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ORIGINAL PAPER

Ideals of the good life and good science among high achieving men and women scientists

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Abstract

Traditional gender roles and gender stereotypes assume different life and career priorities among men and women. Meanwhile, the science profession is commonly considered to abide by a universalist ethos and a meritocracy that is independent of gender. We examined whether men and women scientists held different ideals about the good life and about good science. Furthermore, we investigated if those ideals of good life and of good science were linked in the minds of scientists; and if the linkages differed by gender. This study used a structural topic modeling approach to analyze the interview transcripts of 108 women and 92 men elite scientists who had received highly prestigious postdoctoral fellowships during the 1960s and1970s. In the open-ended interviews, the scientists were asked to describe their ideals of good life and of good science. Regarding the good life, we found that women scientists focused more on enjoying life and relationships and less on intellectual stimulation, relative to men scientists. For good science, women scientists focused more on empirical procedural accuracy and less on basic and fundamental breakthroughs, relative to men scientists. Moreover, we found that women scientists exhibited correlations between life and science ideals, whereas the two domains were completely separate for men scientists. In conclusion, a gendered system of life and science ideals existed even among this group of highly promising scientists.

Keywords Gender difference · Life ideals · Science ideals · Structural topic model · Compartmentalization

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Introduction

On January 24, 2005, Harvard President Lawrence H. Summers made his ill-fated and controversial "Remarks at NBER Conference on Diversifying the Science and Engineering Workforce," which ultimately precipitated his resignation from the Presidency. In the first place among the reasons for women's underrepresentation in STEM fields, Summers noted a reluctance of women to commit to "high-powered intense work."[1] This argument directly points to deeply engrained gendered ideals of the good life. Women, it is still widely assumed, have priorities and motivators in life that center on the family and domestic spheres, whereas men are more strongly interested in work and public spheres. But is this gender stereotype really true among scientists, with women holding ideals of the good life that are different from men's? This question is particularly intriguing because of a widely held universalist ethos (Merton 1973) within science that claims that science is independent of gender (as of other statuses, such as race/ethnicity, nationality, religion, etc.). In other words, when it comes to the ideals of good science, they should be the same for all practitioners, regardless of gender. But is this universalist stereotype really true among scientists, with women holding ideals of good science that are similar to men's? And finally, how, if at all, are ideals of those good life and of good science linked in the minds of scientists; and do these linkages differ by gender?

Rarely do we have a large sample of extensive interviews in which men and women scientists talk about their life and work ideals. Around 1990, a unique and massive research project produced in-depth face-to-face interviews with 200 highly successful scientists in the U.S. on this topic (among others). These scientists had been granted National Science Foundation (NSF) (N = 114), National Research Council (NRC) (N = 51) postdoctoral fellowships or Bunting fellowships in the sciences or engineering (N = 28), or were Bunting finalists in these fields (N = 7), during the 1960s and 1970s. These interviews will help us build a baseline of the science and life ideals held by the scientist cohort who prospered in the late twentieth century, experiencing the early period of Affirmative Action—a necessary baseline for future investigations of what may have changed and what may have remained the same between then and now.

Good life

Thinking about the good life is important for many people. Good life ideals concern the prioritization among numerous life goals and lifestyles. Commonly observed good life ideals include satisfaction in interpersonal relationships (e.g., family, marriage, friendship), occupational success (e.g., rising on the career ladder, being famous, leading others), material achievement (e.g., making money, owning property), leisure enjoyment (e.g. free time, travel, hobbies), and communal contribution

[1] https://www.harvard.edu/president/speech/2005/remarks-nber-conference-on-diversifying-science-engineering-workforce

(e.g., helping others, making a positive difference in the world) (Chang et al. 2006). There has been a long and rich tradition of contemplating good life ideals in scholarship. However, the good life has been approached mostly by philosophers, theologians, and ethicists who have argued about it in a normative way (defining what the good life *should* be). By contrast, there has been a relative dearth of empirical studies of good life ideals people, or a special group of people such as scientists, actually hold.

Gender difference in good life ideals

Gender is a master status in most, if not all, known societies (Hughes 1945; Ridgeway, 1991). Therefore, extremely powerful mechanisms of gender socialization exist from early childhood on (Jones et al. 2000; Tenenbaum and Leaper 2003). These create different gender roles (expected behaviors) and hence gender-specific different ideas of the good life (Cunningham 2001; Eccles 1994). For example, traditional gender roles discourage females from tinkering with technical instruments (Johnson 1987) or developing an interest in scientific phenomena (Kahle and Lakes 1983) from a young age on. In the meantime, males are encouraged to take an interest in objects (Jones et al. 2000; Ngambeki et al. 2012) and to develop "overconfidence" in their intellectual capacity and aspiration for intellectual achievement (Bench et al. 2015; Tellhed, Bäckström, and Björklund et al., 2018).

Traditional gender socialization also emphasizes the caregiving role of women (Eccles 2009) and the breadwinner role of men (Fulcher and Coyle 2011; Maurer and Pleck 2006). As a result, men are more likely to be socialized to aspire to social and economic status (Abele and Wojciszke 2014), whereas women are encouraged to take more interest and involvement in family or other interpersonal relationships (Farmer et al. 1999).

Modern society is marked by a trend in gender convergence—the traditional dichotomies of gender roles have been attenuating (Moen et al. 2009; Prothrow-Stith and Spivak 2005). In the past 50 years, increasing proportions of women have been achieving higher education, entering into the labor force, and obtaining high-level jobs in domains previously defined as male prerogatives (Bureau of Labor Statistics 2018; Council of Graduate Schools 2018; Gati and Perez, 2014). One of the examples of such a previously male dominated domain into which women increasingly enter are the STEM fields (Chen, Sonnert, Sadler 2020a; National Science Foundation 2018). This is one the reasons why it is interesting to examine the good life ideals of elite male and female scientists.

Gender difference in good life ideals among scientists

The gender differences in life ideals among the general population are often observed in the science community as well. Studies have shown that men scientists and men STEM students place a higher priority on competitiveness, employment and money, while placing a lower priority on interpersonal relationships, community service, and flexible time management, relative to their women counterparts (Canetto et al.

2012; Ceci, Williams, Barnett 2009; Farmer et al. 1999, Ferriman et al. 2009). For instance, Ferriman et al. (2009) followed a group of promising mathematics and science graduate students for 10 years. In graduate school, men and women reported equivalent priority on raising children and having free time. Ten years later, those women with children were the most likely to prioritize free time.

Good science and its gender difference

In the STEM field, the idea of good science is tremendously important. It is an intellectual and moral compass that guides scientific research and forms the foundation of the scientific reward system. Commonly observed science ideals include groundbreaking discovery, intellectual brilliance, rigor, dedication, and communal contribution (Kreutzberg 2004; McNaughton 1999; Rull 2014).

Judgments of the quality of science abound in the life of scientists: in the peer-review of articles and in decisions about research proposals, job applications, promotions, tenure, and prizes. The underlying assumption is that these quality judgments are not arbitrary but follow a long-lasting and widespread "objective" and hence universal standard of good science (e.g., Merton's (1973) discussion of the ethos of science). This universalist and objectivist idea about the quality of science, which is probably believed by many practicing scientists, implies that, in contrast to good life ideals, a strong gender difference in good science is not expected.

However, very little empirical work has looked in this assumption (that little gender difference exists in the science ideals among elite scientist), and some indirect empirical evidence suggested that this assumption may not actually hold. For example, just like the general female population (Carli, et al. 2016; Fuesting and Diekman 2017), Ph.D. level women scientists who persisted in science careers reported that communal goals were very important for their career, but that was is not necessarily the case for men scientists (Diekman et al. 2015; Lam 1995).

Not without controversy, some scholars claimed that women and men think differently in or about science. According to them, to think systematically and abstractly is a masculine reasoning style, whereas women are considered to be empathizing, dedicative, and expected to be attentive to details (Chen, Sonnert, Sadler 2020b; Belenky et al. 1986; Keller 1989; Leslie et al. 2015). The more a subject field emphasizes systematizing over empathizing, the lower the representation of women at the senior or advanced levels (Geary 2010; Billington et al. 2007; Lippa 1998). In addition to the posited epistemological differences, some scholars pointed out that women and men tend to carry our slightly different social roles in science: women are more likely to take the responsibility for science outreach to the public (congruent with their communal interests), more likely to be the helper, not the leader in peer collaborations, more prone to methodological perfectionism, and less aggressive in self-promotion (Sonnert 1995). Nevertheless, scientific merit (a dominant criterion, for instance, in tenure evaluations) is commonly defined by scholarly productivity, competitiveness, reputation, theoretical breakthroughs, and impact that are traditionally deemed as masculine ideals, rather than by caring for details and social outreach contributions. Thus, following different priorities from

the dominant ones may be an obstacle to women scientists' attaining professional recognition; and, conversely, those women scientists who have succeeded in this system may have assimilated the prevailing good science ideals (which, depending on the theoretical lens, are considered either universal or traditionally masculine).

Permeability between life and science ideals

After contemplating good life and good science ideals, the obvious follow-up question is whether and how they are connected. In a series of studies, Hakim (2000, 2003, 2006) showed that work orientations and life goals are closely linked, and that the gender difference in work orientation can be largely explained by the gender difference in life goals.

A widespread assumption, in folk knowledge (Szameitat et al. 2015) and partially supported by research (Ren, Zhou, and Fu, 2009), posits that women are better at multitasking than men. This notion and social norms put pressure on working women to maintain interests in both family caretaking and their careers. Thus, it is commonly observed that women shoulder a dual responsibility for domestic and professional duties (Cole and Fiorentine, 1991; Hochschild 1990), and that the permeability between life and science roles or goals is particularly noticeable for women. A study has shown that holding a higher rank in their department is associated with a higher probability of having a family-work conflict only for women scientists, not for men (Fox et al. 2011), suggesting that women scientists need to constantly manage intermeshed domains of family and work, whereas men scientists either do not perceive such challenges or engage in family and work domains separately. Indeed, studies have shown that men scientists more commonly adopt compartmentalization strategies to manage dual responsibilities between work and family (Reddick, et al. 2012; Edwards and Rothbard 2000; Thompson and Walker 1989a, b), whereas women allow multiple roles to intersect (Ward and Wolf-Wendel 2004). Multiple roles do not necessarily lead to diluted attention but may open multiple opportunities to be successful. In a 35-year longitudinal study of mathematically precocious youth, Lubinski and Benbow (2006) showed that fewer women than men entered mathematics or science careers because their multidimensional skill sets were well-suited to other career possibilities such as law, medicine, and social sciences, and that they were equally happy with life and saw themselves as equally successful as their male counterparts.

Within the science realm, many scholars identify the dual interest and dual responsibility between work and life as a key challenge for women scientists (Etzkowitz and Kemelgor 2001; Mason et al. 2006). Studies showed that women scientists who are married or have children are less productive than men scientists after controlling for other attributes (Stack 2004). Schiebinger and Gilmartin (2010) showed that women faculty members in the STEM fields undertake twice the amount of housework as do their male counterparts. In addition, the recent increase in the percentage of women professorships in the STEM fields is largely composed of women who are single and childless (Burelli 2008). Yet, it is unknown if a gender difference in terms of connection and compartmentalization exists among scientists.

Research questions and hypotheses.

Motivated by the abovementioned dearth in the literature, in this study, we asked:

RQ1) Do women and men talk differently about the ideals of a good life? To what extent can we find remnants of a gender difference in good life ideas among a sample of elite scientists.
RQ2) Do women and men talk differently about the ideals of good science? To what extent can we find elements of a gender difference in good science ideas among this sample?
RQ3) To what extent are ideas of good life and good science interconnected among scientists? Is this different for men and women scientists?

To answer these questions, we need first to identify the types of ideals that women and men scientists hold for life and for science and then to compare the prevalence of each type of ideals between the genders. In light of traditional gender socialization, we hypothesized that women have a higher propensity of mentioning interpersonal-relationship-oriented ideals about the good life, and that men are more likely to emphasize achievement and status ideals. We also hypothesized that women emphasize the precision and carefulness of science, whereas men emphasize intellectual brilliance and making (famous) breakthroughs.

Nevertheless, highly successful scientists of both genders may share very similar priorities. Among women and men who have attained professional recognition, it is possible that both genders emphasize similarly masculine-oriented ideals about good science and about the good life because both genders have had to survive professional competition. Considering that the interviewees are all established scientists (who won a prestigious fellowship and persisted in science over 20–30 years), the traditional gender socialization may be less of an influence on women scientists who survived and reached the top, and adherence to prevailing universalist good science ideals may be particularly strong. But have gender differences completely disappeared? If there are gender difference, further research can look into the nature of this difference.

Data and methods

Sample

We used interview transcripts collected from scientists in 1989 and 1990 by Project Access at Harvard University. The question guideline for these semi-structured open-ended interviews had gone through an extensive period of developing and piloting and revision. The sample consisted of 200 scientists who had been granted National Science Foundation (NSF) (N = 114), National Research Council (NRC) (N = 51) postdoctoral fellowships or Bunting fellowships in the sciences or engineering (N = 28), or were Bunting finalists in these fields (N = 7), during the 1960s and 1970s. These were all highly prestigious and competitive postdoctoral fellowships,

with the NSF and NRC fellowships being open to both men and women, and the Bunting fellowship at Radcliffe College being only for women. It is noteworthy that the data are about 30 years old. But the question about the extent to which ideals in science may be related to ideals in life is new. We intend this analysis to provide a baseline for future studies, as explained in our Discussion.

54% of the total sample of former postdoctoral fellows were women. The mean year of receiving the doctorate was 1974 for men and 1971 for women. 38% of the men and 37% of the women had done their postdoctoral fellowship in the biological sciences; 50% of the men and 32% women in physical sciences, mathematics or engineering; 12% of the men and 31% of the women in the social sciences. Most participants remained in scientific professions as of the time of the interview in 1989 or 1990, with many having achieved high professional status.

One interviewer traveled extensively through the United States to conduct the face-to-face interviews. The interviews usually took place in the interviewees' homes or offices and typically lasted between two and three hours. 34.0% of the interviews were conducted in the New England area, 6.5% in the State of New York, 23.5% in the Mid-Atlantic region, 20.5% on the West Coast, and the remainder in other areas of the country.

Data and analysis

During the interview, the scientists were asked to describe their ideals of a good life and their ideals of good science. A traditional narrative analysis approach would manually categorize each utterance into one of a few themes and compare the number of occurrences of each theme between groups. A known challenge of this approach is that it depends on the subjective judgment of the coders and may be criticized for a potential hypothesis-driven bias, often low inter-rater reliability, and questionable replicability. With the availability of vast amounts of text data in social networks, text mining and automated text analysis have become a topics of great interest and have made substantial advances. One of the methods particularly useful for analyzing different combinations of perspectives in a discourse is the Structural Topic Model (STM, see details in https://scholar.princeton.edu/files/bstewart/files/stmnips2013.pdf).

STM, in a nutshell, assumes that a text document is a combination of different topics, and that each topic consists of a list of correlated vocabulary. A metaphor for this assumption is that a topic is a bag of scrambled words, where the tense or syntax does not matter. The words in that bag, or "set," tend to co-occur frequently whereas other words tend not to co-occur with them. STM thus allocates the words in a document to topics. STM is a dimension reduction method that summarizes a sparse matrix of words using a few topics; and each individual is assigned theta scores (for each topic), which correspond to the proportion of each topic in the individual's transcript. The STM algorithm has numerous advantages over the traditional narrative analysis approach, the most pronounced ones are its parameterization of the occurrence of topics, hypothesis-independent (unsupervised) topic categorization through machine-learning, and replicability.

In this study, we separately model each individual's response to the good life and good science questions. In other words, each individual is represented with two documents, one titled "good life," the other, "good science." For each document, we fit a STM to reduce the document to a list of topics. We first created FREX (FRequency and EXclusivity) words for each topic, which are sorted by "the weighted harmonic mean of the word's rank in terms of exclusivity and frequency" (Roberts et al. 2014, p. 12). Conceptually, the top FREX words are the words that occur frequently in one topic but rarely in other topics; therefore, they are the words that most effectively distinguish between topics. For each identified topic, we interpreted the FREX words in paradigmatic excerpts that contain a high proportion of the topic to assign meaning to the topic (note that the unsupervised STM approach does not assign meaning to a topic; meaning is assigned by human beings based on the FREX words and excerpts). Second, we compared the proportions of topics between women and men scientists, which allowed us to examine if women and men scientists conceptualized the good life or good science differently, i.e., if they emphasized different topics when they answered the same question. Third and last, we examined the correlations between topics of good life and good science for women and men scientists. This allowed us to examine the relationships between the conceptualizations of good life and good science and how they differed by gender.

Results

Topics

Good Life and Good Science documents yielded three topics each. The optimal number (K) of topics was determined by (1) the highest cohesive score and (2) the elbow of the L-shaped function of residual against K. A name for each topic was determined by summarizing (1) the set of words that ranked at the top on the FREX metric, and (2) the prototypical excerpts that had the highest probability to be allocated (the highest theta score) to the respective topic, as shown in Table 1.

In the text corpora concerning the *good life*, the following three topics were identified: (1) secure-job, where participants talked about enjoying work, having free time, and being free from financial hardship and occupational frustration; (2) intellectual-stimulus, where participants talked about being excited about intellectual challenges; (3) enjoy-life-and-relationships, where participants talked about traveling and spending more time with family.

In the text corpora concerning *good science*, the following three topics were identified: (1) basic-fundamental, where participants talked about good science as discovering fundamental patterns and deep mathematical connections; (2) empirical-procedural, where participants talked about carefully designing and controlling experiments and paying attention to the details to ensure replicability; (3) important-meaningful, where participants talked about asking big questions, making breakthroughs and contributing to something everlasting in the history of science.

Table 1 Topics, FREX words and quotes

	Good life	Good science
Topic 1	Name: security and comfort Frex words: university, free, recognition, teach, problem, easier, manage, frustrate, choose, profession… Quote: #1 [I think that a good life is when one feels secure and not only in the surroundings but in what he's accomplished, and feels secure that he can continue to accomplish that.] #2 [being at an institution or some other institution where the teaching is, is um, rewarding, but not terribly rewarding, but to consider that as rewarding… And of course no money is bad] #3 [Happy with your work. Having enough money to enjoy life in {CITY}.]	Name: basic, fundamental Frex words: pattern, mathematics, theory, solve, simple, talent, model, idea, deep, mind, prove… Quote: #1 [i mean there are, there are people who are extraordinarily good theorists, extraordinarily good and any one of us can cover a very small part of that spectrum. nd I think that in the, when I was a graduate student the supreme physicist was the guy who could sit off with a pad of paper and essentially envision the whole world from rather diverse principles.] #2 [The really good stuff is what in mathematics is called "deep" … a theorem is deep, or an area is deep if it relates to other things, so the more things that are connected because of that work, then the more important it is… Everyone is sort of looking for the fundamental parts of mathematics… I think the fundamental problems are pretty well pretty well clearly defined.]
Topic 2	Name: intellectual stimulus Frex words: stimulus, intellectual, fulfill, thought, excitement, significant, research, challenge Quote: #1 [something that's varied. And exciting. Um—intellectually stimulating. Obviously, I don't care too much about physical beauty, given that I live in {CITY}, and work in {NEIGHBORHOOD}. I think really just being stimulated is the most important thing to me. Being intellectually stimulated and provoked.] #2 […To actually do something you want to do and look forward to doing when you get up in the morning, as a source of making a livelihood, and I feel very lucky to do that. Having an interesting, challenging career, good friends and, plus, environment and all that good stuff.] #3 [I mean I like to work. I really like at least the heart of the stuff that I do, whatever vicissitudes come with professional life. And what I'd love to do is you know, work good and hard, still usually having the weekend off, but basically working long hours and intently during the week, all through the time. But then really take you know, a month over the holidays and also having the summer then to read and travel and do things.]	Name: empirical, procedural Frex words: design, experiment, control, rigor, statistics, interprete, analyze, detail, factor, repeat, data, sample, literature, replicate, thorough, hypothesis Quote: [Good observation, very careful design to avoid bias careful design to avoid experimenter bias and replication, replication, replication. Fairness and detail I guess the I guess where you can see a consistent evolution of the theoretical approach, careful delineation throughout, meticulous delineation, and replication the experimental design is absolutely must replicate if the experiment is well designed that makes the difference between average work and very, very good work with all the controls, control or possibilities it's hard to do that in this line of work.] [well, one is methodological. To… determine how you collect the data and influence the interpretation. and, I think, acknowledging that and not pretending it is not there which certain scientific institutions pretend it is not there. I think that really matters and I think that is what makes research good, aside from all the methodological which I do absolutely … you know, I mean, from design through sampling techniques all of that, you have to set up most rigorous studies that you can find that you can develop then you can design…but I think the second point about values really matters.]

Table 1 (continued)

	Good life	Good science
Topic 3	Name: enjoy life and relationships Frex words: energy, material, human, nature, interact, children, community, outside, sense, hobby, meet… Quote: [having the opportunities to—have a family, and—participate in it—fully, and offer something to the community. And—and then there's icing on the cake, like travel and—Travel—what other things? Uh—being allowed to learn new things. Time, I guess.] [Clearly if one is spending eighty percent of one's time on that, you cannot expect as deep a relationship with one's loved ones a you would have if you spend fifty percent of your time. But I would say a satisfactory marital relationship and satisfaction and pride in one's children. A close relationship with one's children, within the constraint of not being at home and relaxing at home playing games with children, if which … which I might have done if I were less ambitious. Before, while my health is still good, I.. I think a third or fourth aspect of a good life would be enjoying the beauties of nature. Travelling is … is one thing I greatly enjoy, skiing is another activity that I'm enjoying more and more, but with without a whole lot of time for it.]	Name: Important, meaningful Frex words: contribute, importance, discovery, inspire, sociological, change, answer, excite… Quote:[Well, I guess there's- it has to work on interesting, important problems. And there's a descriptive contribution to be made by some work. Sometimes we just don't know the basic facts, and it takes somebody who goes out and figures out a good instrument and knows how to count and shows us something we didn't know was there. And then sometimes it's being able to build on that analytically, and I guess what I feel as though is always exciting to me is when somebody is at a breakthrough point, where they are showing us, either if it's the descriptive or the analytic, something new.] [Relevance to a critical issue. And focus on the big picture. We deal in in tiny little pieces of information now. … All our fields are so incredibly complex that it is impossible to publish a definitive paper. We … we go particle by particle by particle, and when you see a trend, you you're very happy.]

Gender difference in topic occurrences

Figure 1 shows the difference (and its confidence interval) in the proportions of *good life* topics between women and men scientists. Women scientists talked less about intellectual stimulus by a margin of 12 percent (se = 0.048, p = 0.011) and mentioned more about enjoying life and relationships by a margin of 13 percent (se = 0.047, p = 0.005), after controlling for scientific subject fields, age, and marital status.

Figure 2 shows the difference in the proportions of *good science* topics between women and men scientists. Women scientists talked less about good science being basic and fundamental by a margin of 10 percent (se = 0.049, p = 0.044) and talked more about the importance of empirical and procedural robustness by a margin of 14% (se = 0.049, p = 0.007), after controlling for subject fields, age and marital status.

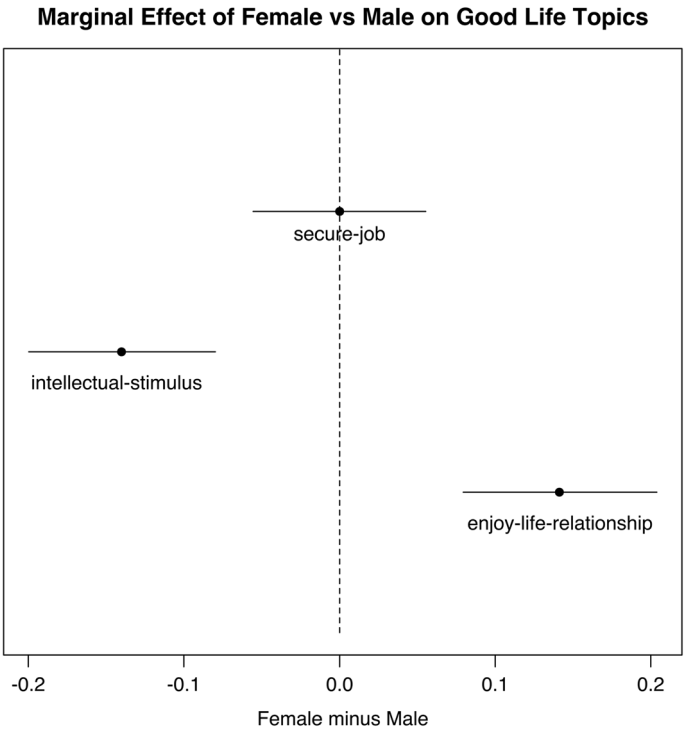

Fig. 1 The marginal effect of gender (and 95% confidence interval) in the probability of mentioning each of the three topics of *good life* between women and men scientists (female minus male proportions)

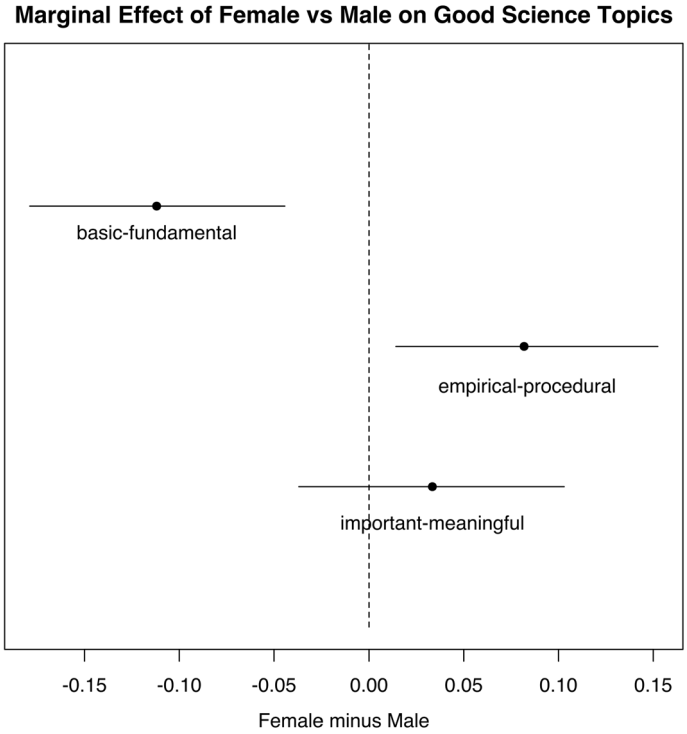

Fig. 2 The marginal effect of gender (and 95% confidence interval) in the probability of mentioning each of the three topics in *good science* between women and men scientists

The relation between good life and good science

Lastly, Fig. 3 shows the relationship between the *good life* topics and the *good science* topics for women and men scientists. A line connects two nodes only if the absolute value of their correlation was higher than r = 0.15 (threshold for weak correlation). The red end of the color spectrum indicates a negative correlation, and the blue end indicates a positive correlation. As shown in Fig. 3, none of the topics that men scientists highlighted to be important for a *good life* had even a weak correlation with the topics in *good science*. By contrast, among women scientists, most topics of *good life* and *good science* were correlated at levels between 0.15 and 0.30. Specifically, women scientists who talked more about intellectual stimulation as a topic of *good life* were more likely to mention the important-meaningful and basic-fundamental topics in *good science*, and less likely to mention the empirical-procedural topic of *good science*. Moreover, women scientists who talked a lot about the enjoying life and relationships in *good life* were more likely to mention the empirical-procedural topic in *good science*, and less likely to focus on the importance-meaningful topic in *good science*.

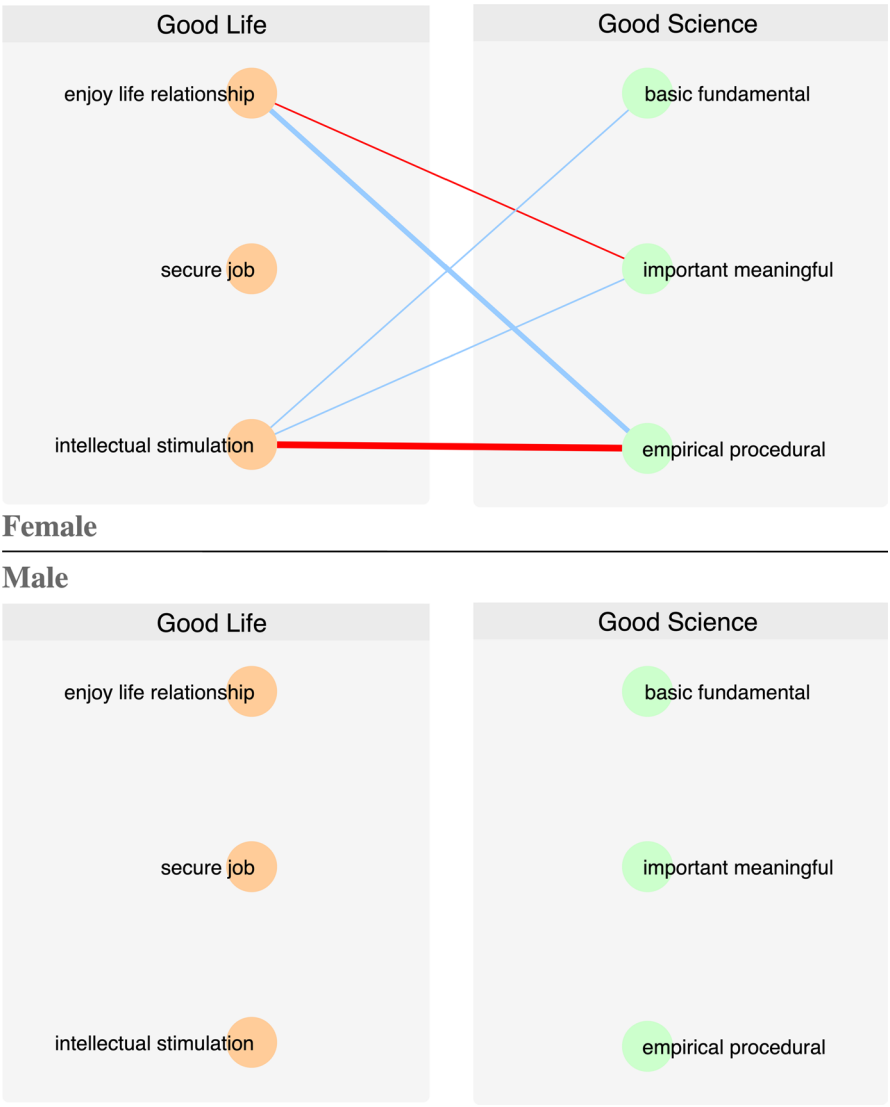

Fig. 3 Correlation between good life and good science topics for women and men scientists. Only correlations larger than 0.15 are shown in the graph

Discussion

To summarize our findings: (1) when talking about the ideals of a good life, women scientists, on average, emphasized enjoying life and relationships more than did men scientists, and they placed less emphasis on having an intellectually stimulating life. This finding supported our hypothesis that women scientists would value interpersonal relationships in a good life, whereas men scientists

would value career satisfaction. (2) When talking about the ideals of good science, women scientists more strongly emphasized empirical design and procedural accuracy and focused less on doing basic and fundamental research, relative to men scientists. This finding did partly support our hypothesis that women scientists would be more likely to emphasize the trainable attributes of science than would men. (3) For women scientists, the ideals of good life and good science were intricately connected, whereas, for men scientists, there was no connection between the ideals of good life and good science.

Gender differences in life and science ideals

To a large extent, the gender difference in good life ideals is consistent with the traditional gender socialization according to which women tend to value interpersonal relationships and men tend to value intellectual stimulation.

The gender difference in good science ideals reflected the observation that men value the fundamental nature of science because it signals inherent and untrainable brilliance, a "static mindset" (Dweck 2015) that has been pre-eminent in the male-dominated discourse of scientific discovery and progress. By contrast, women scientists placed more faith in empirical design and procedural accuracy, which can be interpreted as reflecting a growth mindset that considers careful thinking, hard work, and attending to details the key to success. This finding about the existence of gender differences in good science ideals dovetails with the prior scholarly argument that academic meritocracy is an inherently gendered social construct (Van den Brink and Benschop 2012). In our current academic environment that emphasizes inherent brilliance (Dar-Nimrod and Heine 2009), the activity of exploring basic questions and making fundamental breakthroughs—an ideal that is more popular among men scientists—appears to be also the one that is privileged by the evaluation system in the science community, compared with careful design and procedural operation—an ideal that is more popular among women scientists. This may partly explain the systemic underestimation of women and overestimation of men even among established scientists, also known as the Matilda effect, in the science community (Rossiter 1993; Valian 1998). Furthermore, women's emphasis on results that are amply supported by methodologically solid and sophisticated research might also reflect a certain structural reversal of the burden of proof for women scientists. Claims made by male scientists may be believed unless proven wrong; claims by female scientists may be suspect unless documented beyond doubt, which may heighten their awareness of risk (Sonnert 1995). Based on regulatory focus theory (RFT; Higgins 1998), under this sensitized burden, women scientists of this cohort may tend to adopt a risk-prevention regulatory focus to prevent negative outcomes by reducing error, abiding by obligations and attending to detail, as opposed to the promotion-focused regulatory strategies of aiming for accomplishing scientific breakthroughs (Higgins 2000).

Connection between life and science ideals

It was an interesting finding that men scientists' ideals in life had no connection with their ideals in science whatsoever, whereas women scientists showed rich and complex connections between life and science ideals. As noted above, many studies have investigated gender differences in work-life balance. A common observation has been that women are—or are forced to be—more balanced between work and family than are men (e.g., Keene and Quadagno 2004). However, most of the work-life balance studies have focused on the management of time and on role conflicts (e.g., Frone 2003; Greenhaus and Beutell 1985; Voydanoff 2005), but not on how aspiration in life is associated with aspiration in work. For example, is a scientist who is intellectually driven in life more likely to pursue the fundamental or impactful questions in science? Given the existing literature, one would assume that (1) men scientists are more likely than women scientists to seek intellectual stimulation in the life domain, (2) men scientists emphasize fundamental or impactful work in the science domain more than do women scientists, and (3) men scientists who emphasize intellectual stimulation in the life domain will tend to focus on fundamental or impactful work in the science domain. The first two assumptions are supported by our findings—but not the third. In other words, a male scientist who is interested in intellectual stimulus in daily life does not have a particular preference for fundamental and impactful science. In fact, knowing a male scientist's life ideal does not give us additional information about his science ideal at all.

By contrast, it is among the women scientists that we find a correlation between intellectual-stimulus ideals in life and fundamental or impactful ideals in science. Although women scientists, on average, focused less on intellectual ideals in life and fundamental or impactful ideals in science than did men scientists, once a woman scientist did report an intellectual ideal in the life domain, we had an increased chance of observing her reporting an fundamental or impactful ideal in the science domain and less of a chance of observing her reporting an procedural ideal in the science domain. In other words, once a woman scientist embraces a men-typical life ideal, she is also more likely to embrace a men-typical science ideal, an association that does not even exist among men scientists. Similarly, we observed that women scientists who focused more on interpersonal relationships (a women-typical life ideal) are more likely emphasize procedural ideals in science (a women-typical science ideal). Thus, once a women scientist embraces a women-typical life ideal, she is more likely to also embrace a women-typical science ideal.

If we define work-life ideal permeability as the association between the gendered ideals in work and life, our finding suggests that women scientists exhibit permeability between work-life ideals, but men scientists do not. Concurring with prior studies that showed that men are swifter in compartmentalization, and women are more inclined to address the intersection between life and work, our finding further suggests that this female permeability pattern is not merely a time management strategy, but also ingrained in personal ideal and value systems.

Limitations

An obvious limitation of the study is that the data were collected more than 30 years ago. The pattern we discovered reflects the social and cultural context at the end of the twentieth century and the attitudes of a now older generation of scientists. As a group, the interviewees constitute a transitional cohort, their careers straddling the divide of the early 1970s that saw a tremendous sea change in terms of the situation of women in science, highlighted by the advent of Title IX and affirmative action (Rossiter 1995, 2012). While having been socialized in the traditional social structures of science, they experienced their later careers under the new conditions. great amount of social change has continued to occur, redefining gender roles and narrowing the gender gap. For example, in a series of hiring experiments, Williams and Ceci (2015) showed that men and women faculties preferred female to male applications 2:1. We do not assume the pattern to be necessarily the same in the second decade of the 21th century.

We intend our study to establish a baseline of gender differences in life and work ideals among U.S scientists at the end of the twentieth century, so that future studies can investigate how much has changed over the past three decades. Ceci and William (2011) found that gender discrimination no longer explains women's representation in science, based on their review of the data of the prior 20 years; instead, they attributed the current concerns to knowledge about the STEM profession and the challenges in work-life balance that are exacerbated in STEM fields. As outright gender discrimination in the sciences subsides, personal beliefs and values about life and work gain importance. These factors are precisely what we 'rediscovered' from the decades-old interview data. In this sense, our findings may hold strong contemporary relevance.

It is also noteworthy that the scientists we interviewed were scientists of great promise, those who won a highly prestigious fellowship mainly in the 1960s and 1970s. To what extent our findings are translatable to a more general, and particularly entry-level, scientist population remains an open question. As mentioned above, our sample may exhibit a survivor bias because one would expect that women who excel in a men-dominated field would be more likely to embrace men-typical ideals. Thus, gender differences would be reduced in our sample, and we would expect that, for entry level scientists or for a general scientist population, the gender differences in ideals and ideal permeability or compartmentalization that we observed in this study would be amplified. We call for more studies to investigate the gender difference in the life and science ideals among a broader range of scientists nowadays.

Conclusion

Using a rare and unique interview dataset that asked two hundred exceptional scientists about their ideals in life and in work, we discovered an inherently gendered pattern. Moreover, we found that women scientists exhibited correlations

between life and science ideals, whereas the two were completely separated for men scientists. Thus, a gendered system of life and science ideals was identified even among high achieving scientists.

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Author contributions Dr. CC performed the data analysis and wrote the manuscript. Dr. GS collected the data and edited the manuscript.

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Data availability Data are available upon request, contingent upon the requester's agreement to a subject protection and data confidentiality protocol.

Declarations

Conflict of interest The authors claim no conflict of interest.

Ethical approval The ethics approval for this research was granted by the Institutional Review Board (IRB) at Harvard University. All research was performed in accordance with relevant guidelines applicable to research that involves human participants.

Informed consent Informed consent was obtained from all participants.

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