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Spotlight on scientotheism. Structure and psychometric properties of the questionnaire for the study of scientistic worldview aspects

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The paper presents the individual stages of building the Views of Science Questionnaire used to study the different positions taken on elements of the scientific system. The results of a preliminary selection of the questionnaire items, exploratory factor analysis and a series of confirmatory analyses led to the construction of a tool characterised by a satisfactory degree of reliability, consisting of four subscales: (1) trust in the scientific method, (2) science as a source of hope, (3) scientists as the only experts, and (4) science as a tool of practical influence. The paper furthermore presents the results of a test-retest procedure to determine the stability of the questionnaire and the correlations between scale scores and gender, age and level of education.

Keywords: scientistic worldview; scientotheism; Views of Science Questionnaire; beliefs about science.

INTRODUCTION

At this day and age, science is not only the "scholar's craft," but also an essential element of reality, influencing human lives in various, multiple ways. On the one hand, science underlies applied medical, technological and IT solutions, and on the other hand, it constitutes an object of interest that goes beyond professional reflection (Entradas, 2015). Content referring to elements of the scientific system fills pages of illustrated magazines, TV schedules and popular websites (Biniewicz, 2016; Haynes, 2016). This does not mean, however, that there exists a general consensus among non-professional consumers of science communication on the importance and function of science and its

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role in relation to other macrosystems: law, religion, politics, family, or economics (Mudyń, 2016; Życiński, 2015). In addition to individuals and groups who are enthusiastic about science, its potential and the extent of its influence on contemporary people's lives (see e.g. Bobryk, 2016; Harris, 2008; Shermer, 2016), there are also groups that formulate narratives which distance themselves from the current state of the art in science as well as from the latter's methodology and applications (see e.g. McKee & Diethelm, 2010; Życiński, 2015). An aspect worth investigating more extensively in this case involves the identification of the psychological determinants that make both enthusiasts of science and ones who challenge it function within the same cultural and informational context.

The reception of science communication is related not only to its objective content, but also to cognitive, emotional, motivational and even socio-cultural aspects (Flakus, 2017; Sinatra, Kienhues, & Hofer, 2014). It was on the basis of findings drawing attention to the subjective factors regulating the reception and interpretation of science communication that the concept of scientotheism was formulated, presenting the attitude towards elements of the scientific system as a disposition embedded in the individual worldview (Jach, 2015b). According to that approach, "scientotheism can be defined as a form of worldview characterised by the tendency to justify one's beliefs and behaviour with scientific findings and to function on the basis of theorems formulated by scientists, which is connected with considering the scientific language as the most perfect and most valuable method of relating to the world and to the phenomena taking place in it" Jach, 2015b, p. 154). Typical manifestations of scientotheism include equating the term "good" with the term "scientifically proven," as well as the hope that scientific progress will soon contribute to a significant improvement in the quality of life.

In order to operationalise that construct, work was undertaken to build the Views of Science Questionnaire, the results of which are presented in this paper. First of all, it presents the results of analyses aimed at distinguishing a set of statements, which was then subjected to exploratory factor analysis. Secondly, the results of confirmatory factor analyses and of analyses of the internal consistency of the tool are shown, as well as the results of a test-retest stability investigation. The subsequent part presents the relations between specific aspects of scientotheism on the one hand, and age, gender and level of education on the other hand.

COMPILATION AND PRELIMINARY SELECTION OF ITEMS FOR THE VIEWS OF SCIENCE QUESTIONNAIRE

Method, subjects and procedure

The questionnaire items were inspired by a list of ideas about science compiled on the basis of the set of religious misunderstandings mentioned by Pascal Boyer (2003; see also: Jach, 2015b). Each of them (e.g. "science provides answers to metaphysical questions," "scientific theorems are based on indis-

putable assumptions") was treated as a starting point to formulate statements that could be included in the psychological questionnaire. The use of positions taken on phenomena connected with religion as a context for the creation of items concerning attitudes towards science, scientists and scientific discoveries resulted from the functional convergence of science and religion in the contemporary world, as indicated by researchers (Pollack, 2008), and from the presentation of the phenomenon of science in the social discourse as an alternative or competition for religion by scientists themselves (Harris, 2008; Pabjan, 2016; Porco, 2008). As a result of the work, a tool consisting of 75 statements was prepared, on which the respondents could take a position by choosing one of five options arranged on the following scale: 1—definitely disagree, 2—rather disagree, 3—difficult to say, 4—rather agree, 5—definitely agree. The Views of Science Questionnaire was distributed in hard copy using the snowball method to individuals differing in terms of gender and age. The respondents were allowed to spend as long as they wished filling them in. The selection of the items for the tool was based on data from 508 individuals, including 329 women, 177 men and 2 persons who did not provide information concerning their gender. The mean age was 38.16, with a standard deviation of 14.61 years. Primary education was declared by 1.3% of the respondents, vocational education by 10.6%, secondary education by 52.2%, higher education by 35%, while 0.9% of the participants did not provide any data concerning this.

Results and discussion

The data gathered were analysed in order to identify the most valuable items for the measurement of scientotheism. In this case, two criteria were adopted to select items with a high degree of response specificity and differentiation: (a) the frequency of choosing option "3—difficult to say" should not exceed 50% of the total number of choices, and (b) the ratio of affirmative attitudes (i.e. "4" and "5") to opposing ones (i.e. "1" and "2") should not be lower than 1:2 or higher than 2:1. The above requirements were met by 22 items (29.3% of the initially prepared set), the contents of which are presented together with the number of individual positions taken in Table A included in the Appendix.

In none of the 75 original items did the majority of the respondents choose the "3—difficult to say" option. This shows that, although the respondents were given the possibility of declaring no opinion on a given aspect, the majority of them had affirmative or opposing views on the subject. While all the items within the tool met the criterion involving the small number of times when the neutral option was chosen, it turned out that the criterion involving a similar number of affirmative and opposing positions was not met in the case of most statements. From a different point of view, the data gathered made it possible to identify common beliefs concerning elements of the scientific system, which usually took either an affirmative or an opposing form. The development of the Views of Science Questionnaire thus made it possible to obtain, at the same time, a set of data indicating a certain "social climate"

concerning the aspect of science, its status and scope of application (for more details, see Jach, 2017).

IDENTIFICATION OF TOOL SCALES IN EXPLORATORY FACTOR ANALYSIS

Method, subjects and procedure

The selected list of 22 Views of Science Questionnaire statements was subjected to exploratory factor analysis (EFA), for which it was decided to use half of the data in the set related to the individuals studied in connection with the procedure described above. All the respondents were sorted by age in ascending order and then divided into two groups of 254 individuals each. The subset with the odd-numbered individuals was used at the EFA stage, while the subset with the even-numbered ones was planned to be used as one of the samples to verify the model obtained in confirmatory factor analysis (CFA). The subgroups that were distinguished did not differ in terms of age ($t(504) = -0.10$, $p = .92$), gender ($\chi^2(1) = 0.28$, $p = .60$), or education ($\chi^2(3) = 2.91$, $p = .41$).

The exploratory sample included 161 women, 91 men and 2 individuals who did not reveal information concerning their gender. The mean age was 38.10, with a standard deviation of 14.58 years (min = 18, max = 75). The results obtained in this group concerning the position taken on the 22 questionnaire items were subjected to exploratory factor analysis using Varimax normalized rotation. Previously, however, a Kaiser-Mayer-Olkin test and Bartlett's test of sphericity had been carried out to verify the validity of the said procedure.

Results and discussion

The values of the Kaiser-Mayer-Olkin test (.89) and of Bartlett's test of sphericity ($\chi^2(231) = 1696.31$, $p < .001$) made it possible to consider it justified to search for a multidimensional structure in the data set being analysed. The basis taken for identification of the number of factors was the Kaiser criterion, which recommends that factors should be taken into account whose eigenvalues are greater than 1 (see e.g. Stanisz, 2007). This criterion was met by six factors, the last of which was composed of only one item. It was therefore decided to take into account only five factors explaining a total of 54.83% of the variance, and composed of a total of 20 statements. The conditions for inclusion of a given statement in the factor were the following: (a) a factor loading exceeding .50, and (b) a high factor loading solely in relation to one of the dimensions. Information on the items connected with the dimensions is presented in Table 1.

Table 1.

Views of Science Questionnaire – the results of exploratory factor analysis

Item number and content	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
19. Doubting the objectivity of science is like doubting the existence of the world.	.758				
20. Those who doubt the premises of science are actually people who are unable to grasp them.	.683				
23. Scientific theories are based on indisputable foundations.	.605				
57. Humanity cannot know that which science is unable to discover.	.517				
30. Scientific discoveries make the old divisions among people become increasingly insignificant.		.670			
37. Scientific discoveries and knowledge contribute to the mitigation of conflicts.		.623			
50. Scientific discoveries allow us to be less worried about our future.		.635			
75. Thanks to the development of science, different worldviews will less often constitute sources of conflict.		.760			
6. Scientists can replace philosophers and priests in attempts to answer questions bothering humanity for thousands of years.			.714		
46. If truth exists, it can only be reached through scientific cognition.			.595		
47. Scientists' work is more useful than the work of priests, philosophers, and artists.			.787		
72. Even the boldest scientific concepts are more rational than philosophical or religious ideas.			.684		
9. Thanks to science, humans gained the possibility of controlling nature.				.690	
14. Even phenomena such as love, art, friendship and faith can be described and explained thanks to science				.561	
15. Thanks to the development of science, we will soon be able to modify reality according to our needs.				.560	
60. Sooner or later, scientists will be able to solve all of nature's mysteries.				.624	
18. All phenomena occurring in nature can be explained using scientific theories.					.562
32. Problems such as hunger and overpopulation could be eliminated if people listened more carefully to scientists.					.796
42. Only scientists are capable of providing reliable explanations of the phenomena occurring in nature.					.534
58. If people listened to scientists more carefully, the world would be free from many problems.					.506
Eigenvalue	6.64	1.76	1.34	1.22	1.11
Explained variation	30.18%	7.99%	6.07%	5.53%	5.06%

The dimensions that were distinguished were given names related to the contents of the items within their scope. The statements related to factor 1 were mainly related to the aspect of the foundations of science and of the scientific method as an adequate way of discovering the mechanisms of the world's functioning, and consequently this factor was described as "trust in the scientific method". Factor 2 included items presenting science as a tool used to mitigate conflicts and reduce fears, hence it was called "science as a source of hope". Factor 3, comprising statements that emphasise the superiority of scientific reflection, was called "scientists as the only experts". Factor 4 included items focusing on how science can be used to control and modify reality, hence the name "science as a tool of practical influenc." The statements included within the scope of the fifth factor were not convergent with one another and corresponded in terms of content with the other dimensions. Taking into account the low substantive value and the difficulties in interpretation of this factor, as well as the aspects related to the unsatisfactory fit of the five-factor model in confirmatory analysis and the practical utility of the dimension in the research using the tool, it was decided to exclude it from the final version of the Views of Science Questionnaire. Consequently, the final version of the tool included 16 statements linked with four factors, explaining a total of 49.77% of the variance. Information on their internal consistency and intercorrelations is provided in Table 2.

Table 2.
Internal consistency and intercorrelations of scales identified in exploratory factor analysis

Scale	(1) Trust in scientific method	(2) Science as a source of hope	(3) Scientists as the only experts	(4) Science as a tool of practical influence
		Intercorrelations (Pearson's *r*)		
(1)	1	.32***	.56***	.37***
(2)		1	.37***	.41***
(3)			1	.47***
(4)				1
		Consistency and internal validity coefficients		
Cronbach's α	.71	.71	.78	.65
Item–factor correlation (range)	.42–.57	.47–.54	.53–.69	.38–.45
Mean item–item correlation	.38	.38	.48	.31

Note. *** $p < .001$.

The positive correlations between all the results obtained in the scales of the final version of the Views of Science Questionnaire indicate that the individual aspects of the scientistic worldview tended generally to appear together, which argues in favour of taking into account not only the results of particular scales of the tool but also the overall result. However, it should be noted that the correlation coefficients recorded ranged from .32 to .56 with a mean value of .42, so the determination coefficients indicated a percentage of common variance between 10 and 31 percent. This suggests that the various aspects of scientotheism should be treated as separate constructs, connected with different areas of manifestation of the scientistic worldview. Cronbach's α for the individual factors was in the range of .65 to .78, which makes it possible to consider the internal consistency of each dimension as acceptable. The parameters relating to the overall indicator, calculated by summing up the values related to all the statements, were also satisfactory: Cronbach's α = .85; item-factor correlation between .29 and .56; mean item correlation = .26.

INVESTIGATION OF TOOL STRUCTURE IN CONFIRMATORY FACTOR ANALYSIS

Method, subjects and procedure

The model that was distinguished, taking into account four dimensions of scientotheism, was subjected to confirmatory factor analysis (CFA) in four data sets, the first of which was also used at the EFA stage. The size and demographic structure of the samples mentioned above are presented in Table 3.

Table 3.

Demographic structure of samples used in confirmatory factor analyses

Sample number	Gender			Age				Level of education				
	F	M	N.D.	Mean	*SD*	Min.	Max.	Primary	Vocational	Secondary	Higher	N.D.
1 (*n* = 254)	161	91	2	38.10	14.58	18	75	2%	10.2%	54.3%	32.3%	1.2%
2 (*n* = 254)	168	86	0	38.23	14.68	18	76	0.8%	11%	50%	37.8%	0.4%
3 (*n* = 380)	248	117	15	33.19	13.54	18	69	0.3%	5%	47.4%	43.7%	3.6%
4 (*n* = 242)	142	98	2	36.13	13.26	19	69	1.2%	6.6%	53.3%	31.8%	7.1%

Note. N.D. – no data.

The data gathered were subjected to confirmatory factor analysis using the maximum likelihood method (ML; see e.g. Konarski, 2009). Sixteen statements distinguished at the EFA stage were introduced as manifest vari-

ables, being indicators of latent variables. In the procedure, both the model containing the four equivalent dimensions of scientotheism and the model taking into account a higher-order factor, i.e. the general level of a strongly scientistic worldview, were analysed. The said models are represented visually in Figure 1. Information about the mean values and standard deviations concerning the questionnaire items, particular factors and the general results is presented in Table B of the Appendix.

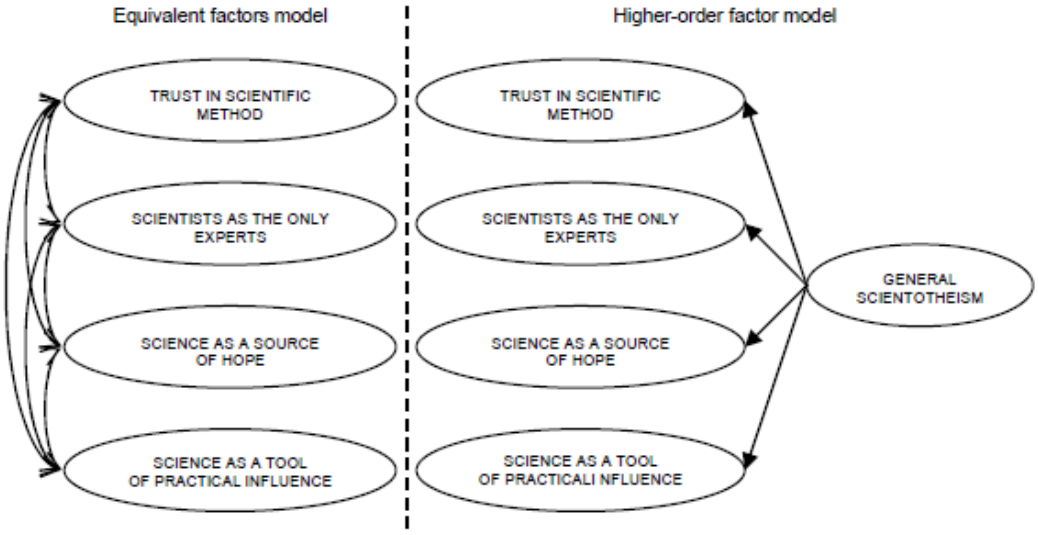

Figure 1. Models of the structure of the Views of Science Questionnaire tested in confirmatory factor analysis.

Results

The models with equivalent and higher-order factors were subjected to confirmatory factor analysis. Their fit was estimated using six indices frequently used in procedures of this type (see e.g. Hopper, Coughlan, & Mullen, 2008; Hu, & Bentler, 1999; Konarski, 2009; Lance, Butts, & Michels, 2006; Schermelleh-Engel, Moosbrugger, & Müller, 2003). The first one was the CMIN/*df* index, based on χ^2 statistics. The absolute model fit indices used were the standardised root mean square residual (SRMR) and the GFI and AGFI indices. The CFI index was used to measure the relative model fit, while the RMSEA index was used to measure the error of approximation. Information concerning model fit in the analysed data sets is presented in Table 4.

Table 4.

Model fit coefficients in confirmatory factor analysis

Sample	Model	χ^2/df	RMSEA (90% C.I.)	SRMR	GFI	AGFI	CFI
1 (n = 254)	four equivalent factors	1.616	.049 (.034–.063)	.053	.930	.902	.941
	higher-order factor	1.666	.051 (.037–.065)	.057	.926	.899	.934
2 (n = 254)	four equivalent factors	1.827	.057 (.044–.070)	.054	.923	.893	.932
	higher-order factor	1.798	.056 (.043–.069)	.054	.922	.894	.933
3 (n = 380)	four equivalent factors	2.448	.062 (.052–.072)	.053	.925	.895	.912
	higher-order factor	2.424	.061 (.052–.071)	.054	.924	.896	.912
4 (n = 242)	four equivalent factors	1.890	.061 (.047–.074)	.055	.911	.876	.918
	higher-order factor	1.880	.060 (.047–.073)	.056	.910	.878	.918

Both in the case of the four-factor model and of the hierarchical model, most of the fit indices had values that allowed the analysed tool structures to be considered adequate. Only the AGFI index for both model types was slightly below the assumed threshold. However, the deviation was small, and eventually it was considered potentially fit for use in research into the correlates and determinants of scientistic worldview aspects, in the context of the acceptable values of the other indices, the postulated necessity of relying on criteria going beyond the fit indices in model selection (Lance et al., 2006), and the fact that the tested models were embedded in the assumptions of the scientotheistic concept. Table 5 provides ß-values concerning the strength of the correlation between the individual statements and the factors. All standardised regression coefficients were above the threshold value of .40 (see e.g. Karasiewicz & Makarowski, 2012). This makes it possible to consider the use of the tested items of the Views of Science Questionnaire justified in the scales to which they were assigned at the stage of exploratory factor analysis.

Table 5.
Standardized regression coefficients in the four factors model and the hierarchical model

Item number	Factor	Sample 1 (n = 254)		Sample 2 (n = 254)		Sample 3 (n = 380)		Sample 4 (n = 242)	
		FFM	HM	FFM	HM	FFM	HM	FFM	HM
19 (1)	A Trust in scientific method	.65	.65	.71	.72	.48	.48	.56	.57
20 (4)		.71	.71	.71	.71	.62	.62	.57	.58
57 (11)		.58	.58	.42	.42	.52	.53	.62	.61
23 (15)		.52	.52	.59	.59	.63	.64	.64	.64
30 (3)	B Science as a source of hope	.56	.57	.67	.67	.44	.44	.56	.56
37 (7)		.62	.61	.62	.62	.64	.64	.56	.55
50 (10)		.63	.63	.57	.57	.73	.73	.56	.57
75 (14)		.65	.65	.66	.65	.54	.54	.67	.67
6 (2)	C Scientists as the only experts	.61	.61	.68	.68	.62	.62	.64	.64
46 (6)		.65	.65	.70	.71	.68	.67	.67	.66
47 (9)		.80	.80	.74	.74	.79	.79	.71	.71
72 (13)		.73	.73	.76	.76	.72	.72	.72	.72
9 (5)	D Science as a tool of practical influence	.44	.43	.50	.50	.48	.48	.56	.56
14 (8)		.61	.61	.48	.48	.53	.53	.57	.57
15 (12)		.58	.56	.52	.52	.54	.53	.55	.55
60 (16)		.61	.62	.69	.69	.67	.67	.76	.76
A	General factor	x	.79	x	.84	x	.89	x	.84
B		x	.61	x	.70	x	.81	x	.77
C		x	.85	x	.87	x	.82	x	.83
D		x	.77	x	.97	x	.89	x	.94

Note. FFM—four factors model; HM—hierarchical model; Each coefficient's $p < .001$.

In addition to the previous analyses, reliability parameters were calculated in the confirmatory tests as well as the intercorrelations of the Views of Science Questionnaire scales. The results obtained are presented in Table 6. The Cronbach's α values that were recorded make it possible to consider the internal consistency of the tool acceptable, particularly with regard to the "scientists as the only experts" dimension and the general level of scientotheism. The correlations between individual scales of the questionnaire in the confirmatory sample were slightly higher than in the exploratory sample, but they did not generally challenge the validity of examining the results as ones referring to different constructs. The percentage of common variance for the individual pairs of scales ranged between 18 and 36%.

Table 6.
Internal consistency and intercorrelations between VoSQ scales in confirmatory factor analysis

Scale	(1) Trust in scientific method			(2) Science as a source of hope			(3) Scientists as the only experts			(4) Science as a tool of practical influence		
Intercorrelations (Pearson's *r*)												
Sample				2	3	4	2	3	4	2	3	4
(1) Trust in scientific method	x			.44***	.47***	.42***	.59***	.55***	.54***	.54***	.48***	.53***
(2) Science as a source of hope	x			x	x	x	.47***	.46***	.45***	.48***	.49***	.55***
(3) Scientists as the only experts	x			x	x	x	x	x	x	.60***	.53***	.56***
Consistency and internal validity coefficients												
Scale	(1) Trust in scientific method			(2) Science as a source of hope			(3) Scientists as the only experts			(4) Science as a tool of practical influence		
Sample	2	3	4	2	3	4	2	3	4	2	3	4
Cronbach's α	.69	.66	.70	.72	.68	.67	.81	.79	.78	.62	.63	.70
Item–factor correlation (range)	.34–.59	.34–.50	.44–.52	.41–.57	.36–.52	.37–.53	.58–.68	.53–.68	.54–.63	.32–.48	.36–.50	.45–.57
Mean item–item correlation	.36	.33	.37	.39	.35	.34	.51	.49	.47	.51	.30	.37
Consistency and internal validity coefficients of general VoSQ score												
Sample	2			3			4					
Cronbach's α	.87			.86			.87					
Item–factor correlation (range)	.37–.63			.36–.63			.37–.65					
Mean item–item correlation	.29			.28			.30					

Note. ***$p < .001$.

Discussion

Analyses carried out in four data sets showed a satisfactory fit of two alternative Views of Science Questionnaire models: the four-factor one and the hierarchical one, taking into account a generalised scientotheism index. In each case, satisfactory values were also recorded for standardised factor loadings related to the questionnaire items. Since the models that were identified dif-

fered only to a small extent in terms of goodness of fit, it was decided, due to the more extensive interpretative possibilities of the results obtained, to use both the results concerning particular aspects of scientotheism and the overall result in further research.

Cronbach's α for the individual scales of the Views of Science Questionnaire ranged between .62 and .81, while for the overall result the index ranged between .86 and .87. This makes it possible to consider the tool presented here to be characterised by an acceptable level of internal consistency. It is worth noting that the highest values of Cronbach's α were related to the "scientists as the only experts" dimension, the second scale in terms of consistency was the "science as a source of hope" one, followed by "trust in the scientific method," while the lowest level of internal consistency characterised the "science as a tool of practical influence" scale. This suggests that the differences in reliability between the scales are relatively stable and that the most accurate measurement of scientotheistic aspects should be expected when it comes to the positions the respondents took on the role of scientists as experts and on the hope that science would eliminate universal human concerns. Greater confidence in the result concerning the generalised saturation of worldview with scientistic elements also seems justified.

TOOL STABILITY INVESTIGATION

Method, subjects and procedure

In order to determine the stability of the Views of Science Questionnaire, data were used gathered in the group of first-year full-time students of psychology at the University of Silesia in Katowice. The first measurement was performed in a group of 146 people, while the second measurement, which took place two weeks later, in a group of 106 people. The measurement performed twice, whose results were used in further analysis, covered 100 individuals (81 women, 15 men and 4 persons who did not provide information concerning their gender). The mean age in the studied sample was 19.48, and the standard deviation was 1.53 years. An anonymous coding procedure was applied to make it possible to connect the results of the two measurements. Each survey respondent stated their exact date of birth and the first three letters of their mother's maiden name. A set of unique codes was obtained as a result of that, each composed of four digits and three letters.

Results and discussion

The mean values and the standard deviations of the results obtained in individual items of the Views of Science Questionnaire at the test and retest stages are presented in Table D included in the Appendix. Table 7, on the other hand, provides information concerning the descriptive statistics related to the dimensions of scientotheism in both measurements, as well as the test-retest correlation coefficients of the individual scales.

Table 7.
Descriptive statistics and test-retest reliability coefficients of the Views of Science Questionnaire

Measur-ement	Statistic	Trust in scientific metod	Science as a source of hope	Scientists as the only experts	Science as a tool of practical influence	General score
Test	Mean	10.91	10.96	10.19	10.86	42.92
	Standard deviation	2.93	2.70	3.50	3.06	8.68
	Skewness	0.07	-0.10	0.12	0.06	-0.07
	Kurtosis	-0.14	-0.80	-0.78	-0.42	-0.72
	Minimum	4	5	4	4	25
	Maximum	19	17	18	18	61
Retest	Mean	10.68	10.86	9.99	9.75	41.28
	Standard deviation	3.22	2.86	3.35	2.98	8.72
	Skewness	0.01	-0.28	0.21	0.06	-0.14
	Kurtosis	-0.74	-0.15	-0.48	-0.56	0.27
	Minimum	4	4	4	4	17
	Maximum	17	17	18	17	64
Test-retest correlation coefficient		.75***	.66***	.75***	.58***	.78***

Note. *** $p < .001$.

A high level of convergence of the results obtained in the scales of the tool analysed here was identified in the test-retest procedure. Both with regard to the four dimensions of scientotheism and to the overall result, correlation coefficients were recorded whose values can be interpreted (Stanisz, 2006) as high (in the case of the "science as a source of hope" and the "science as a tool of practical influence" scales) or very high (in the case of the overall result and the "trust in the scientific method" and "scientists as the only experts" scales). These values of correlation coefficients of the results of the survey performed twice using the Views of Science Questionnaire make it possible to consider it as a tool characterised by a high level of measurement stability. Thus, it seems accurate to perceive scientotheism as a fundamentally lasting world-view disposition.

ASPECTS OF SCIENTOTHEISM AND DEMOGRAPHIC VARIABLES

Method, subjects and procedure

In order to identify the relations between scientotheism, gender, age and level of education, the results gathered at earlier stages of construction of the tool were used. The relevant variables were analysed in the four groups presented

earlier in Table 3. Due to the small number of study subjects declaring primary and vocational education, it was decided to combine them into a single group of respondents with below-secondary education.

RESULTS

Scientotheism and gender

The results of tests with regard to gender in sample 1 did not reveal any differences between women and men in terms of saturation of the worldview with scientistic aspects ($t(250)$ between -0.07 and -1.11; p between 0.27 and 0.94). A similar situation was observed for the results obtained in sample 3 ($t(363)$ between 0.68 and 1.69; p between .08 and .50) and sample 4 ($t(238)$ between -0.37 and -1.61; p between .11 and .71). Only in sample 2 with respect to the scale "science as a source of hope" scale ($t(252) = -2.33$, $p = .02$) were the male respondents characterised by higher results ($M = 12.31$, $SD = 3.05$) than the female respondents ($M = 11.36$, $SD = 3.09$), with no other differences (the remaining $t(252)$ between -0.36 and -1.82; p between .07 and .72). The results obtained make it possible to consider the scientistic worldview as a variable that does not essentially show any gender-based differences.

Scientotheism and age

The analysis of the correlations between the components of scientotheism and the age of the respondents in the individual samples was performed using the r Pearson correlation coefficient. The values obtained are shown in Table 8.

Table 8.

Correlations between aspects of scientotheism and participant age

Views of Science Questionnaire scale	Sample 1	Sample 2	Sample 3	Sample 4
Trust in scientific metod	.15*	.13*	.28***	.25***
Science as a source of hope	.03	.05	.15**	.14*
Scientists as the only experts	-.05	.03	.12*	.12
Science as a tool of practical influence	-.07	.07	.06	.18**
General score	.02	.08	.19***	.21**

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

Only the results of the "trust in the scientific method" scale correlated positively in a consistent manner with age in all the groups studied, which suggests that older respondents were more inclined to agree with the understanding of science as activity based on reliable and fully objective foundations. In the case of the remaining scales and of the overall result, relations

with age were observed only in some samples. It should be noted, however, that all the correlations being revealed had a positive direction. This argues in favour of considering scientotheism as a variable related to a certain extent with age and potentially taking higher values in the case of older individuals.

Scientotheism and education

One-factor variance analyses were performed to identify differences in groups with a different level of education, the qualitative predictor being the completion of below-secondary, secondary, or higher education. If a result was obtained in the F test suggesting the presence of such differences, a post-hoc Tukey test was performed for the unequal sizes in the subgroups. The results obtained are shown in Table 9.

Table 9.

Scientotheism and the participants' level of education

VOsQ scale	Sample	*F*(*df*)	η^2_p	Level of education		
				Primary and vocational	Secondary	Higher
Trust in scientific method	(1)	0.87 (2, 248)				
	(2)	3.40* (2, 250)	.03	12.10	12.62a	11.48a
	(3)	4.14* (2, 363)	.02	13.05	12.38b	11.48b
	(4)	0.73 (2, 222)				
Science as a source of hope	(1)	2.34 (2, 248)				
	(2)	6.49** (2, 250)	.05	12.23	12.21c	10.79c
	(3)	1.90 (2, 363)				
	(4)	1.77 (2, 222)				
Scientists as the only experts	(1)	2.50 (2, 248)				
	(2)	3.58* (2, 250)	.03	12.67	12.54d	11.25d
	(3)	3.50* (2, 363)	.02	12.15	11.85e	10.74e
	(4)	0.44 (2, 222)				
Science as a tool of practical influence	(1)	2.17 (2, 248)				
	(2)	2.09 (2, 250)				
	(3)	1.84 (2, 363)				
	(4)	0.31 (2, 222)				
General score	(1)	1.17 (2, 248)				
	(2)	5.71** (2, 250)	.04	49.03	49.52f	44.81f
	(3)	4.36* (2, 363)	.02	49.00	47.11g	43.94g
	(4)	0.95 (2, 222)				

Note. * $p < .05$; ** $p < .01$. Means with same letters were significantly different in the post-hoc procedure.

The analyses in sample 1 did not demonstrate any differences in terms of saturation of worldview with scientistic aspects. A similar situation was observed with regard to the results obtained in sample 4. In sample 3, differ-

ences were revealed only in terms of the results of the "trust in the scientific method" and the "scientists as the only experts" scales, and the overall result. In the case of the results gathered in sample 2, differences were not revealed only with regard to the "science as a tool of practical influence" dimension. They did appear, however, in the case of the three remaining subscales and the overall result.[1]

The relations between the level of education and scientotheism were found only in a part of the groups and their nature was selective. It should be pointed out, however, that when these were noted, individuals with higher education were characterised by a weaker saturation of worldview with scientistic elements than individuals with secondary education. The average value of indicators of scientotheism among respondents with below-secondary education was similar to that recorded among respondents with secondary education, but probably due to the small size of that group (see Table 4), no differences between them and respondents with higher education exceeded the materiality threshold.

Discussion

In most cases, the analyses did not reveal any gender-based differences with regard to the aspects of scientotheism, which indicates that the scientistic worldview reaches similar levels of distinctiveness in the case of men and women. This result is in line with the theoretical assumptions underlying the concept, namely that the scientific context today manifests itself equally strongly in communication addressed to men and to women, e.g. in relation to goods and services developed for them (Jach, 2015a).

The level of trust in the scientific method correlated positively with age in a consistent manner in each of the groups. These results may seem surprising from the point of view of the diagnoses which speak of detachment of the experience and vision of the world of young people from those of the older generations, and which associate youth with technology and scienticised visions of the world, and old age with tradition and values related to it. However, the result that was recorded may be attributed to the contemporary tendency of young people to treat life as an individual project, for which it is impossible to indicate the criteria of absolute rightness or wrongness of choices (Giddens,

[1] In the context of the analyses carried out, there was a likelihood that relations between the scientistic worldview aspects and education derived, in fact, from the age of the respondents. In order to check this, it was decided to compare the age of individuals within the groups between which the differences had been recorded with regard to the elements of scientotheism. Although in both cases, the results of F tests indicated the presence of intergroup differentiation (in sample 2: $F(2, 259) = 4.34$, $p = .01$; in sample 3: $F(2, 361) = 13.05$, $p < .001$), no differences between the participants with secondary and higher education were revealed in the post-hoc Tukey tests either in sample 2 ($p = .13$) or in sample 3 ($p = .63$). This indicates that the differences observed in the levels of saturation of the worldview with scientistic aspects in individuals with different levels of education were probably not based on age-related determinants.

2006; Jacyno, 2007). The reduced trust in the scientific method among the younger respondents may therefore be a sign of a more general tendency to be sceptical about various systems that offer an interpretation of reality. When it comes to the results related to other aspects of the scientistic worldview and the overall result, correlations with age were recorded only in some cases, but they were each time positive and relatively weak. These results do not allow one to make an unambiguous judgment concerning the relationship between scientotheism and age, and suggest that the relationships between the relevant variables should be monitored further. It should be assumed, however, that although the scientistic worldview may be more characteristic of older people than of younger people, this tendency is of marginal importance from the point of view of the other contexts in which the positions taken on elements of the scientific system are developed (especially in the case when age is considered as a variable with a non-specific, aggregate status; see Spendel, 2011).

The comparison made in the groups distinguished in terms of education in two of the four samples did not show differences in any of the aspects of scientotheism, while in the other two, differences appeared only in relation to some dimensions. This indicates that the basis for the development of enthusiastic attitudes towards the elements of the scientific system does not have to be provided by the individual level of knowledge understood in school-related or academic terms. The result obtained supports the assumptions according to which scientotheism is in fact not a scientific worldview, but a scienticised one, whose connections with scientific theories, procedures, results and nomenclature can only be superficial (Jach, 2015b).

In the case of the differences recorded in relation to education, higher results characterised individuals with secondary education, and not those who completed academic education. In general, this would indicate that people who have actual contact in their lives with research bodies and institutions engaging in scientific reflection have a less scientistic worldview than individuals without these experiences. People who perceive science mainly on the basis of popular presentations of its results may be characterised by a tendency to idealise elements of the scientific system to a greater extent than individuals who are to some extent familiar with the methodological assumptions, the degree of complexity of problems, and the various positions emerging within the framework of individual disciplines. A different interpretation refers to the results of studies by Kruger and Dunning (Kruger & Dunning, 1999; Dunning, 2011). These researchers showed, in a series of studies, that individuals with a low level of knowledge or skill in the given field tended to overestimate their proficiency compared to others, while those with the highest competencies tended to rate them as weaker than they actually were. However, a boundary condition for this effect to manifest itself was the possession of the minimum amount of knowledge or skill on the basis of which the overestimated self-esteem could develop. In today's world, popularised information with scientific connotations accompanies humans virtually at every step of the way (see e.g. Biniewicz, 2016; Hanlon, 2011; Piasecka-

Strzelec, 2016), so beliefs about science are likely to constitute a field where relationships may be revealed in line with the Dunning-Kruger effect. Better-educated people, who are better informed with regard to the practice of scientific research and the status of scientific theories, may have been less inclined to choose the more extreme options when it came to taking positions on the individual Views of Science Questionnaire items.

When interpreting the above differences related to demographic variables, one should bear in mind that, from the psychological point of view, each of them has the status of a non-specific aggregate variable, which does not reveal the actual mechanisms underlying the specific phenomenon (Spendel, 2007, 2011). The aim of presenting the results concerning the relations between these variables is therefore to indicate the directions for further research into the determinants and correlates of scientotheism, rather than to put forward diagnoses with a high degree of generality and applications. The gender-based differences found with regard to treating science as a source of hope lead to the question whether individuals motivated to seek conflictual or conciliatory solutions to specific problems representing humanity's perennial concerns (such as hunger or armed conflict) differ in terms of the degree of recognition of solutions inspired by scientific discoveries and theories. The positive correlation between age and the level of trust in the scientific method leads to questions whether one can speak of a pluralistic reception of information from the field of science apart from the contemporary manifestations of worldview pluralism. The relations between scientotheism and education lead, in turn, to the question whether the relationship between knowledge about what science is and the enthusiastic position taken on its elements is in fact a negative correlation.

CONCLUSION

The paper presents the individual stages of procedures aimed at building a tool embedded in the context of the concept of scientotheism, used to measure the ways in which positions are taken on elements of the scientific system. The final version of the Views of Science Questionnaire consisted of 16 items grouped in four scales, which also made it possible to calculate the overall result. Investigations of internal consistency and stability of the tool showed that it demonstrated satisfactory reliability indices. Analyses of the correlations between the results obtained in the questionnaire scales and demographic variables made it possible to determine that aspects of scientotheism do not tend to be gender-related, that they may correlate positively to a slight extent with age, and that they tend to be more distinctive among less educated individuals. Operationalisation of the scientistic worldview makes it possible to develop research into the determinants and correlates of contemporary ways of perceiving the status of science, its tasks and limitations. Promising directions for future investigations include the connections between scientotheism and cognitive, personality-related and motivational variables,

as well as aspects related to the presence of scientific contexts in the fields of health, ethics, and marketing.

It is also important to point out the limitations related to the use of the tool presented here. Firstly, the starting point for the construction of its items was a list of misunderstandings about science based on similar misunderstandings about religion, presented by Boyer (2003). This means that although the questionnaire examines many aspects of the scientistic worldview, it may have failed to take into account the ones that were not addressed in the underlying theoretical perspective. Secondly, although efforts were made to ensure that the individuals taking positions on the individual statements of the questionnaire differed in terms of gender, education and age, the results used to identify the tool scales had been derived from snowball sampling. Therefore, it may prove valuable from the point of view of the tool's utility value to check its psychometric properties and the relations between scientism and demographic variables on a representative sample. Thirdly and finally, both in the scientotheistic concept and in the tool used to study its aspects, the scientistic worldview is analysed in isolation from the actual knowledge of the studied subjects. This approach seems justified in the context of contemporary ways of presenting science in a popularised manner, whose aim is more to evoke specific emotions, focus the attention of the target audience and skilfully guide their beliefs rather than transmit actual, substantive knowledge (Szpunar, 2015). However, individual levels of knowledge are likely to be a factor influencing the manner in which one understands "science." Consequently, the positions taken on the questionnaire items will differ not so much as a result of different beliefs about the importance of elements of the scientific system in today's world, but as a result of the different ways of conceptualising the matter. This aspect deserves more attention in future research using the tool presented here.

There might also be some doubts in relation to the fact that the final version of the tool contained only four factors, while one more dimension had been revealed at the stage of exploratory factor analysis. However, the items included in the fifth factor not only failed to converge with one another in terms of the contents, but actually corresponded with the other factors in that respect. For example, item 42: "Only scientists are capable of providing reliable explanations of the phenomena occurring in nature" was similar to the aspects addressed within the "scientists as the only experts" scale, while item 18: "All phenomena occurring in nature can be explained using scientific theories" was expressed in a way that made it similar to the statements included in the "science as a tool of practical influence" scale. Even though, given the wide range of aspects covered by the fifth factor items, it could have been a general indicator of the belief about the civilisational mission of science, it should be noted that the dimensions of "science as a source of hope," "scientists as the only experts" and "science as a tool of practical influence" referred to this mission more specifically. Therefore, it does not seem that an additional factor would have effectively extended the scope of information obtained from the questionnaire on the scientistic worldview. The exclusion of

the fifth factor was also supported by the weaker fit of the five-factor models in confirmatory factor analysis carried out on three samples with an extended version of the tool (see Table C in the Appendix). However, it is worth taking into account the "fifth element" trail within the framework of the scientistic worldview during potential work on an extended version of the tool for a more comprehensive study of scientotheism.

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Appendix

Table A.
Candidate items selected for further evaluation during the development of the Views of Science Questionnaire

No.	Item contents	Number of times the answer was chosen				
		1	2	3	4	5
6	Scientists can replace philosophers and priests in attempts to answer questions bothering humanity for thousands of years.	94	117	127	112	58
9	Thanks to science, humans gained the possibility of controlling nature.	83	92	87	172	74
14	Even phenomena such as love, art, friendship and faith can be described and explained thanks to science.	95	134	121	116	42
15	Thanks to the development of science, we will soon be able to modify reality according to our needs.	38	99	162	172	37
18	All phenomena occurring in nature can be explained using scientific theories.	64	126	114	159	45
19	Doubting the objectivity of science is like doubting the existence of the world.	47	97	151	157	62
20	Those who doubt the premises of science are actually people who are unable to grasp them.	46	111	138	148	65
23	Scientific theories are based on indisputable foundations.	59	131	164	134	20
30	Scientific discoveries make the old divisions among people become increasingly insignificant.	42	149	158	134	24
32	Problems such as hunger and overpopulation could be eliminated if people listened more carefully to scientists.	72	93	144	159	39
37	Scientific discoveries and knowledge contribute to the mitigation of conflicts.	45	125	178	125	35
42	Only scientists are capable of providing reliable explanations of the phenomena occurring in nature.	40	99	138	163	68
46	If truth exists, it can only be reached through scientific cognition.	53	113	165	132	45
47	Scientists work is more useful than the work of priests, philosophers, and artists.	83	106	139	106	74
50	Scientific discoveries allow us to be less worried about our future.	66	135	164	122	21
55	Scientists are one of the few groups who can actually be fully trusted.	69	129	205	91	14
57	Humanity cannot know that which science is unable to discover.	55	131	153	117	52
58	If people listened to scientists more carefully, the world would be free from many problems.	43	103	199	130	33
60	Sooner or later, scientists will be able to solve all of nature's mysteries.	83	135	173	86	31
65	Thanks to the development of science, we will know the answer in the future to every question bothering us.	118	199	100	22	69
72	Even the boldest scientific concepts are more rational than philosophical or religious ideas.	45	82	195	136	50
75	Thanks to the development of science, different worldviews will less often constitute sources of conflict.	53	142	194	98	21

Table B.

Means and standard deviations of the Views of Science Questionnaire items in confirmatory samples

Item (in brackets, number of the item in the final version of the questionnaire)	Sample 1		Sample 2		Sample 3		Sample 4	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
19 (1)	3.20	1.14	3.20	1.11	3.29	1.22	3.24	1.24
20 (4)	3.18	1.11	3.11	1.23	3.21	1.22	3.19	1.29
57 (11)	2.90	1.19	3.02	1.11	3.65	1.26	2.76	1.27
23 (15)	2.91	1.03	2.80	1.08	2.86	1.14	2.90	1.25
30 (3)	2.85	1.00	2.95	1.07	3.08	1.15	3.02	1.14
37 (7)	2.86	1.04	3.06	1.07	2.71	1.15	2.98	1.16
50 (10)	2.76	1.12	2.83	1.02	2.76	1.23	2.71	1.25
75 (14)	2.74	0.96	2.84	1.05	2.55	1.06	2.53	1.07
6 (2)	2.80	1.23	2.90	1.32	2.98	1.32	2.91	1.37
46 (6)	2.98	1.11	3.03	1.13	2.76	1.27	2.89	1.25
47 (9)	2.94	1.28	2.99	1.30	2.78	1.39	2.85	1.28
72 (13)	3.09	1.08	3.16	1.07	2.86	1.29	2.79	1.23
9 (5)	3.14	1.33	3.11	1.32	3.03	1.33	2.86	1.34
14 (8)	2.68	1.26	2.83	1.20	2.50	1.27	2.69	1.31
15 (12)	3.11	1.06	3.17	1.04	3.12	1.09	2.97	1.10
60 (16)	2.70	1.15	2.70	1.08	2.76	1.22	2.62	1.23
Factor 1	12.19	3.27	12.13	3.27	12.00	3.39	12.09	3.66
Factor 2	11.20	3.01	11.70	3.10	11.11	3.29	11.47	3.97
Factor 3	11.81	3.67	12.07	3.84	11.39	4.14	11.24	3.27
Factor 4	11.63	3.34	11.81	3.18	11.40	3.39	11.15	3.63
General score	46.84	9.98	47.70	10.74	45.90	11.23	45.93	11.57

Table C.

Fit coefficients of the five factor model abandoned in confirmatory factor analysis

Sample	Model	χ^2/df	RMSEA (90% C.I.)	SRMR	GFI	AGFI	CFI
1 (n = 254)	five equivalent factors	1.687	.052 (.041–.063)	.056	.905	.876	.919
	higher-order factor	1.717	.053 (.042–.063)	.059	.901	.874	.912
2 (n = 254)	five equivalent factors	2.181	.068 (.0.59–.078)	.058	.880	.843	.890
	higher-order factor	2.121	.067 (.057–.076)	.058	.880	.847	.893
3 (n = 380)	five equivalent factors	2.937	.071 (.064–.079)	.057	.890	.856	.863
	higher-order factor	3.023	.073 (.066–.080)	.060	.886	.854	.852

Tabela D.

Descriptive statistics of the Views of Science Questionnaire items obtained in the test–retest reliability procedure

Item	Test		Retest	
	Mean	*SD*	Mean	*SD*
1	3.08	1.04	3.13	1.04
2	2.61	1.20	2.61	1.17
3	3.00	1.07	2.95	1.07
4	2.79	1.18	2.61	1.05
5	2.76	1.30	2.40	1.18
6	2.58	1.16	2.41	1.05
7	2.90	1.09	2.76	0.97
8	2.70	1.35	2.47	1.21
9	2.45	1.31	2.46	1.18
10	2.63	1.16	2.64	1.01
11	2.35	1.08	2.31	1.12
12	3.09	1.03	2.88	1.02
13	2.55	1.08	2.51	1.13
14	2.43	1.05	2.51	1.04
15	2.69	1.07	2.63	1.16
16	2.31	1.08	2.00	0.97