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Gendered Beliefs in STEM Undergraduates: A Comparative Analysis of Fuzzy Rating versus Likert Scales

Ana M. Castaño [1], M. Asunción Lubiano [2] and Antonio L. García-Izquierdo [1,*]

[1] Department of Psychology, University of Oviedo, 33003 Oviedo, Spain; castanoperez.ana@gmail.com
[2] Department of Statistics and Operations Research and Mathematics Didactics, University of Oviedo, 33007 Oviedo, Spain; lubiano@uniovi.es
* Correspondence: angarcia@uniovi.es

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Abstract: Women are underrepresented in growing positions such as those related to STEM field careers (i.e., science, technology, engineering, and mathematics). One of the causes for remaining out of that field could lie on gender stereotypes. Undergraduate stereotypes and beliefs are important as could easily uphold future gender segregation at the workplace. In the research arena the measurement of those biased beliefs is important as most commonly used Likert scales (LS) could raise problems in terms of accuracy. As fuzzy rating scales (FRS) are a promising measurement alternative, the aim of this study is to compare the properties of FRS against LS. We conducted a cross-sectional study with 262 STEM and non-STEM participants who answered to a questionnaire that, besides gendered beliefs and injustice perception towards the situation of women at the workplace, included personal characteristics as coursed degree and working experience. Results pointed out, on one hand, that FRS allowed for a better capture of the variability of individual responses, but on the other hand, that LS were better valued than FRS in what is concerned with satisfaction and ease of response. Advantages of FRS for psychosocial measurement are discussed to facilitate the study around causes of segregation that excludes women from the STEM labour market.

Keywords: fuzzy rating scale; Likert scale; stereotypes measurement; gender equality; STEM studies

1. Introduction

In the present times, growing Industry 4.0 grounds on the information and communications technology (ICT), conditioning both the educational and the labour environments [1]. In this regard, STEM careers (i.e., science, technology, engineering, and mathematics) are one of the pillars for the expected development of the ICT sector that will be present in all production and service sectors in the coming years [2]. Consequently, attracting students to the STEM area could contribute to the labour market needs in the ICT sector [3]. However, gender discrimination behaviours, often based on stereotyped and biased employment decisions [4], could lead women to miss out the economic benefits of choosing positions related to STEM careers [5]. In addition, gender discrimination could lead to important social costs as it contributes to the loss of the advantages of labour diversity [6], hindering equality expectations agenda in terms of Decent Work [7] and Sustainable Development Goals of the United Nations [8]. This would make those countries where gender inequalities in access to STEM careers occur, to be relegated in social and economic development in the future. Taking all of this into account, if we want to promote a sustainable labour, the measurement and the analysis of gendered beliefs that may imply the underrepresentation of women in STEM careers, are crucial and probably more necessary than ever.

The Likert type (LS) [9] is probably the most popular rating scale in the design of instruments for psychosocial measurement because of its adequate psychometric properties and for its easiness for answering. However, some criticisms have been brought against the LS (e.g., [10,11]). For example, the choice of the 'value' that best represents the answer is often a complex task, since respondents should frequently choose from a small number of options without intermediate nuances between the points that compose the LS. Moreover, in some instances, respondents have to choose a value when none of the LS options accurately fit their desire response. In consequence, the variability, diversity and subjectivity associated with individual responses are generally less than would be, and these limitations could raise problems especially when measuring socially sensitive attitudes such as gendered beliefs for which there may be a lack of self-awareness [12].

The fuzzy rating scales (FRS) [13,14] proposed by Hesketh et al. [15,16] are a promising flexible and accurate alternative to LS when dealing with the imprecision inherent to psychosocial issues. With the aim of shedding light on potential advantages of FRS over LS for measuring gendered beliefs, we developed the present study. Firstly, we focused on gender stereotypes which may lead to gender labour segregation in the STEM field. Secondly, we dealt with the measurement characteristics of FRS that could benefit the study of gender stereotypes. Thirdly, we carried out a comparative study on gendered beliefs using both FRS and LS. Finally, advantages and disadvantages of FRS over LS, as well as the theoretical and practical implications of the results for both, measurement and sustainable development, are discussed.

1.1. Gender Stereotypes and Gender Labour Segregation from the Early Career Choice

Stereotypes can contribute to maintain gender discrimination in employment from the early gender differentiation between STEM versus non-STEM career choice, since the different self-assessment of competencies may impact on women and men decisions [17,18]. In this regard, it has been found that STEM male students endorsed male-favouring stereotypes to a greater extent than STEM female students [19]. Gender stereotypes can trigger inaccurate assessments which lead women and men to behave differently in order to preserve their gender identity in the way society expects for not being penalized (e.g., [20,21]). This phenomenon, which is known as the *stereotype threat* [22], is related to the concern of confirming a negative stereotype in the science field, even when women do not endorse it [23]. As a consequence, it is possible that women and men expectations for success and belongingness in the STEM field differ, impacting on their university career choice (e.g., [5,24,25]). This could explain the remaining gender imbalance in STEM degrees, being more men than women, in general [26]. Similarly, gender segregation remains after university years, with less STEM women in related labour fields [27,28], precisely those fields with high employment demands [29]. In this context, the existing status quo where women face the homosocial reproduction of men [30,31] results in labour discrimination against women from the beginning of their professional careers, from the first contacts with organizations where they face discriminatory clues in the application forms (e.g., [32]) despite legislation for promoting equality [33] being on force.

Moreover, gender discrimination could be taking new subtle forms [34] that make difficult the identification and, in consequence, the adoption of specific measures against it. Specifically, these new forms of gender discrimination may go unnoticed in the current post-feminism and neoliberal ethic of meritocracy climate in science, which assume equality through personal effort for women while it privileges men [35]. All of this is exemplified in the research by Powell, Dainty and Bagilhole [36], who have found that women claim the achievement of their accessibility to masculine-dominated jobs through effort, while often adhering to gender stereotypes. This is better understood from the Just World hypothesis [37], which suggests that people who believe in a just world get what they deserve. In this sense, some women could react negatively to equality actions as they consider them not necessary [38] and eschew the feminist label [39] without questioning the status quo.

Taking everything into consideration, the measurement of gender stereotypes can be especially complicated as respondents may have attitudes towards gender equality but may be influenced by

gender stereotypes. It is even possible that respondents do not have a clear attitude and/or even have contradictory attitudes. In this regard, numerous efforts have been made in favour of gender equality, such as the fifth Sustainable Development Goal of the United Nations and the enactment of legal dispositions and Government policies (e.g., [33,40,41]), that could be at the beginning of influencing on the gendered beliefs of younger people. Since the measurement of attitudes should be "sensitive to the ways in which they may be produced" and "attitudes in all their complexity and all their manifestations" should also be measured [42] (p. 63), the use of methodologies as that of FRS that clarify responses can be helpful on gaining precision when measuring socially sensitive attitudes.

1.2. The FRS for Measurement

A key concept to handle the FRS is that of fuzzy set, introduced by Zadeh [43], which provides a more flexible modelling of human judgment data. The use of random fuzzy sets in Puri and Ralescu's sense [44] allows us to formalize the statistical analyses of data corresponding to values in FRS, and provides the appropriate techniques to develop descriptive and inferential approaches. This has been made possible by treating this type of data as a whole, since one can state arithmetic and distances, preserving the meaning of fuzzy numbers. In fact, many well-known concepts and developments of the statistical analyses of real-valued data we are used to express with LS (e.g., central tendency, dispersion, estimation, hypothesis tests, *p*-values) can be considered when managing fuzzy number-valued data (e.g., [45,46]). In this regard, some packages in R language have been built allowing to operate with fuzzy data and to apply appropriate statistical analyses [47] similarly to LS.

Nonetheless, FRS measurement cannot be conducted in any setting, since they require paper-and-pencil surveys/questionnaires or a computerized form to be filled out by the respondents. Moreover, the respondent needs either to have an adequate background or to be trained in drawing the fuzzy numbers associated to FRS responses. Figure 1 summarizes the key guidelines to draw a fuzzy number that best represent the FRS response [16]. Firstly, a bounded interval, named as the referential, is considered, for instance the interval [0, 10]. Secondly, respondents may select a representative rating on the given referential and draw the real value or interval of values from the referential which are considered to be fully compatible with their valuation. That is, respondents draw the 1-level set of their fuzzy valuation. Thirdly, respondents indicate the interval of values from the referential which are considered to be compatible with their valuation to some extent. That is, respondents draw the 0-level set of their fuzzy valuation. Fourthly, responses are completed by considering linear arms, that is, by building the fuzzy number.

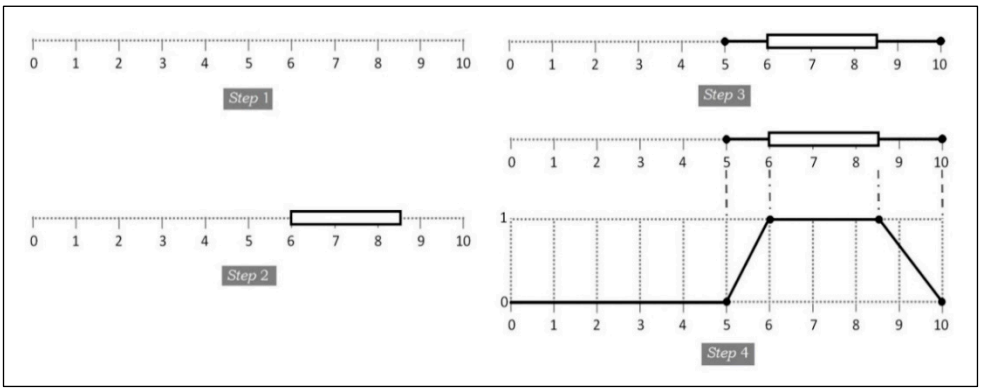

Figure 1. Steps for drawing the fuzzy number according to the definition of the fuzzy graphic rating scale by Hesketh et al. [16].

The transition from one value to another within the FRS responses is fully gradual, both in location and in precision. In this regard, data retrieved from FRS is expected to be much richer and more expressive than any one based on an unavoidably finite natural language, where the intrinsic

variability, diversity and subjectivity are not lost. That is, the FRS provides freedom and expressiveness in responding being less constrained than when choosing among a few pre-specified options [48]. This implies that the FRS results may be different from those drawn from numerically encoded Likert values (e.g., [49,50]), and the decisions made accordingly may be also different. For this reason, the measurement of gender stereotypes could especially benefit from the advantages of FRS accuracy, since the higher the quality of the information we obtain, the higher the quality of the decisions made to establish gender equality plans in order to achieve gender equality in the STEM field.

1.3. The Present Study: Are Spanish Undergraduates Moving towards a More Egalitarian Society?

Spain is one of the European countries where the 2008 economic crisis has had a greater impact on job destruction [51]. Thus, the incorporation of women in such growing STEM-related positions is essential, so that structural gender inequalities do not continue to increase in the future. In this regard, there have been more women than men in STEM degrees through the last years, suggesting small steps towards a more egalitarian society [52]. For example, according to data from the latest *Encuesta de inserción laboral de titulados universitarios*—Survey of labour insertion of university graduates (Table 1) by the Instituto Nacional de Estadística (INE)—National Institute for Statistics [53], there were more graduate women than men in the science field, despite women and men still being segregated in traditionally considered feminine (e.g., legal sciences, arts and humanities, and health sciences) and masculine (e.g., engineering and architecture) degrees. Furthermore, when graduates face access to the work setting, there seems to be no evidence of discrimination based on gender, since the employment rates by gender remain very similar to the graduate rates according to the field of knowledge [53], as we can see in Table 1.

Table 1. Spanish university graduates and employment rates by field of knowledge.

Field of Knowledge	Graduates (%)		Employment Rates (%)	
	Men	Women	Men	Women
Social and legal sciences	31.53	68.47	32.18	67.82
Arts and humanities	33.92	66.08	33.43	66.57
Health sciences	23.07	76.93	24.08	75.92
Engineering and architecture	71.05	28.95	72.54	27.46
Science	35.84	64.16	34.56	65.44

Note: Source: Latest official data from the Instituto Nacional de Estadística (INE) [53].

These data point out that competence equality has increased [54], and that the students have moved to more equitable awareness of stereotypes from early childhood [55]. In the Spanish case, young undergraduates, especially women, could become increasingly aware of their own gender stereotypes and show fewer gendered beliefs. Subsequently, this would lead to a reduction in the gendered beliefs about STEM and non-STEM students, which are on the basis of the stereotype threat. In addition, the employment rates described above suggest that the access into the work context is moving towards a more egalitarian setting.

Therefore, we consider the context of the Spanish tertiary education as an appropriate setting for analysing the measurement of sensitive issues. In this sense, in this study we hope to shed light on undergraduate gendered beliefs regarding their gender, field of knowledge and working experience using FRS versus LS, as has already been done in other educational areas (e.g., [56]). All of this aims at providing tools that facilitate obtaining high quality data for the study of gender segregation that excludes women from the STEM field.

2. Materials and Methods

2.1. Participants

We obtained a total of 369 responses from university students after discarding the responses of: (i) 6 participants due to the lack of information on the gender and the field of knowledge of the coursed degree, (ii) 6 participants due to the fact that they were exchange students with language issues to properly understand the questions, (iii) and 31 participants due to an inadequate completion of the FRS responses (i.e., the LS responses were not included within the FRS limits). Also, in order to avoid biased results due to the gender unbalance with respect to the participants belonging to the five fields of knowledge (i.e., non-STEM degrees: social and legal sciences, arts and humanities and health sciences; STEM degrees: engineering and architecture and science), 107 responses were randomly removed to obtain a ratio of women to men of 50:50 in every field. This finally resulted in a total of 262 participants. These participants had a mean age of 22.46 years (SD = 3.72), 42% were STEM students and 28.2% presented some working experience. Table 2 shows the initial and final sample broken down by gender, field of knowledge and working experience.

Table 2. Number of participants by gender, field of knowledge and working experience.

Field of Knowledge and Working Experience	Number of Participants					
	Initial Sample (N = 369)			Final Sample (N = 262)		
	Men	Women	Total	Men	Women	Total
		No STEM				
Arts and humanities	34	18	52	18	18	36
Health sciences	50	25	75	25	25	50
Social and legal sciences	70	33	103	33	33	66
Working experience	46	15	61	21	15	36
No working experience	108	61	169	55	61	116
		STEM				
Science	29	26	55	26	26	52
Engineering and architecture	29	55	84	29	29	58
Working experience	18	27	45	18	20	38
No working experience	40	54	94	37	35	72
Totals by gender	212	157	369	131	131	262

Note: The lower number of participants by gender and field of knowledge in the initial sample was taken as the criterion for establishing the 50:50 gender ratio by field of knowledge in the final sample. There were 230 non-STEM and 139 STEM participants in the initial sample, whereas there were 152 non-STEM and 110 STEM participants in the final sample.

2.2. Procedure

Two researchers attended to university classrooms in order to request undergraduates' collaboration in a study dealing with the comparison of response formats for the measurement of beliefs. Researchers explained to undergraduates how to access via web link and complete the online questionnaire where responses were given on the same issues using both a 7-point LS and the FRS as shown in Figure 2. Instructions for completing the questionnaire were also fully available for consultation on the online questionnaire, since participants could freely share the web link with other students.

The online questionnaire was comprised of biographical information (i.e., age, gender, field of knowledge, and a dichotomous item about whether participants work and/or have worked previously or not), as well as the following variables and scales about gendered beliefs, the perception of injustice towards women in the workplace and several quality questions.

General belief in a just world: It was measured by means of the six-item subscale of the General Belief in a Just World (e.g., "*Basically, the world is a just place*") by Dalbert [57], who indicated that Cronbach's coefficient for this instrument ranged from 0.68 to 0.73 in different studies.

Gendered beliefs: These were measured by means of the Gender Ideology Scale [58], consisting of 12 items (e.g., "*It is natural for men and women to perform different tasks*"). These authors indicated that Cronbach's coefficient ranged from 0.71 to 0.88 in different studies.

The perception of injustice towards women in the workplace: It was measured by means of the Scale of Perception of Injustice on the Situation of Working Women which consists of nine items (e.g., "*I believe that women are unfairly treated in this country*") adapted by Moscoso, García-Izquierdo and Bastida [59], who indicated a Cronbach's coefficient of 0.89.

Finally, six quality questions about the response characteristics of both FRS and LS with respect to the satisfaction, degree of accuracy, and ease of response were included (e.g., "Indicate [your degree of satisfaction with the response format]/[to what degree the response format has allowed you to accurately reflect your thinking]/[to what extent you found it easy to respond with each response format]"). Participants provided a value between 0 and 10 for both FRS and LS format, being 0 if they were not satisfied with the response format/the response format has not allowed them to accurately reflect their way of thinking at all/the response format seemed very difficult to them, and 10 if they were very satisfied with the response format/the response format has allowed them to fully and accurately reflect their way of thinking/the response format seemed very easy to them.

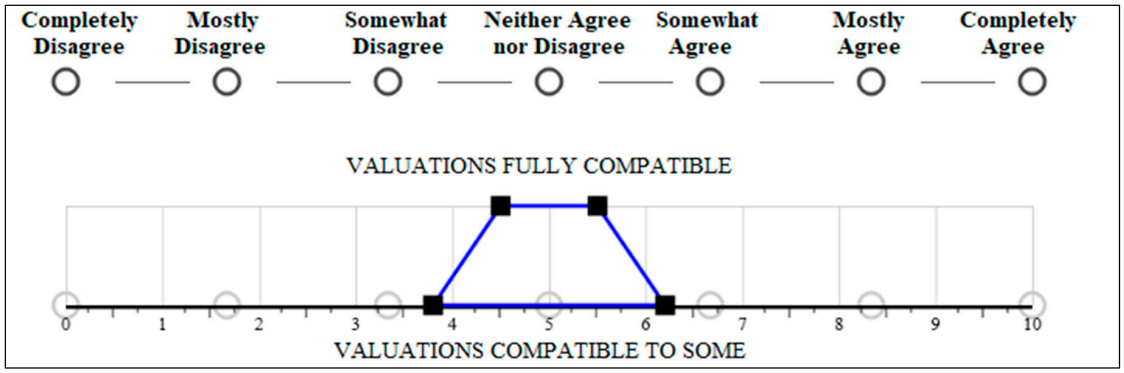

Figure 2. Likert scales (LS) and fuzzy rating scales (FRS) response formats.

2.3. Data Analysis

Cronbach's alpha indexes and mean comparisons were performed using the R package (version 3.5.1) by means of non-parametric tests, as normality of the variables could not be proven. Specifically, for the analyses of the LS responses, the *R psych* package [60] was used for computing the Cronbach's alpha indexes, and the *lsr* package [61] was used for computing the Cohen's *d* effect sizes. For the analyses of the FRS, the *SAFD* [62] and the *FuzzyStatTra* [63] packages provided some basic functions for doing statistics with trapezoidal fuzzy numbers. Moreover, functions to compute Cronbach's alpha and Cohen's *d* FRS coefficients were implemented ad hoc for the present study.

3. Results

3.1. Descriptive Statistics

Figure 3 and Table 3 show the descriptive statistics for both FRS and LS disaggregated by gender, field of knowledge and working experience. As for reliability indexes, they were quite similar for FRS and LS, being slightly higher for FRS than for LS in the case of the belief in a just world. In addition, the reliability index for the traditional conception of gender was also slightly higher for FRS than for LS when only undergraduate women were considered.

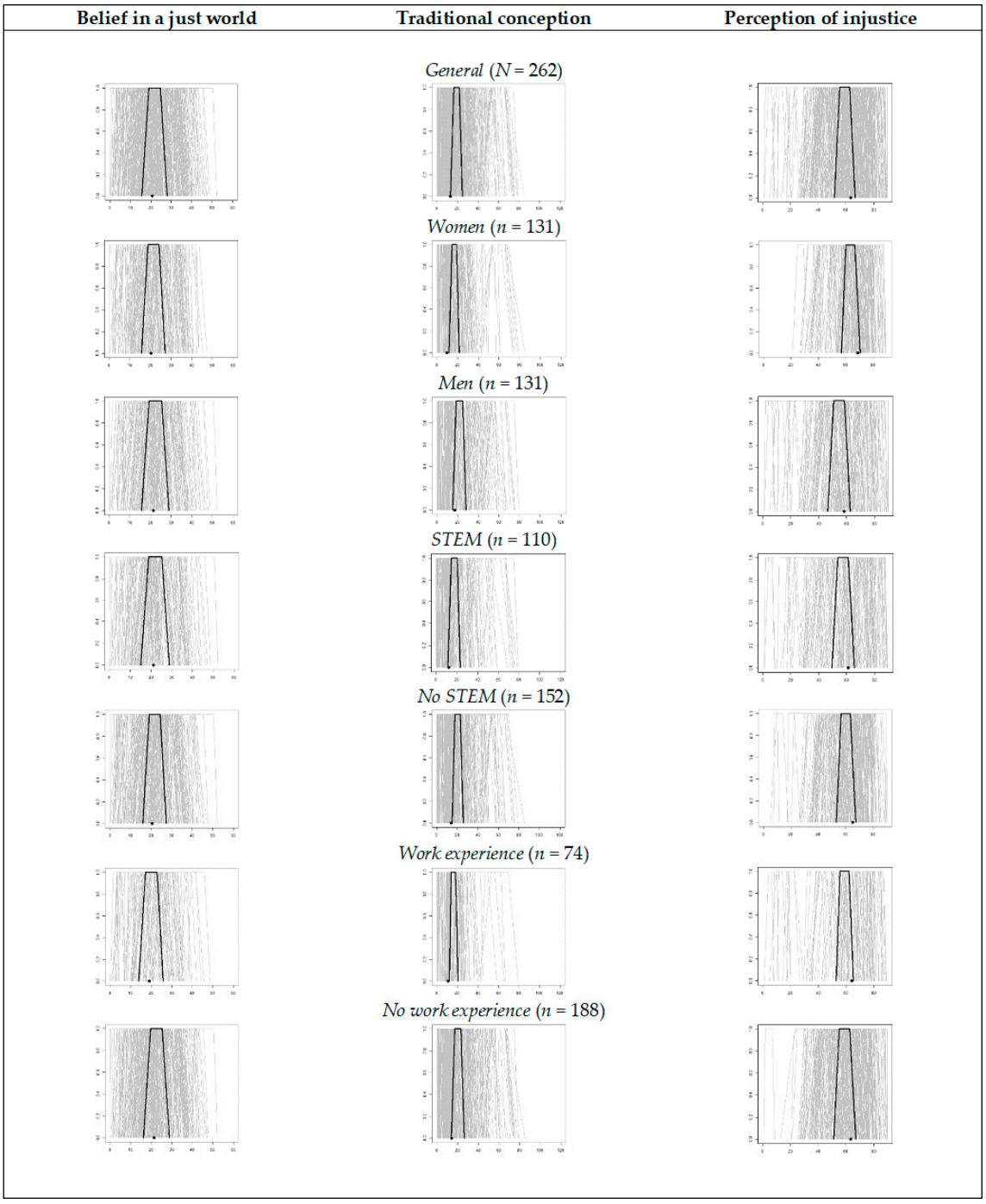

Figure 3. Graphical means for FRS and LS. FRS means are represented by trapezoids; LS means are represented by dots.

Table 3. Reliability and descriptive statistics for FRS and LS.

Variables	α		FRS					LS						
	FRS	**LS**	**Inf0**	**Inf1**	**Sup1**	**Sup0**	***SD***	**Min.**	**Max.**	***M***	***Scale max.*** *	***SD***	**Skewness**	**Kurtosis**
All participants (N = 262)														
Bel. just world	*0.800*	0.744	15.59	19.03	24.73	27.97	9.24	7	36	18.469	42	5.571	0.262	0.100
Trad. conception	0.812	*0.825*	13.41	16.44	21.89	24.86	15.42	12	52	20.000	84	8.414	1.217	0.902
Per. of injustice	0.883	*0.909*	51.67	55.45	62.57	66.66	16.23	11	63	47.130	63	10.124	−0.994	1.079
Women (n = 131)														
Bel. just world	*0.799*	0.722	15.62	18.82	24.11	27.01	9.29	7	30	18.107	42	5.357	0.027	−0.472
Trad. conception	*0.783*	0.736	11.71	14.43	19.02	21.49	14.15	12	41	17.740	84	6.403	1.410	2.074
Per. of injustice	0.796	*0.840*	56.88	60.20	66.74	70.61	12.65	26	63	50.405	63	7.571	−0.787	0.526
Men (n = 131)														
Bel. just world	*0.801*	0.764	15.57	19.24	25.34	28.92	9.19	7	36	18.832	42	5.774	0.429	0.433
Trad. conception	0.832	*0.850*	15.11	18.45	24.77	28.22	16.24	12	52	22.260	84	9.531	0.870	−0.158
Per. of injustice	0.913	*0.926*	46.45	50.69	58.39	62.70	18.08	11	63	43.855	63	11.263	−0.736	0.332
STEM (n = 110)														
Bel. just world	*0.794*	0.741	15.17	18.94	25.19	28.79	9.107	7	36	18.745	42	5.574	0.262	0.331
Trad. conception	0.823	*0.832*	11.37	14.66	20.33	23.31	15.32	12	52	19.418	84	8.334	1.437	1.872
Per. of injustice	0.904	*0.917*	49.48	53.62	61.24	65.73	18.30	11	63	45.782	63	11.273	−0.913	0.523
No STEM (n = 152)														
Bel. just world	*0.804*	0.747	15.90	19.09	24.38	27.37	9.351	7	36	18.270	42	5.578	0.267	−0.019
Trad. conception	0.802	*0.821*	14.89	17.73	23.03	25.98	15.41	12	44	20.421	84	8.473	1.083	0.389
Per. of injustice	0.859	*0.899*	53.25	56.77	63.53	67.33	14.49	14	63	48.105	63	9.118	−0.953	1.379
Working experience (n = 74)														
Bel. just world	*0.825*	0.770	13.97	17.28	22.94	25.85	9.697	7	32	17.446	42	5.784	0.140	−0.104
Trad. conception	0.674	*0.747*	12.11	14.02	18.24	20.39	12.45	12	42	18.514	84	7.099	1.482	2.273
Per. of injustice	0.913	*0.942*	52.95	55.79	62.09	65.46	19.67	11	63	47.446	63	12.451	−1.267	1.108
No working experience (n = 188)														
Bel. just world	*0.786*	0.730	16.24	19.72	25.43	28.80	8.981	7	36	18.872	42	5.447	0.357	0.164
Trad. conception	0.840	*0.843*	13.92	17.39	23.33	26.61	16.29	12	52	20.585	84	8.827	1.109	0.521
Per. of injustice	0.863	*0.886*	51.16	55.31	62.75	67.13	14.69	12	63	47.005	63	9.082	−0.710	0.475

Note: The highest reliability indexes are highlighted in italics. * The maximum score that participants can obtain on every scale.

Moreover, generally speaking, mean scores obtained through LS were medium and high for the belief in a just world and the perception of injustice, whilst low for the traditional conception of gender. In addition, it must be noted here that FRS allowed us to better capture individual differences than LS, as shown in Figure 4, which exemplifies how the same response in LS was composed by different FRS responses.

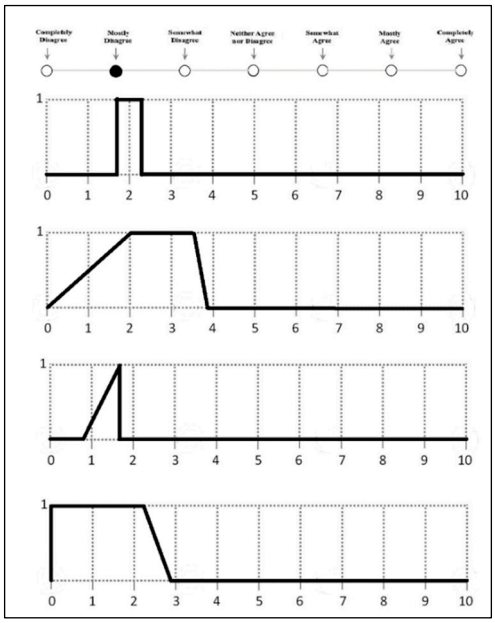

Figure 4. Graphical representation of the FRS response variability for a 2-LS response.

3.2. Mean Comparisons

A summary of the FRS and LS gendered beliefs mean comparisons by gender, field of knowledge and working experience is provided in Table 4 and Figure 5.

Dealing with the mean comparison analyses through the LS, there were significant differences considering the gender regarding: the perception of injustice towards women in the workplace, where women (M = 50.405, SD = 7.571) scored higher than men (M = 43.855, SD = 11.263); and the traditional conception of gender, where men (M = 22.260, SD = 9.531) scored higher than women (M = 17.740, SD = 6.403). No significant differences were found regarding the field of knowledge, nor the working experience.

Table 4. Summary of gendered beliefs mean comparisons by using FRS and LS.

Comparisons by	Results	
	FRS	**LS**
Women (n = 131)/ Men (n = 131)	BJW p = 0.320, d = 0.122 TRAD (+Men) p = 0.006, d = 0.337 INJ (+Women) p = 0.000, d = 0.583	BJW p = 0.455, d = 0.130 TRAD (+Men) p = 0.000, d = 0.557 INJ (+Women) p = 0.000, d = 0.683
STEM (n = *110*)/ No STEM (n = *152*)	BJW p = 0.466, d = 0.094 TRAD p = 0.118, d = 0.196 INJ p = 0.181, d = 0.171	BJW p = 0.496, d = 0.085 TRAD p = 0.299, d = 0.119 INJ p = 0.192, d = 0.227
Working experience (n = *74*)/No working experience (n = *188*)	*BJW (+No experience)* p = 0.048, d = 0.272 *TRAD (+No experience)* p = 0.019, d = 0.304 INJ p = 0.643, d = 0.069	*BJW* p = 0.105, d = 0.254 *TRAD* p = 0.146, d = 0.259 INJ p = 0.152, d = 0.040

Note: BJW = Belief in a just world. TRAD = Traditional conception of gender. INJ = Perception of injustice towards women in the workplace. A + symbol is used to highlight the group with the higher mean. Highlighted in italics those mean comparisons which differ between FRS and LS.

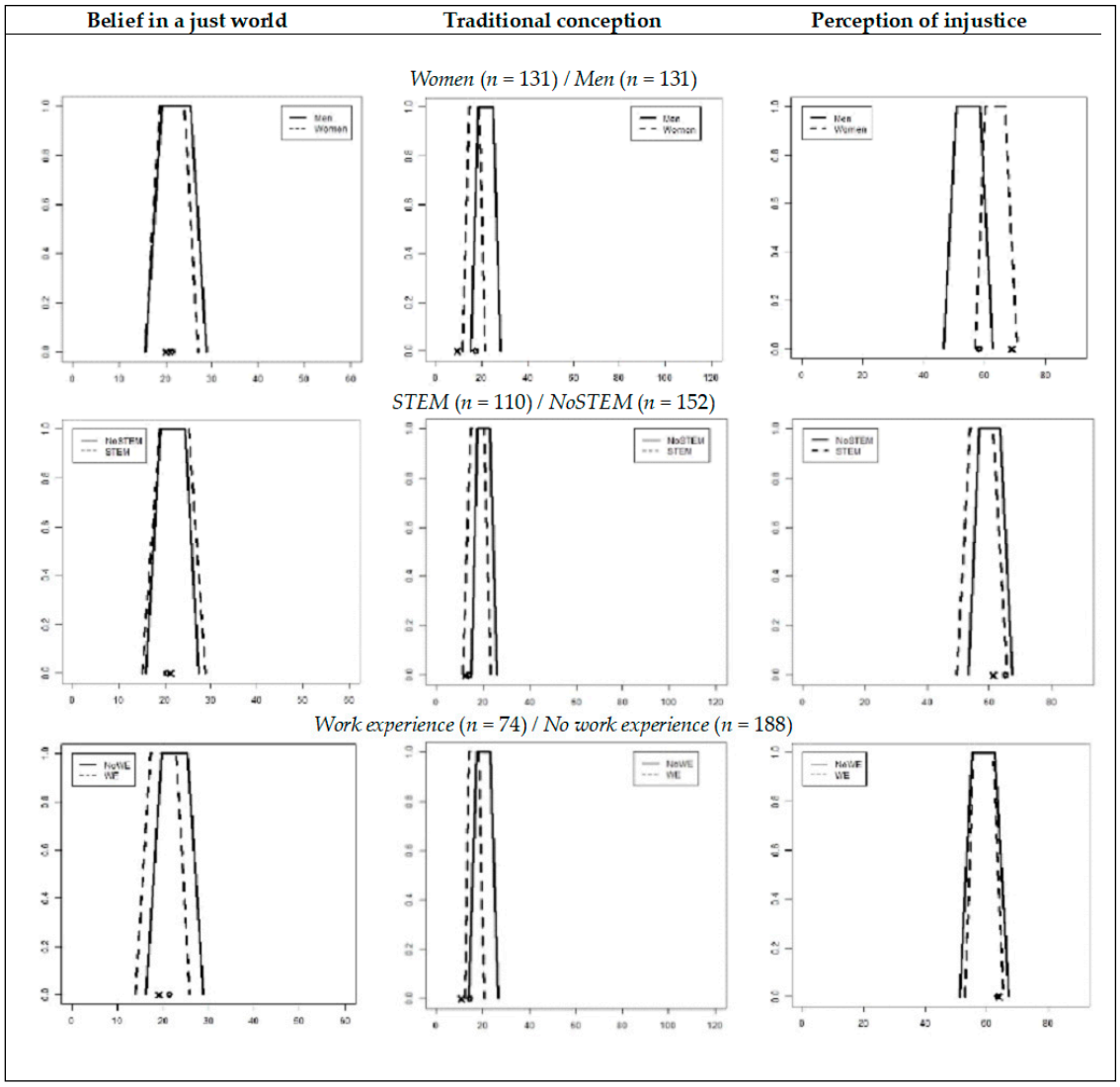

Figure 5. FRS and LS gendered beliefs mean comparisons. FRS means are represented by trapezoids; LS means are represented by dots for the solid lines, and crosses for the dotted lines.

In the case of the FRS, the mean comparison analyses showed similar results to those obtained with the LS. Specifically, there were significant differences considering the gender regarding: the perception of injustice towards women in the workplace, where women scored higher than men; and the traditional conception of gender, where men scored higher than women. Moreover, no significant differences were found regarding the field of knowledge. However, significant differences were found regarding the working experience: scores on the belief in a just world and the traditional conception of gender were higher for participants with no working experience than for participants with working experience.

As a conclusion, Table 5 contains a summary of the results where it is worth noting that different results were found on gendered beliefs when dealing with FRS or LS.

Table 5. Summary of mean comparison results by response format.

FRS	LS
Gender	
- No score differences were found between undergraduate women and men in the belief in a just world.	
- Undergraduate women scored lower than men in the traditional conception of gender.	
- Undergraduate women scored higher than men in the perception of injustice towards women in the workplace.	
Field of knowledge	
- No score differences were found between STEM and non-STEM undergraduates in: the belief in a just world, the traditional conception of gender, nor the perception of injustice towards women in the workplace.	
Working experience	
- Undergraduates with no working experience scored higher than those with working experience in the belief in a just world.	- No score differences were found between undergraduates with working experience and those with no working experience in the belief in a just world.
- Undergraduates with no working experience scored higher than those with working experience in the traditional conception of gender.	- No score differences were found between undergraduates with working experience and those with no working experience in the traditional conception of gender.
- No score differences were found between undergraduates with working experience and those with no working experience in the perception of injustice towards women in the workplace.	

3.3. Comparison of the Quality Response Characteristics of FRS and LS

Finally, according to the comparison of the quality characteristics for both FRS and LS response formats, as illustrated in Table 6, participants showed: (i) a higher degree of satisfaction with LS; (ii) that there were no statistically significant differences between the FRS and the LS in terms of to what extend the scales allowed them to accurately reflect their response; and (iii) that LS were easier to respond to. In addition, these results were similar when considering gender for the purpose of doing a cross-validation.

Table 6. Comparison of the response quality characteristics of FRS and LS.

Response Quality Characteristic	FRS	LS	*p* Value and Cohen's *d*
	General (N = 262)		
Satisfaction	M = 5.893, SD = 2.665	M = 8.372, SD = 1.491	p = 0.000, d = 0.753
Accuracy	M = 7.053, SD = 2.489	M = 7.523, SD = 1.642	p = 0.178, d = 0.145
Ease of response	M = 5.646, SD = 2.649	M = 8.826, SD = 1.595	p = 0.000, d = 0.925
	Women (n = 131)		
Satisfaction	M = 5.718, SD = 2.676	M = 8.592, SD = 1.366	p = 0.000, d = 0.872
Accuracy	M = 7.125, SD = 2.651	M = 7.775, SD = 1.638	p = 0.189, d = 0.192
Ease of response	M = 5.589, SD = 2.726	M = 9.080, SD = 1.287	p = 0.000, d = 1.072
	Men (n = 131)		
Satisfaction	M = 6.069, SD = 2.653	M = 8.153, SD = 1.581	p = 0.000, d = 0.641
Accuracy	M = 6.981, SD = 2.324	M = 7.271, SD = 1.614	p = 0.589, d = 0.094
Ease of response	M = 5.702, SD = 2.579	M = 8.573, SD = 1.823	p = 0.000, d = 0.799

4. Discussion

In this study we have compared the properties of FRS against LS while analysing gendered undergraduate beliefs. Below we discuss the main results found.

First, it can be said that the results obtained through the LS differed from those obtained through the FRS: statistically significant differences were found for the scores on the traditional conception of gender roles and the belief in a just world among participants with and without working experience that had not been revealed by LS analyses. In this regard, these different results suggest that the FRS allows to detect differences that would otherwise go unnoticed.

Secondly, following the above, it should also be noted that the reliability indexes were slightly higher for FRS than for LS in the case of the belief in a just world. Moreover, in the specific case of

women, a higher reliability index for FRS was also found for the traditional conception of gender. This points to a greater capacity of FRS to detect nuances and to a better accuracy in the measurement of gendered beliefs. However, more research is needed in order to expand the information on the advantages of FRS in terms of reliability indexes, since only a slight improvement in the reliability of FRS has been found.

Third, despite of that described advantages, the FRS are in a clear disadvantage in comparison to the LS for the satisfaction and ease of response quality characteristics. Nonetheless, it is true that no differences were found in terms of the perception of respondents to accurately reflect their responses using FRS or LS. In this sense, the response format could have a lot to do with these results, and further research will be needed to improve and facilitate how to respond to FRS using an online application. For example, we should analyse if the interval valued fuzzy scale where participants only indicate two values to represent their response [64,65], facilitate this process and improve the scores about quality questions (i.e., satisfaction, accuracy and ease of response) in comparison to LS.

Fourth, with respect to the gender results, it has been found that undergraduate women seem to be more aware of gender stereotypes and potential injustices they could face in the workplace. Similarly, no significant differences have been found between STEM and non-STEM participants in terms of gendered beliefs and the perception of injustice towards women in the workplace. These results may be related to the fact that scores about gendered beliefs have been low, in line with the idea that younger people have evolved towards greater awareness of stereotypes and equality [54,55]. Precisely, these low scores on stereotypical beliefs could mean that women are less affected by the stereotype threat, resulting in women participation in STEM degrees increased. Another possible explanation is that the academic and work settings have both become less discriminatory during recent years, as expected in light of the INE data [53] showed in Section 1.3. In this sense, it has been found that scores on the traditional conception of gender were higher for participants with no working experience, which may point to the labour market being a fair setting. However, we must not forget that men have shown more stereotypical beliefs than women, so the existing status quo is re-emphasised despite the existence of a veneer of equality [27]. Indeed, despite the fact that stereotypes about the roles of women have changed socially more rapidly than those of men, women are also perceived as taking on masculine-agency characteristics [66], and working women are still perceived as feminine/communal, so they would continue to be subject to double-bind judgements [67]. These double-bind judgments could continue to hinder women enrolment in STEM field studies and their subsequent incorporation into the STEM labour market. Thus, we must continue working on the advancement of equal gender opportunities as one of the aspects of global sustainability. The current growth of the STEM labour field gives us a unique opportunity to design and to implement sustainable practices in the educational context. In this regard, it becomes essential to challenge traditional conceptions that men are or will be more successful in the STEM field [55], in line with sustainable targets which aim to "ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life" and "enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women". In this sense, it is necessary to plan interventions that reduce the stereotype threat in the STEM field [68], for example, through: (i) transmitting co-educational values in equality without the restriction of gender roles that will allow the profession to be freely chosen according to the real demands of the labour market [69]; (ii) teaching about gender bias in STEM to help women to identify themselves with women scientists [70]; (iii) teaching STEM educators on how to avoid paternalistic messages about women's STEM competence [71] (since it has been found that girl career selection is mostly influenced by teacher's expectancies [72]); and (iv) helping women to develop strategies to reduce internal attributions of their setbacks when facing negative STEM environments [73].

Altogether, the main objective of this research was to analyse whether the FRS could allow to obtain more reliable results and more accurately appreciate the variability of responses with the purpose to provide tools that facilitate the study of gender segregation that excludes women from

sustainable growth in the STEM field. On this basis, we argued that the higher the quality of the information we obtain, the higher the quality of the decisions made to establish gender equality plans in the Universities and in previous educational periods in order to achieve gender equality in the STEM field. However, the results have not been clearly favourable towards the FRS, and more research will be needed to facilitate the response format of the FRS to the respondents, since perhaps the perceived difficulty for their response could be biasing and masking differences between the groups analysed. That is, although the FRS seems to be especially expedient to design many items in questionnaires related to the measurement in Psychology and social sciences, we believe it is necessary to facilitate their completion by the participants so that these socially sensitive aspects can be properly captured.

Limitations and Future Research

As to the main limitations of this research, it should be noted that the participants belong to a single University, so results cannot be generalized to all of the Spanish undergraduates. In order to generalize the results, it will be necessary to conduct the study with a more heterogeneous sample. That is, future research should be designed taking into account responses of young Spanish undergraduates from a representative sample of all the Spanish public and private universities. This will also provide us with a greater sample for more detailed comparison analyses of beliefs by taking into account the specific areas of knowledge that comprise STEM and non-STEM studies.

Another caveat of this research is that questionnaires involving FRS cannot be conducted in any framework (e.g., telephone, face-to-face survey) and the use of paper-and-pencil forms could often make data collection a cumbersome task, so that the use of computers is preferred. Further research should be conducted in this regard in order to improve the computer software for facilitating the designing and filling out of such questionnaires. Moreover, we would like to point out that the development and implementation of methods for FRS analyses must take into account that, in contrast to what happens with numerical data, the structure of the space of fuzzy data with the usual fuzzy arithmetic is non-linear and, consequently, ad hoc techniques should sometimes be developed. Further research should be in line with recent developments along the last years regarding methodology development for statistically analysing FRS-based data by means of R packages.

Finally, it should be noted that only cross-sectional data was included. In this regard, future research should be focused using longitudinal design research methods for obtaining further information regarding the professional career of participants and the evolution of their gendered beliefs.

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Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author, ALGI. The data are not publicly available due to restrictions (e.g., their containing information that could compromise the privacy of research participants).

Code Availability: R packages for the analyses of the fuzzy rating scales (i.e., *SAFD* by Trutschnig, & Lubiano [62]; *FuzzyStatTra* by Lubiano, & de la Rosa de Sáa [63]) are publicly available in the CRAN repository. Developed functions to compute Cronbach's alpha and Cohen's d coefficients are available on request from the second author, M.A.L.

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