expectations about the inventor's attire, social skills, beliefs, and so on (cf. Collins & Olson, 2014). When reality violates these expectations, audiences may hesitate to believe what they see and hear (cf. Simons, 2000; McGrath, 2017).

Knology partnered with PBS NewsHour and the Lemelson Foundation to explore the specific stereotypes that NewsHour audiences hold about inventors, including details about their projects, their workplaces, and their sociodemographic data. We also explored whether different terms spark different stereotypes. This is part of a broader grant from the Lemelson Foundation for NewsHour's "Breakthroughs" inventions and innovations series, which focuses on inventions with an entrepreneurial, economic, or environmental impact or that address basic human needs and major problems facing the world. By featuring these inventions in broadcasts and other sources, NewsHour seeks to educate and inspire its audiences, while simultaneously boosting the profiles of the inventors and their work.

We found some fairly persistent stereotypes about inventors when we analyzed responses from a sample of NewsHour audiences, including specific ideas about how they dress, their sociodemographic details, how they work, what their work environments look like, and how much they earn. One group of respondents imagined a team of inventors wearing lab coats; another group imagined an individual tinkering in a garage or basement.

Furthermore, most respondents thought of inventors largely in the context of the sciences, including medicine, engineering, and other technical fields. People also seemed to think that inventors are generally in the middle class, making north of $50,000 annually, with some respondents thinking inventors make much more. Interestingly, although one cluster of people thought of inventors as white Caucasian men working in isolation in a garage or basement, another cluster didn't ascribe a specific race or ethnicity to the inventors they envisioned. Lastly, participants did not report different judgments about *inventors*, *innovators*, *entrepreneurs*, *scientists*, and so on. This is a powerful outcome because groups of participants were not explicitly informed about the other possibilities.

Overall, the data suggests that the exact stereotypes people hold likely depend on their unique life histories, including their media habits (the movies, books, and other resources they consume). As media producers – such as news organizations – create content, it is important for them to think about these stereotypes and their effects because audiences tend to rely on norms and stereotypes in making judgments about others (Kruglanski, 2005). Moreover, Finson (2002) showed that exposure to real scientists appears to mitigate fiction-based stereotypes. Exposing audiences to real inventors might have the same effect.

Table of Contents

List of Tables

Knology Publication #NPO 100 589 01

List of Figures

Introduction & Methods

PBS NewsHour and the Lemelson Foundation have partnered since 2014 to support news coverage about inventors and inventions. The Lemelson Foundation takes a multi-pronged approach to supporting impact invention, including partnerships with media organizations like the NewsHour to inspire future generations of inventors.

In 2019, Knology joined this partnership to develop and implement a survey for NewsHour audiences, to better understand the images that first come to mind when they think about inventors and inventions. The survey was designed to be implemented repeatedly over time to identify changes in these stereotypes. The specific research questions this survey addressed included:

- What stereotypes do NewsHour audiences hold about inventors? This question includes the types of problems inventors are tackling, their tools and working conditions, and sociodemographic characteristics.
- What community and/or global problems do these audiences see as most in need of invention?
- Do different terms (e.g. *invention* vs. *innovation*; *inventor*, vs. *innovator*, *entrepreneur*, etc.) cue different stereotypes? This work allows us to compare with earlier work on perceptions of *scientists* (Losh, 2020; Besley, 2015)

About This Report

This report provides information on how the survey was developed, and reports on results from surveying a sample of NewsHour audiences recruited via various social media platforms and other sources.

Research Methods

We used a modified version of the Draw a Scientist Task or DAST (Farland 2003, cited in Farland-Smith 2012) to elicit respondents' stereotypes about inventors. The DAST has been used to demonstrate the lifelong persistence of gender, racial, and activity-related stereotypes about scientists (e.g., Miller, Nolla, Eagly, & Uttal, 2018). These stereotypes influence public perceptions of who can address controversial science, such as GMOs and climate change (Suldovsky, Landrum, & Stroud, 2019).

Survey Instrument

The survey instrument we developed contained four content modules. The full survey is provided in Appendix A.

Module 1: Imagine-an-Inventor test

We adapted the Draw-a-Scientist test (Chambers, 1983) for use with adults. The DAST asks children to draw a scientist and then codes for the presence of certain stereotypical features (lab coats, eyeglasses, facial hair, scientific instruments, etc.). We adapted this test for adults in two ways. First, we prompted for *inventor* rather than *scientist* (cf. Lee & Kwon, 2018). Second, we asked respondents to envision an inventor rather than draw one. We then asked them to respond to a number of open- and closed-ended items about what they envisioned, beginning with open-ended items so that we could verify that they had attempted the exercise. These items also asked them to report back on the inventor's sociodemographic characteristics (including gender, age, race & ethnicity), environment (e.g. indoors or outdoors, lab or home, etc.), and type of symbol of research (e.g. tools, lab equipment, computers, pen and paper, etc.).

A meta-analysis of the Draw-a-Scientist test (Miller, Nolla, Eagly, & Uttal, 2018) indicates that perceptions of science as a primarily male field are shifting, but they are shifting slowly, and children may become more aware of these perceptions as they age. We were particularly interested in learning whether similar stereotypes of inventors would emerge from this imagination task.

Module 2: Adult perceptions of inventors

We adapted the items developed by the National Science Foundation about adult perceptions of scientists (Losh, 2010; Besley, 2015) to see if the NewsHour audience holds similar stereotypes of inventors. These items ask adults to rank their agreement with stereotypical statements like "Inventors are apt to be odd and peculiar people" and "Inventors' work is dangerous." as well as to indicate the desirability of these careers through a second series of questions. Respondents were assigned one of a series of terms in order to assess differences between the terms:

- *Inventors;*
- *21st century inventors;*
- *Modern inventors;*
- *Today's inventors;*
- *Innovators;*
- *Entrepreneurs; and*
- *Scientists,* for comparison with existing data sets.

Module 3: Applicability of invention to community and global problems

This module asked respondents to identify the community and/or global problems they see as most pressing and amenable to invention. In this module, we included an experimental manipulation that was consistent with the prior module: each respondent consistently saw either the term *invention* or the term *innovation*. After each respondent selected up to three problems, they were asked to identify **who** they see each problem as affecting.

Module 4: Sociodemographics

We collected sociodemographic information about respondents to see if there were differences by gender, income, education, geography, age, or race/ethnicity.

Thinkaloud Exercise

After developing the survey, we conducted thinkaloud exercises with a convenience sample of four adults from different backgrounds. We recruited these participants from Craigslist. These exercises were designed to identify any confusing or tedious items on the survey. A list of changes made as a result of these exercises is available in Appendix B.

Survey Participants

This survey was conducted with a sample of NewsHour audience members recruited between February 20th and February 26^{5h}, 2020 through NewsHour web and social media channels, including ads in other newsletters, posts on Facebook and Twitter, and a dedicated email blast.

A total of 2363 participants started the survey. Exclusion criteria are reported in Appendix C. Our final sample (*N* = 2,258) was largely female, White, wealthier, more highly educated, more urban, and older than the general U.S. population. While women make up 51% of the US population, they made up 59% of our sample. About 60% of the U.S. population is White and not Hispanic or Latina/o/x, while 87% of our sample described themselves this way. Our median respondent had a household income between $75,000 and $99,999. While 32% of the U.S. population above age 25 has a bachelor's degree or higher, 85% of our sample did. Furthermore, more than half of our sample had a master's, doctorate, or professional degree. Our median respondent was in their 60s, while the median U.S. adult is in their 40s. Full demographics of our sample are reported in Appendix C.

Survey Analysis

The quantitative analyses reported in the results section are based on complete and valid responses from 2,258 participants. The qualitative analyses are based on a random sample (*n* = 997) of all complete and valid responses. There were no meaningful differences between those selected for qualitative analysis and those who were not selected.

Results

The Default Inventor

Previous studies such as Ames (2004) show that people often rely on normative representations and stereotypes in reasoning about others. This extends to the inferences that they make about others' competence, reliability, sincerity, and whether they have the authority to speak on a topic (Kruglanski, Raviv, Bar-Tal, Raviv, Sharvit, Ellis, Bar, Pierro, and Mannetti, 2005). In making these inferences, people exhibit greater epistemic trust for normative authorities and others like themselves (cf., Dugas & Kruglanski, 2018). This study used various survey tasks to indirectly eliciting people's stereotypes about inventors.

Normative Representations & Inventor Stereotypes

Our modified version of the Draw-a-Scientist test asked participants to think about the following scenario: ***Imagine that tomorrow you are going on a trip (anywhere) to visit an inventor in a place where the inventor is working right now. Spend some time to visualize this person busy at work. Consider what this inventor might be saying to you about the work you are watching.***

We then asked them to report back on the inventor's sociodemographic characteristics (including gender, age, race & ethnicity), environment (e.g. indoors or outdoors, lab or home, etc.), and the symbols of research they envisioned (e.g. tools, lab equipment, computers, pen and paper, etc.). We analyzed the choices and ratings responses, and identified quantifiable patterns in the text responses. The distribution of participant responses to the Imagine-An-Inventor test are provided in Appendix D.

Participants envisioned many responses either considerably more or less frequently than chance, and five responses were particularly frequent. We observed these five responses, listed below, in more than 50% of cases:

- The inventor is using a computer or mobile phone
- The inventor is working with a team
- The inventor is wearing jeans
- The inventor's appearance is generally tidy
- I did not specify the inventor's race or ethnicity

Other stereotypes appeared almost as frequently as the aforementioned five. These included wearing glasses, working in the laboratory, and doing dangerous work in a controlled fashion. Almost half of respondents reported imagining an inventor with unspecified gender. Those who did envision a gendered inventor were much likely than chance to envision a man (Binomial Test, $p < .001$). Respondents who identified as men reported imagining a man more often than respondents who identified as women (31% vs. 24%, Binomial Test, $p < .001$).

This effect cannot simply be attributed to some variation of homophily, where respondents projected their own characteristics on the inventors they imagined. Respondents who identified as women reported imagining a man about as often as they imagined a woman (24% vs. 22%, Binomial Test, $p = 0.08$). They also reported imagining a woman less often than the respondents who identified as men reported imagining a man (31% vs. 22%, Binomial Test, $p < .001$).

Table 1: The gendering of imagined inventors relative to the most prevalent genders self-reported by respondents.

Gender of Imagined Inventor	Woman respondents		Man respondents		All respondents	
	n	%	*n*	%	*n*	%
Woman	289	22	112	13	408	18
Man	326	24	276	31	596	26
Non-binary	52	4	41	5	100	4
Described	76	6	48	5	128	6
Did not specify	587	44	416	47	1025	45

Notes. A reliable test of responses requires at least 300 respondents in each comparison group. The sample did not include sufficient numbers of respondents who abstained from reporting their own gender, described their own gender identity, or reported their own gender as non-binary. "Described" indicates those who chose to describe the inventors' gender presentation in their own words.

Revealing Competing Inventor Profiles

The results described above help set expectations for what a randomly-selected NewsHour viewer might first imagine when they encounter stories about inventors. However, the aggregated results hide up to eleven discernable inventor profiles among the responses. We identified these eleven profiles using a clustering simulation that searches for and tests possible groups of respondents with similar responses (Tibshirani, Walther, & Hastie, 2001). Ultimately, splitting the data into two clusters yielded the clearest solution.

Figure 1 below shows respondent groupings based on the similarity of their responses to the Imagine-An-Inventor-Test. Each respondent is represented by a point. The locations of the points were estimated using multidimensional scaling (Cox & Cox, 2001), with which we translated the similarities between each respondent on each of the various possible responses into coordinates in a two-dimensional plane. The side panels show which characteristics queried on the survey were at least moderately associated with each group of respondents. These constitute the inventor profile for that group.

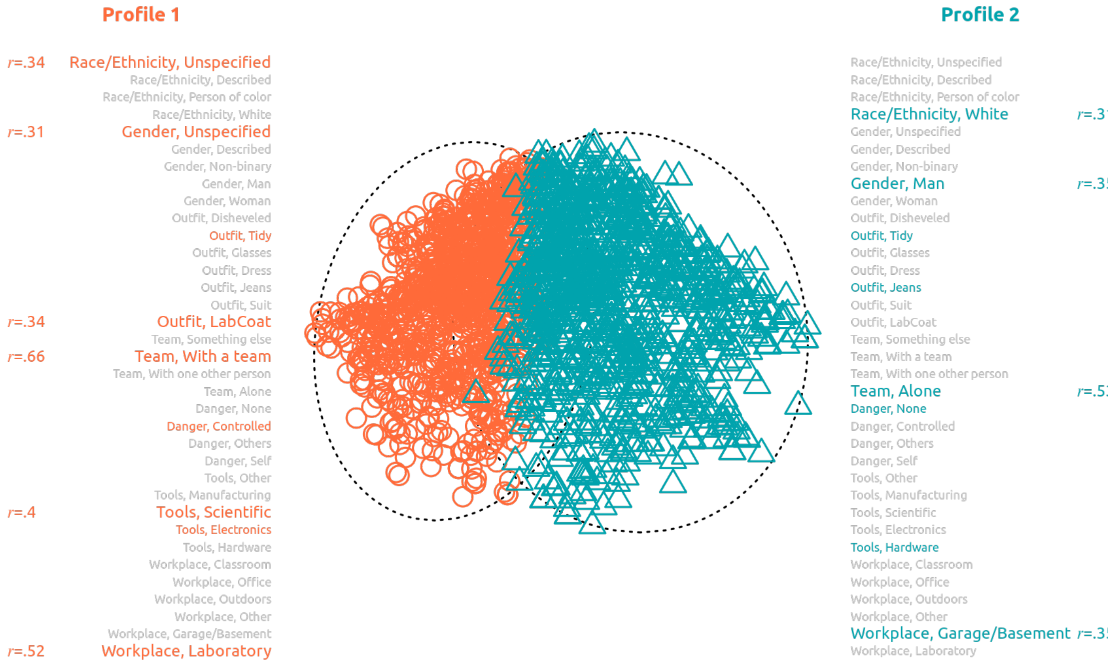

Figure 1: Grouping of respondents based on the similarity of responses to the Imagine-An-Inventor-Test.

Notes: Point types indicate respondents. Ellipses mark the grouping boundaries. The side panels show which among the characteristics queried on the survey were associated with each group of respondents (color coded) and which are reliable predictors ($r \geq .3$) of each group of respondents (larger type, with correlation coefficient).

The inventor profile for ***Group 1*** is most associated with the presence of six characteristics, while the inventor profile for ***Group 2*** is most associated with the presence of four characteristics (Table 2). The characteristics associated with each respondent group jibe with images from entertainment media (cf., Bartsch, 2017).

Table 2: Inventor profiles and associated characteristics

	Group 1	Group 2
Workplace	*Laboratory*	*Garage/Basement*
Tools	Includes ***scientific tools***	No specific association.
Team	*With a team*	*Alone*
Outfit	Includes a *lab coat*	No specific association.
Gender	*I did not specify*	*Man*
Race/Ethnicity	*I did not specify*	*White*

We assessed whether the two inventor profiles could be predicted by the respondents' demographic characteristics. Of the six demographic variables—Age, Gender, Race/Ethnicity, Geography, Education, Income—only reported Gender showed even a tenuous relationship to whether the respondent was clustered into ***Group 1***. Using logistic regression, we estimated that the responses from those who reported "Man" as their gender identity were

18% more likely to be clustered into ***Group 2*** (*Odds Ratio* = .82, *p* = .04; for interpreting odds ration as effect size, see Chen, Cohen & Chen, 2010). All other demographic relationships failed to exceed chance occurrence (*ps* > .05). These results suggest that the stereotypes likely depend on participants' life histories including their media habits (cf. Shrum, 2017). Full results of the logistic regression are available in Table 14 in Appendix D, as is additional interpretative detail. Table 15 in Appendix D presents the responses of the most representative members of each group.

News providers have to contend with these stereotypic profiles because consumers tend to rely on norms and stereotypes in judging others (Kruglanski, 2005). Nevertheless, Finson (2002) showed that exposure to real scientists appears to mitigate fiction-based stereotypes. The same might be true for exposure to real inventors.

Adding Nuance: Free Text Responses

We provided a range of stereotype and counter-stereotype options for each question but we also allowed respondents to write in their own responses. This provided additional nuance to their mental representations of inventors. Some of the most common responses are described below in further detail.

Where Is the Inventor Working?

Within the set of 997 respondents, 213 individuals wrote in their own answer for this question (Table 3). Many respondents indicated a combination of response options or provided specific details about an existing category. Other common responses were manufacturing facilities (factories, plants, or warehouses), workshops, and the inventor's home.

Table 3: Write-in responses to *Where is the inventor working?*

Category	*n*	Example
Combination of responses or multi-purpose space.	48	"A combination lab/classroom, or workshop (as in space lab, where things are built and tested)."
Provided specific details about at least one existing category.	47	"A lab that is large enough to hold soil and grass samples and allow for planning and the tracking of follow through. Somewhere close to those with the required knowledge, interests, and skills."
Warehouse, factory, plant, or manufacturing space.	40	"Some kind of factory or plant."
Workshop or 'engineering' space.	36	"A workshop sort of place. Didn't seem like a garage."
At home, including 'home office.'	29	"At a table in a kitchen."
(Art) studio.	16	"A glassblowing studio."
Shed or barn.	9	"A barn."
Collaborative or co-working space.	8	"Worker space with other inventors/artists/tinkerers, like an industrial building with various tools available."
Non sequitur or nonsense response.	3	n/a
Another category not captured here.	51	"Maybe in a children's playground or in some imaginative place. Surely not in a lab or classroom or office. Too structured."

Notes. Of the 997 responses that were analyzed, 213 respondents wrote in their own answers for this question. Some responses fell into multiple categories. We have lightly edited some responses to standardize spelling and punctuation.

What tools is the inventor using?

Of the 997 responses, 303 wrote in their own answer for this question. The most frequent responses (seen in more than one-third of the write-ins, Table 4) included laboratory tools or materials, spanning a wide range of laboratory set-ups. These included medical tools and equipment (such as *"MRI, fMRI, CAT, EEG machines"* and "*cadavers*"), electric and electronic tools (such as *"An even Larger Hadron Collider"* and *"[...] electronic gear such as oscilloscopes and test equipment"*), and a wide range of tools used in other lab scenarios (such as *"[...] tools to measure food quality, freshness, or spoilage. Then tools to measure how easily it can be recycled or composted."* and "*Whatever is needed to analyze the components of animal leather in order to chemically duplicate it for plant-based leather [...].*")

Many respondents also described specific hardware or software. This category included circuit components (*"Something with wires and metal plates."*), common software (*"spreadsheets"* and *"drafting or CAD program"*), and highly advanced machines (*"The inventor is working with a quantum computer[...] in a controlled environment and they are using a desktop computer to program and interact with it."*)

As in other responses, clarifications or combinations of listed responses were also fairly frequent.

Table 4: Write-in responses to *What tools is the inventor using?*

Category	*n*	Example
Laboratory tools or materials, including medical, electrical, and physical tools.	108	"Mechanical tools that are streamlined and do delicate work. Robot arms that are thin. There are glass containers and things done behind glass or Plexiglas. Goggles are worn by all watching. The space is immaculate."
Specific hardware or software.	79	"Data collection, interpretation and visualization analyses described by a computer,"
At least one previously listed option.	48	"I could see using any of the above depending on item."
Everyday items.	35	"He is using simple tools perhaps herbs and tinctures, wood and water."
Intellectual tools including concepts, data, and discussions with colleagues.	31	"The human mind. IN a classroom because young minds are the most creative and foreseeing."
New tools, including proprietary tools and tools that do not yet exist.	29	"The inventor is using a combination of tools listed above but in addition a new cooling tool not yet known to mankind that stabilizes current temperatures while the other tool, also not yet known to mankind which is a 'reverse temperature impact subversion' technique is submerged into the oceans floor to begin the cooling reversal of the planet."
Artistic or drafting tools.	27	"Paint brushes. Glue. Lamps. Containers for holding water and paint thinner. Pencils. Paint palette. Camera."
Respondent is unsure of the specific tools.	7	"' Tools' !? Tools & methodologies that I cannot even imagine. Go ask Kubrick or Tesla or Thorn or Tyson."
Another category not captured here.	30	"She needs a variety of protective gear and safety protocols for her work. Note that she is likely improvising as she isn't considered important enough or even good/smart enough for the necessary equipment."

Notes. Of the 997 responses that were analyzed, 303 respondents wrote in their own answers for this question. Some responses fell into multiple categories. We have lightly edited some responses to standardize spelling and punctuation.

How Is the Inventor Working?

Within the set of 997, 60 respondents wrote in their own answer for this question (Table 5). The most frequent write-in answers either explained that the inventor works with a team only in particular circumstances, or clarified the nature of who was on that team.

Table 5: Write-in responses to *How is the inventor working?*

Category	*n*	Example
The inventor sometimes works with a team.	25	"Mostly alone but collaborates with other like-minded people as thoughts arise."
Details on team composition or work.	18	"Working with others who are not a 'team' and are people with disabilities who are helping the inventor create and discuss and test what they envision and of course at least one of those participating is an Interpreter."
The inventor works with a remote team.	8	"After creating his invention, he has created an online community for other users to share ideas. These people have said they like the community feel almost as much as the invention. They like sharing ideas and problem solving together."
The inventor shares space with colleagues but does not work together directly.	5	"The inventor works in a space where others too, so they do not necessarily collaborate or share ideas, but the works are progressing at the same time."
The inventor works with animals or robots.	2	"She is working with several intelligent robots."
Non sequitur or nonsense response	2	n/a
Another category not captured here.	7	"Who knows? Spontaneity."

Notes. Of the 997 responses that were analyzed, 60 respondents wrote in their own answers for this question. Some responses fell into multiple categories. We have lightly edited some responses to standardize spelling and punctuation.

What Is the Inventor Wearing?

Within the set of 997, 166 respondents wrote in their own answer for this question (Table 6). Almost half of these respondents described casual or comfortable clothing, either generally or by mentioning specific items. One out of every three respondents mentioned some sort of protective or safety equipment, including aprons, goggles, and weather protective gear like sun hats and rain boots.

Table 6: Write-in responses to *Which of the following describe the inventor that you imagined?*

Category	*n*	Example
The inventor is wearing casual or normal clothing.	78	"Black turtleneck, black coat."
The inventor is wearing safety gear or weather protection gear.	56	"Clothing associated with protecting against exposure to an infectious agent."
The inventor's clothing is irrelevant / I didn't picture clothing.	23	"Does it really matter? It is about what they accomplish, not how they look. Inventors could be teenagers to senior citizens."
Commentary on the inventor's gender presentation.	16	"YES! Wearing a Dress. And it's a 'She', btw. Although I really don't care. But a dress with jeans probably won't garner respect from The Team - unless they all wear the same outfit. BAAAAD for funding."
Another category not captured here.	16	"She is wearing fashionable see-through body armor."

Notes. Of the 997 responses that were analyzed, 166 respondents wrote in their own answers for this question. Some responses fell into multiple categories. We have lightly edited some responses to standardize spelling and punctuation.

How Old Is the Inventor that You Imagined?

In general, our respondents pictured inventors as adults old enough to be professionally established: most respondents pictured someone in their 30s, 40s, or 50s, with another small number specifically writing in *"middle-aged"* or similar responses (Table 7 below).

Table 7: Responses to *How old is the inventor you imagined?*

Category	*n*
20's	65
30's	323
40's	386
50's	217
60's	70
70's	16
80's	5
They could be any age	63
"Middle-aged"	36
Don't know	5
Imagined a group of people	5

Notes. Total responses exceed total number of respondents (997) since some responses indicated more than one age group.

How Much Money Do You Think this Inventor Makes Each Year?

People had very specific perceptions of how much money inventors make per annum (Table 8). Most people believed that inventors are fairly well off compared to the rest of the population. Roughly equal numbers of people thought that inventors' earnings fall into one of the following ranges: $50-75K, $75K-100K, $100K-150K, and over $150K. The most common source of funding that respondents mentioned was grants (philanthropic, federal, & unspecified), followed by earnings from jobs or corporate funding. Table 16 in Appendix D provides further detail.

Table 8: Responses to *How much money do you think this inventor makes each year?*

Category	*n*	Example
No money	12	$0.00
less than $25,000	36	Value lower than $25,000
$25,000-$34,999	33	Value between $25,000-$34,999
$35,000-$49,999	76	Value between $35,000-$49,999
$50,000-$74,999	195	Value between $50,000-$74,999
$75,000-$99,999	191	Value between $75,000-$99,999
$100,000-$149,999	180	Value between $100,000-$149,999
more than $150,000	146	Value more than $150,000
Contingent	18	"Depends on how good the inventions are."; "Depends on the country where he/she is located"; "According to the financial times"
Low	71	"less than the national average"; "probably not much"; "very little"
Middle	44	"comfortable"; "enough"; "living wage"; "middle income"; "median income"
High	19	"A lot", "millions", "upper middle class"
Irrelevant/not motivated by money	18	"irrelevant"; "I don't really think about how much the inventor is making because that doesn't really matter.";
NA/No idea	79	"Have no clue" "I don't have any idea"
Story	7	n/a

Notes: Sum of rows exceeds 997 because responses were coded into multiple categories when applicable. When a respondent entered a range, such as $40,000-$100,000, the response was coded into all relevant categories.

Terminology & Adjacent Occupations

We assessed the extent to which different terms elicit different concepts and responses to the same questions. We used a between-subjects design that compared the responses of groups who encounter only one of the experimentally manipulated terms. We used this approach because it better captures subtle conceptual distinctions between different names for more or less the same thing. The explicit comparisons in a within-subjects design may invite respondents to exaggerate subtle differences. A between–subjects design side-steps this issue by postponing the comparison until the analysis of differences in the data.

We began with terms including ***inventor***, ***21st century inventor***, ***modern inventor***, ***today's inventor***, ***innovator***, ***entrepreneur***, and ***scientist***. The term ***entrepreneur*** emerged from conversation between the research partners. We also include ***scientist*** to allow for comparison with data from the General Social Survey (GSS, cf. Besley, 2015), from which the items are adapted. We asked respondents to rate their agreement with the following statements listed in Table 9 below on a 4-point scale, ranging from *Strongly disagree*, *Disagree*, *Agree*, *Strongly agree*, and included an option to indicate *Don't know.*[1]

Table 9: Survey items adapted from the General Social Survey and added by research team.

Positive Views	Negative Views	Other	Additional Items
[Inventors] are helping to solve challenging problems	[Inventors] are not likely to be very religious people	[Inventors] work is dangerous	[Inventors] usually have advanced degrees in their field
Most [inventors] want to work on things that will make life better for the average person	[Inventors] have few other interests but their work	[Inventors] usually works alone	People like me can easily be [inventors]
[Inventors] are dedicated people who work for the good of humanity	[Inventors] are apt to be odd and peculiar people	[Inventors] earn less than other people with equally demanding jobs	[Inventors] usually work in a university setting
	[Inventors] don't get as much fun out of life as other people do	A job as an [inventor] would be boring	

Notes: All items in the first three columns were adapted from the GSS. The categorization of items as "positive" or "negative" follows Besley (2015).

We adapted the items from the GSS and substituted one of the following occupations/social roles for [Inventors]:

- Inventors
- 21st century inventors
- Modern inventors
- Today's inventors
- Innovators
- Entrepreneurs
- Scientists (for comparison with existing data sets)

Respondents saw only one of the randomly assigned occupations/social roles for all questions. Between 302 and 336 respondents saw each occupation/role, which resulted in a balanced between-subjects design.

[1] "Don't know" responses were treated as "no response" for the purposes of comparison with Besley (2015). However, "Don't know" is the logical equivalent of the "neither agree nor disagree" rating option that is available in most other surveys. For this reason, our within-sample tests treat agreement as 5-point scale with "Don't know" as a neutral rating.

We first compared how NewsHour audiences rated ***scientist*** on these statements against the ratings that Besley (2015) sampled from the GSS. These were drawn from the entire U.S. population in 2012. We used Student's *t* test to assess whether ratings from our sample conform to previous observations. Table 17 in Appendix E shows the full results of these comparisons.

The results show that NewsHour audiences have very different views on scientists compared to the general-population. Except for comparable ratings on the peculiarity of scientists, all differences exceeded chance ($p < .05$) and, for three items, were extremely large (Cohen's $d > |\pm 1|$, i.e. more than 1 standard deviation). The difference on the remaining items ranged from negligible (Cohen's $d < |\pm .2|$) to medium-sized (Cohen's $d < |\pm .8|$).

Figure 2 below shows the average agreement with which respondents rated each item for each of the seven occupations/roles that they were assigned to rate. Three gross patterns are relatively easy to discern: (1) most items for all occupations/roles were rated between ***disagree*** and ***don't know***; (2) three items - *solve problems, less fun,* and *job boring* – were rated between ***don't know*** and ***agree***; (3) ***entrepreneurs*** were rated differently from other occupations/roles.

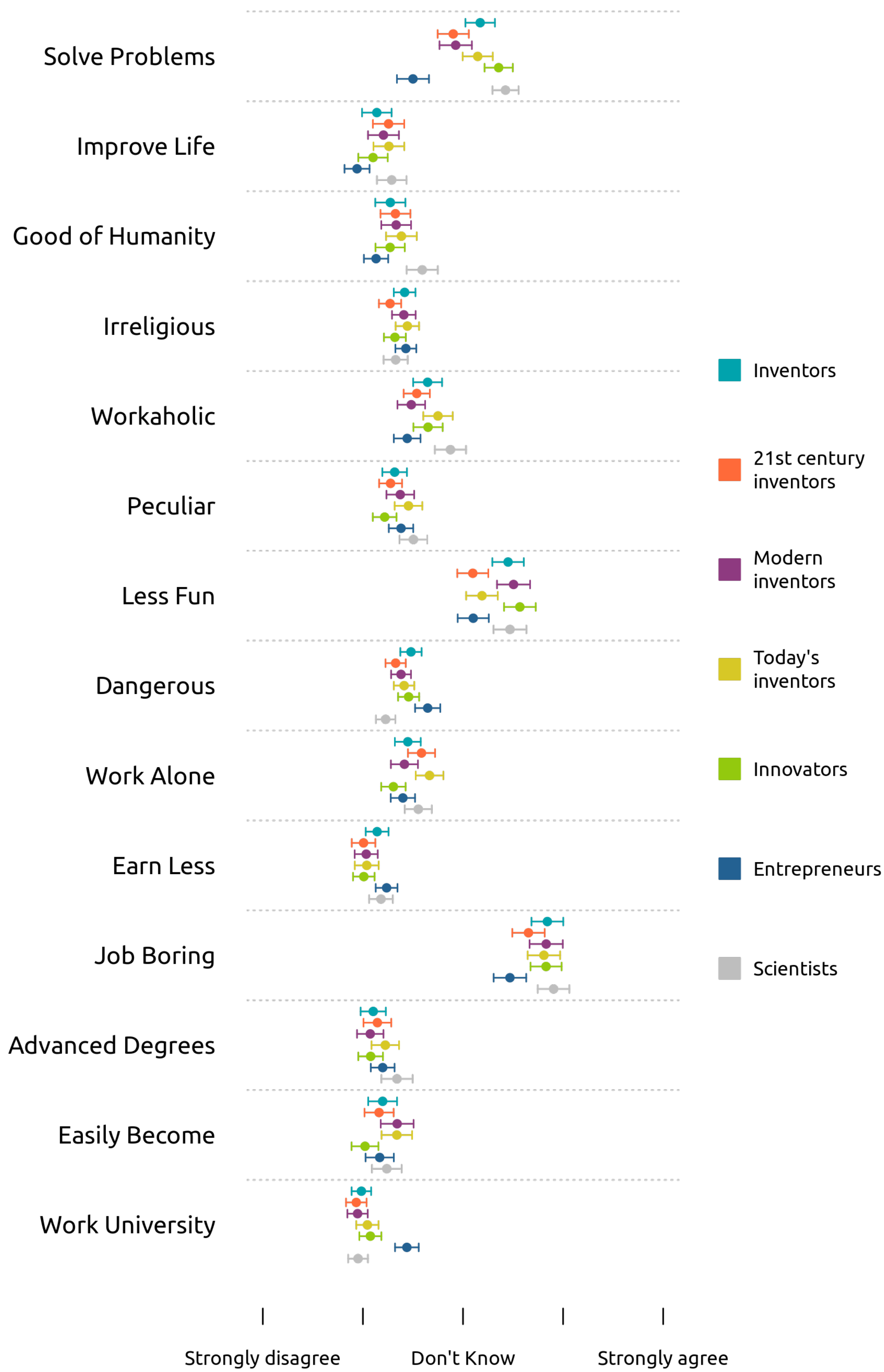

Figure 2: Distribution of ratings for items querying attitudes towards seven different occupations and social roles with some association with invention.

Note: Points represent mean ratings.

Table 18 in Appendix E shows the results of a principal components analysis that identified components that align with groups of variables – Negative Views, Positive Views, and Other Views. Note that our groups do not fully align with those identified by Besley (2015). We used PCA to estimate the location of each participant on each of the three components, and translated their rating on the 14 GSS items into three scores. We used these scores to compare whether and to what extent people think about inventors and other adjacent occupations and social roles as different from one another. We then used a multivariate analysis of variance (MANOVA) to account for differences on GSS items based on randomly-assigned occupation/roles labels. Specifically, we tested the differences in ratings for six contrasts: ***entrepreneurs vs all other occupations/roles***, ***scientists vs innovators and all types of inventors***, ***innovators vs all inventors***, (***unspecified) inventors vs specific inventors***, ***today's inventors vs other specific inventors***, and ***modern inventors vs 21st Century inventors***.

The results show that respondent demographics accounts for less than 1% of the variance ($\eta_p^2 < .01$) in the data. For the comparisons of labeling effects, only the contrast between ***entrepreneurs vs. all other occupations/roles*** accounted for even a small proportion of the variance in the data. All other pairs of labels elicit similar responses from respondents. Table 19 in Appendix E shows the results of the multivariate tests on all three views as well as effect sizes for the univariate tests on each view.

We examined whether aggregated results might be hiding groups of respondents that differ, and between which we might discern more meaningful differences on how NewsHour audiences think about inventors and adjacent occupations/roles. Given that the preceding analysis found only negligible differences between the occupations/roles, we used the entire data set to run the clustering simulation. The results were ambiguous as to whether the data could be split into one or two groups of respondents based on similarities in their components scores. Figure 3 below shows the two-cluster solution, with respondents grouped by the similarity of components scores.

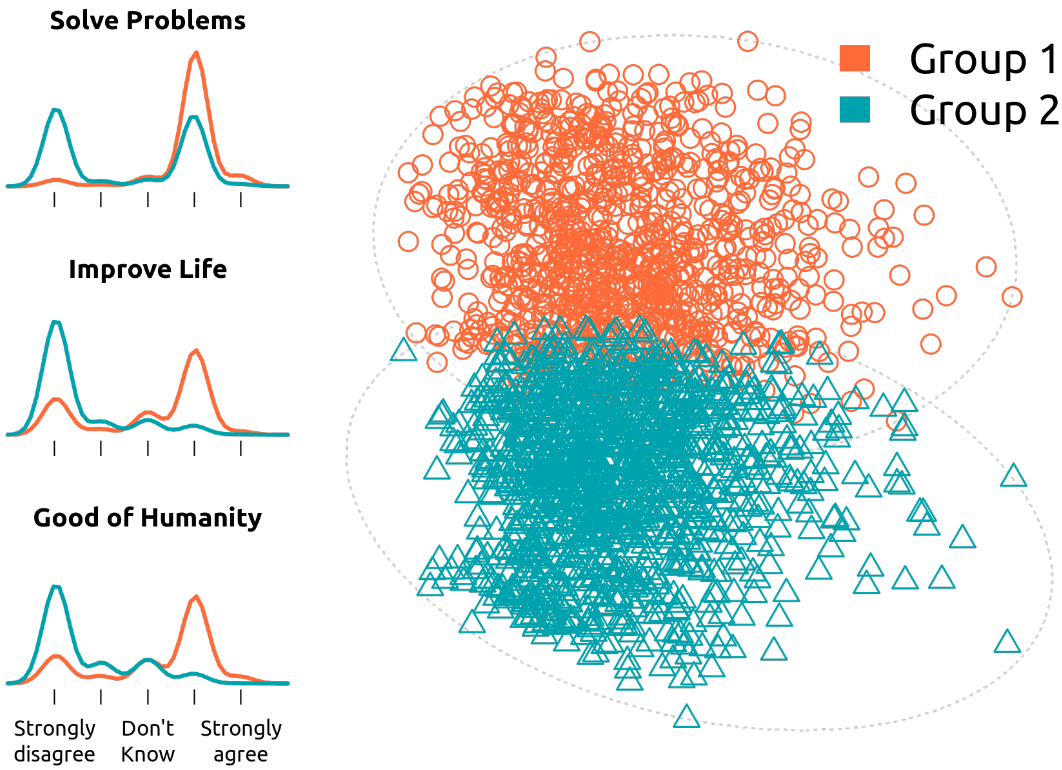

Figure 3: **Respondents grouped by the similarity of scores on the components representing positive and negative views of inventors and adjacent occupations or social roles.**

Notes: Each respondent is represented by a point, and the locations of the points are the scores of each respondent on the Positive Views component (Y axis) and Negative Views component (X axis). Right panel shows the distribution of responses by each group on the three items that constitute the Positive Views component

The figure above provides the reason for the ambiguity of the simulation results. Specifically, respondents differentiate only on one component—Positive Views—with high versus low scores. We confirmed this apparent differentiation with a discriminant function analysis, which showed a very strong relationship between the Positive Views component-scores and cluster membership (η = 0.66, F = 4406.89, p = <.001). The other two components showed essentially no relationship to the respondent group – (η = .03) for Negative Views and (η < .01) for Other Views.

Social Problems & Levels of Relevance

Stereotypes & Social Problems

A researcher coded 997 respondents' answers to questions about what the pictured inventor was saying and doing, with an eye towards whether these responses were primarily pragmatic, primarily aesthetic, both, or neither (Table 10).

Primarily pragmatic responses focused on helping humanity, improving quality of life, or addressing a major global issue such as developing cures for illnesses, or solutions to alleviate climate change or homelessness. Responses describing what the inventor does ranged from more general statements such as *"Doing research into positive and doable solutions for the planet's most severe political, sociological, and environmental problems"* to specific statements such as *"He is working on something of value to the environment....energy conversion or conservation, something to reduce the production of methane from agricultural activities and from the decomposition of garbage, or on a cleaner process for some industrial chemical activity".*

Primarily aesthetic responses typically focused on an interesting technological advancement or innovative product such as *"a device that mows your lawn automatically".* A portion of these responses seemed to be relevant to improving the participant's daily life, for example, *"A bird feeder that can easily be raised to any height/ lowered again for refilling, is squirrel-resistant but also not extremely fragile. Not so heavy that an older person has trouble getting it up-down. Has umbrella-like structure atop so ice doesn't build up".*

More than half (*n* = 555, 56%) of the responses included a heavily pragmatic element, suggesting that respondents see inventors' priorities as aligning with the social good.

Table 10: Responses to *What do you think this inventor might say to you about the work you're seeing? and In your own words, tell us in a sentence or two what the inventor is working on.*

Category	*n*	Example
Primarily Pragmatic	497	Say: "I think the inventor will be telling me some background to the research and telling me what they are trying to prove or disprove." Do: "The inventor is working on a biodegradable material to package food or consumer goods to replace plastic."
Primarily Aesthetic	396	Say: "Do you understand what it is? Do you understand the goal?" Do: "A higher range capacity battery that uses a quartz-based material in an electrolytic gel under pressure."
Both	58	Say: "This invention will change the way we think about recycled materials. Help the planet." Do: "A home recycling machine. Uses food waste as fuel to reuse recyclable materials on an as needed basis. Works like a 3D printer to turn your water bottle or ketchup bottle into a storage container for that night's dinner leftovers."
Neither	46	Say: "I'm creating this for my granddaughter." Do: "He is carving a dollhouse from wood."

Note. *N* = 997.

Relevance & Importance

In addition to exploring mental representations of inventors, this survey was designed to assess the following general questions:

1. What community and/or global problems do respondents see as most pressing and in need of invention and innovation?
2. Does the current state of invention and innovation align with community and/or global problems?

To answer the first question, we assessed the opinion of NewsHour audiences on community and/or global problems that might be amenable to engineering solutions. We asked participants to choose up to three problems to capture information about consensus priorities for solving such problems. We wanted to test the extent to which priorities differ when the question is framed as either a need for ***innovation*** (arguably, incremental solutions) or for ***invention*** (arguably, paradigm-changing solutions). Initial tests showed that the word choice had no effect – less than 1% increase in the likelihood of selecting a topic (*Odds Ratio* < 1.01, $p > .1$). The same test also showed no effect of demographics – less than 1% increase or decrease in the likelihood of selecting a topic (.99 > *Odds Ratio* < 1.01, all *p*s > .1).

We adapted the problems used for the selection question from a pre-existing list of social problems. Respondents also had the option to specify ***Something else*** for the most pressing problem amenable to engineering solutions:

- Access to safe drinking water
- Job access and mobility
- Climate disaster prevention and resilience
- Participation in elections and election security
- Health needs of an aging population
- Economic vulnerability
- Mobility needs of people with disability
- Access to education
- Public transportation and roadway infrastructure
- Over-policing or over-incarceration
- Polluting or limited energy
- Uncertain access to food
- Polluting or limited food sources

To answer the second general question, we assessed the relevance and importance that respondents ascribed to the topics they chose. One way to understand the distinction between the relevance and importance of invention is in terms of its perceived scope of impact, increasing from personal (i.e. helps me) to societal (helps society). Specifically, we asked respondents to rate their agreement – using a continuous scale from ***Strongly Disagree = -1*** to ***Strongly Agree = 1*** – on the following statements:

- ***Personal:*** An [innovation|invention] that improves [topic] would directly help me.
- ***Interpersonal***: An [innovation|invention] that improves [topic] would help my close family and friends. <Strongly Disagree…|…Strongly Agree>
- ***Local***: An [innovation|invention] that improves [topic] would help people who live near me. <Strongly Disagree…|…Strongly Agree>
- ***Societal***: An [innovation|invention] that improves [topic] would help society as a whole.

The results of these analyses are presented in Tables 20 and 21 in Appendix F to this report. Of all the topics, respondents selected ***climate disaster*** most frequently as the social problem with the greatest need for innovation and invention. The next three topics that participants frequently selected were: ***access to safe drinking water***, ***polluting or limited energy***, and ***polluting or limited food sources***. A logistic regression confirmed that the apparent order is reliable (except for the least frequent topics—over-policing or over-incarceration, job access and mobility, and "something else"—which had similar frequencies).

On average, participants, strongly agreed that innovations or inventions that improved the topics they selected would have broad societal impact. Their ratings on impact closer to home, from personal to local, showed greater variability. Importantly, respondents reported that some impacts, such as access to drinking water and access to education, might be further from home, but have a large impact on society. In other words, participants selected social problems for invention that they considered societally important to solve, even when those solutions would have little impact on themselves or those close to home.

Looking closer at the relationships between impact levels, we found that ratings on the first three levels of scope of impact are almost perfectly correlated with one another (r = 0.83 to r = 0.95, ps < .001), but not corelated with ratings on the societal level (r = 0.14 to r = 0.17, ps > .1)[1]. A principal components analysis confirmed two components: one which unites ratings on the personal, interpersonal, and local scope of impact, and a second component that splits off societal impact. These results align with the argument that scope of impact captures the difference between relevance and importance. Specifically, the first component represents relevance and the second component represents importance.

Figure 4 shows the results of a cluster analysis of the 14 social problems, based on similarities between participants on their relevance and importance scores. The clusters split along the relevance dimension forming a ***high relevance group*** and ***low relevance group***. We note here that the topics included in each group might suggest certain realities about the localized lives and concerns of the NewsHour audience. For example, inventions addressing an aging population would have impacts closer to home than inventions that address over-policing and over-incarceration.

The arrangement of the topics also reveals how the NewsHour audiences think about ***importance*** as distinct from ***localized relevance***. For example, while inventions to address an aging population rank highly on relevance, such inventions rank much lower on importance. Similarly, while inventions to improve access to education cluster with the lower relevance topics, such inventions rank highly on importance.

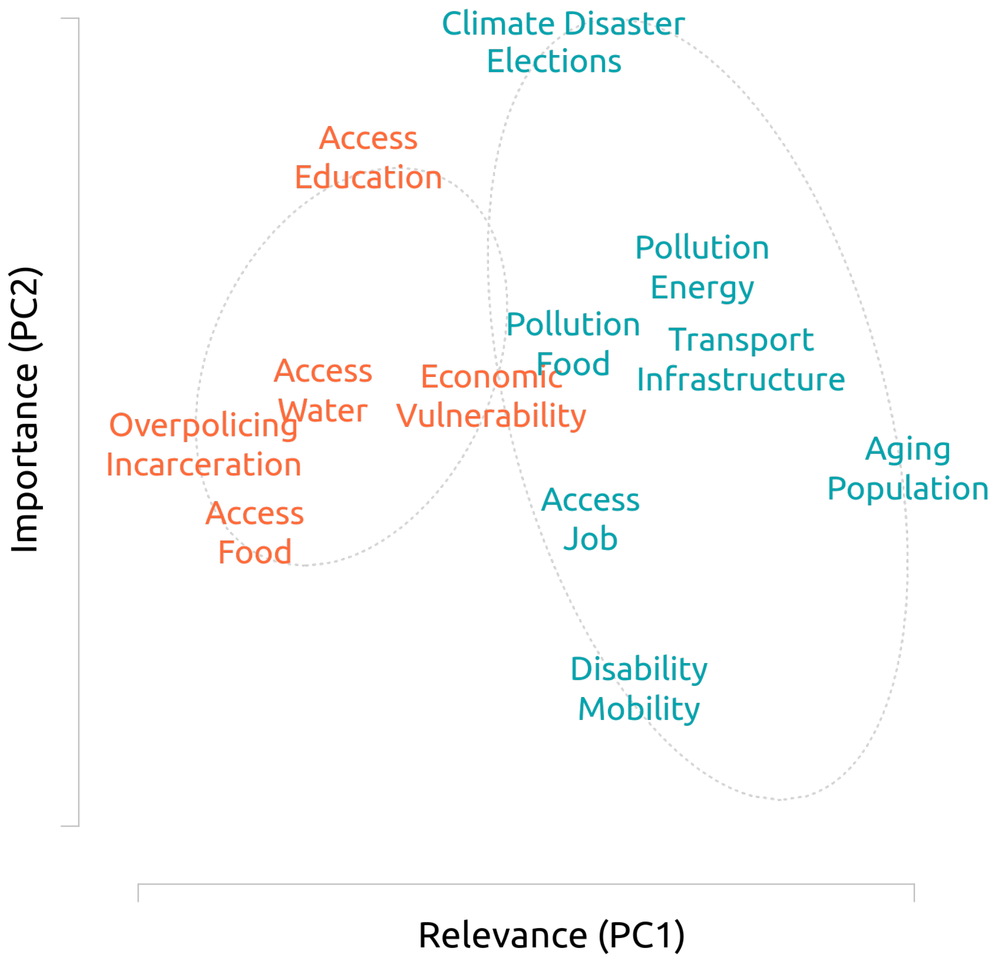

Figure 4: Grouping of social problems based on the similarity of scores on the components representing Relevance (PC1) and Importance (PC2).

Notes: Point types indicate high versus low relevance groups. Ellipses mark the grouping boundaries.

Discussion & Recommendations

The three parts of this survey—Imagine-An-Inventor-Test, General Attitudes towards Inventors (and adjacent occupation/roles), and the Social Problems & Levels of Relevance assessment— provide a well-rounded picture of how NewsHour audiences think about inventors and invention. The responses show that they see inventors through a common stereotypic lens, and are divided as to whether inventors have humanity's best interests at heart. However, NewsHour audiences can clearly rank what problems they think inventors should address with their inventions, while showing that they understand the difference between localized relevance and globally important topics for inventors to tackle.

Public Perceptions of the Default Inventor

A direct line of questioning allows respondents to articulate the stereotypes that they hold most consciously, or to exclude particular categories of people or things from this stereotype. One danger in using this approach is that it can prompt the inferential process of stereotyping: participants start from the first characteristic of inventors that comes to mind, then infer additional characteristics (Hilton & von Hippel, 1996; Operario & Fiske, 2008).

In contrast, we first asked respondents to envision an inventor before asking more specific questions. Doing so provided an opportunity for respondents to tap into the fullness of their imaginations, leaving the articulation of the inventor's characteristics for the last step. This process can mitigate stereotyping because participants could use multiple imagined characteristics to infer any single characteristics that the survey queried.

Overall, our respondents thought very imaginatively about inventors. This is evident from the level of detail in the open-ended responses that people provided in the survey. However, these responses revealed two general stereotypes of inventors that are prevalent in entertainment media. One group of people thought of inventors as similar to the stereotypical image of scientists: wearing lab coats, working with teams, using scientific tools, and working in a lab. The second cluster envisioned an inventor as white man working alone in a garage or basement. These stereotypes are likely based on each individual's unique life history, including their particular media habits – the movies, books and other resources they consume. As news organizations create content, they need to be cognizant of these stereotypes and their effects. Existing research shows that people tend to rely on norms and stereotypes in judging others and what they say (Kruglanski, 2005). Later in this chapter, we offer some general recommendations for how news organizations might help move their audiences past these perceptions.

We also observed some specific traits that most respondents envisioned, independent of these two groups. Specifically, when thinking of inventors, the majority of respondents thought of a person:

- Using a computer (often alongside other tools)
- Working with a team
- Wearing jeans or casual clothes
- Tidy appearance

- Unspecified race or ethnicity

Participants' responses to the open-ended questions also added more color and nuance to these stereotypes, particularly by providing additional detail about workplaces, work tools, and work styles. Rather than selecting *laboratory* as an option, a number of respondents chose to describe inventors' work environment even though what they described was consistent with a laboratory. They often went into considerable detail about the equipment found in such a space, often tying it to the tools of particular medical, engineering, or scientific fields. Similarly, other common write-in responses suggested that inventions tend to be physically large: a number of respondents said that the inventor was working in a shed, barn, or warehouse, or said explicitly that the work requires considerable space.

Similarly, while more than half of our respondents envisioned an inventor using a computer, the free-text responses further contextualized this image. Few respondents saw the inventor as creating a computer tool or app; instead, computers were part of a much larger toolkit used in invention.

Terms for Inventors & Adjacent Occupations

Because asking people to compare terms directly tends to amplify small differences, we took a more indirect approach. We randomly assigned each individual one single term (*inventor, today's inventor, modern inventor, 21st century inventor, innovator* or *entrepreneur*), and then compared the responses of each group. We also added one additional term, *scientist*, for comparison with the GSS. Rather than asking directly about relevance, we triangulated on this question by asking people to respond to a number of statements from the GSS, including three that speak directly to relevance and importance:

- [Inventors] are helping to solve challenging problems.
- Most [inventors] want to work on things that will make life better for the average person.
- [Inventors] are dedicated people who work for the good of humanity.

We did not see meaningful differences between the variants of *inventor* that we tested: *inventor*, *21st century inventor*, *modern inventor*, *today's inventor*, *innovator*. Respondents were fairly neutral as to whether any of these professions were solving challenging problems, and disagreed somewhat that individuals in these professions want to make life better or work for the good of humanity. We observed the same lack of differentiation between *inventor* variants for all the items we tested.

However, we did find some differences in audiences' perceptions when we swapped in terms from adjacent occupations such as *entrepreneurs* and *scientists*. In particular, *entrepreneurs* were rated:

- Lower than other groups on: *[Entrepreneurs] are helping to solve challenging problems.*
- Lower than other groups on: *A job as an [entrepreneur] would be boring.*
- Higher than other groups on: *[Entrepreneurs] usually work in a university setting.*

Social Problems & Levels of Relevance

We also approached the perceived relevance of varying terms somewhat indirectly:

- When our respondents envisioned an inventor, did they picture that person working on practical problems, particularly as opposed to chiefly aesthetic or interesting ones?
- When our respondents identified problems they saw as ripe for invention, did they see those problems as personally relevant?

What we found was that the answer to both questions was, largely, yes. Many respondents connected inventors and invention to social problems. In the Imagine-an-Inventor Test, most respondents imagined inventors working on something that would solve some issue that seemed to be relevant to the inventor or important to society. These ranged from small daily life annoyances (such as improved technology for bird feeders) to global-scale problems (such as resolving ocean pollution). More than half of them described pragmatic inventions that would solve or lessen real social problems. In particular, many spoke to the need to solve environmental and sustainability issues facing our planet.

These challenges aligned with respondents' priorities for social challenges that invention might solve. Climate disaster prevention and resilience was the most commonly selected issue, and the three next-most-common issues were all arguably related to climate change: access to safe drinking water, polluting or limited energy, and polluting or limited food sources. Respondents saw nearly all of the issues we mentioned as unanimously important on a societal level, but there was much greater variety in perceived personal effect. That is, what people saw as important problems to be solved by invention depended much less on their personal needs and much more on what they saw as widespread societal needs.

We also observed that differences in perceived personal impact may be due to the demographics of this particular sample. Our median respondent was in their 60s – much older than the median American adult – Caucasian, more educated, urban, and wealthier than the average American, with a household income between $75,000 and $99,999. In their responses, our respondents were highly unlikely to say that **uncertain access to food** affects them, and almost equally unlikely to say that **over-policing or over-incarceration** affects them: these problems tend to affect people living below the poverty line and people of color, respectively. Meanwhile, they were most likely to say that the **health needs of an aging population** have a personal effect.

Recommendations

Based on these findings, we have the following recommendations for news providers to help them help audiences replace misconceptions about inventors with more realistic representations:

- A review of previous research (Finson, 2002) showed that exposure to real scientists appears to mitigate fiction-based stereotypes. For example, 4th and 5th grade students who were exposed to real scientists, had fewer stereotypes about the gender of scientists as well as the danger of doing science. ***News organizations could consider increasing the frequency with which they present diverse inventors to help shift audiences' perceptions from their default ideas***.
- Our results show that audiences recognize that social problems are solvable through invention. While they agreed that inventors solve problems, they were uncertain as to whether they addressed problems with the good of humanity and improving life in

mind. ***It may be useful in news stories to emphasize the motivations of inventors to help people improve their lives***.

Given the evidence presented in this report about the trade-offs between relevance and importance, if news providers want to increase audience attention to stories that aren't personally relevant to them, we recommend that they use news stories to:

- Remind audiences that impacts are felt at different levels – even if a topic may not be personally relevant, it is still important. Our results show that they are already primed for this.
- Some topics were selected by very few people such as over-policing and incarceration. People who selected these topics rated them as important but very far from home. When covering such topics, news providers should help audiences find points of connection with people who may be different from them and might prioritize different social needs as areas for invention and innovation.

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