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Associations between value priorities and attitudes toward science

Abstract: *The paper investigates the relations between Schwartz's values and beliefs which may reflect skepticism toward science – specifically vaccine rejection, climate change denial and creationism. Recent research on the causes of anti-science indicates that they may be motivational, pertaining to ideologies, worldviews, and one's moral codes. Therefore, we postulated that value priority hierarchies hierarchies may be predictors of anti-science. Results (N = 509) indicated that Conservation metatype values were positively associated with anti-science, while Self-Transcendence and Openness to change metatypes were connected with support for science. We also found significant differences in value profiles between participants with lower vs. higher anti-scientific beliefs. We discuss the possible motivational underpinnings of these results*

Keywords: *climate change, values, anti-science, vaccine rejection, creationism*

1. INTRODUCTION

Anti-science is a conscious rejection of well-established scientific knowledge, assuming a priori the falsity of such knowledge. This rejection, also known as skepticism toward science and anti-scientific beliefs, has no basis or scientific evidence supporting it (Diethelm & McKee, 2009; Lewandowsky, Oberauer, & Gignac, 2013). Anti-scientific attitudes include skepticism manifested by disbelief in general science, undermining its specific discoveries (e.g. vaccine skepticism, denial of climate change, intuitive opposition to GMOs), as well as the so-called pseudoscience – supporting theories which are contradictory to modern scientific knowledge or not confirmed by scientific research (e.g. the flat Earth model, creationism, homeopathy).

It has traditionally been accepted that the evaluation of science, scientific knowledge and scientists may be shaped by cognitive variables, i.e. associated with barriers to human cognition that hinder its understanding. Discoveries and theories of empirical sciences are often contradictory to our intuitive understanding of the world, and assimilating them requires some educational training (McCauley, 2011).

However, research shows that the level of education and knowledge of science makes it possible to predict attitudes toward science only to a small extent (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008; Lewandowsky & Oberauer, 2016). It turns out that people question scientific discoveries not only because they cannot understand them. Therefore, in recent years, attempts have been made to move beyond cognitive constraints when explaining science rejection. Recent studies show that it is related mainly to: a) ideology and worldviews (religious identity, political orientation, conspiratorial beliefs), b) motivation (the existential-motivational underpinnings and functions of belief in science) and c) morality (moral concerns about what scientists do and their discoveries; see: e.g. Hornsey & Fielding, 2017; Rutjens, Heine, Sutton, & van Harreveld, 2018).

The aim of our research was to broaden the knowledge about motivational factors of attitudes toward science. Namely, we investigated whether one's system of individual values (presented by S. H. Schwartz, 2006, as a motivational and cognitive construct) can be a predictor of science skepticism. To the best of our knowledge, values as variables have not been included in existing research in this topic. We focused on three most often investigated beliefs which reflect science skepticism: rejection of vaccination, climate change denial and creationism (it should be added that modern research has shown that vaccine skepticism does not necessarily equal science skepticism; Rutjens & van der Lee, 2020).

Various psychological and ideological causes of attitudes toward vaccination, climate change and theory of evolution have been discovered. Anti-vaccine attitudes are associated with religious orthodoxy, moral purity

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concerns (Rutjens Sutton, & van der Lee, 2018), conspiratorial thinking, high levels of disgust toward blood and needles, and individualistic/hierarchical worldviews (Hornsey, Harris, & Fielding, 2018). Political conservatism is a main predictor of climate change denial (Lewandowsky et al., 2013, 2013; Lewandowsky & Oberauer, 2016; see also: Rutjens et al., 2018). Climate change skepticism is also predicted by the endorsement of free-market ideology (Lewandowsky et al., 2013), conspiracist ideation theory (Douglas & Sutton, 2015) and belief in a just world (Feinberg & Willer, 2001). Religious orthodoxy is also a main predictor of creationism (Rutjens, van der Pligt, & van Harreveld, 2010).

Our research concerns attitudes toward these phenomena in the context of values system and preferences. Below, we briefly address the values theory and present our predictions.

Schwartz's values theory

Schwartz (2012) understands values as cognitive representations (beliefs) of desired trans-situational goals. Individuals' values form an ordered system of value priorities which differ in importance and serve as standards or criteria, guiding attitudes, beliefs, and behavior. In his original theory, Schwartz identifies ten basic personal values: (1) Conformity (obedience, compliance with social norms, self-discipline, respect for the elderly), (2) Tradition (acceptance and respect for customs and ideas of one's own culture or religion, modesty, humility, piety, zeal), (3) Benevolence (care for the good of your loved ones, friendship and love, helping, memory, loyalty, responsibility), (4) Universalism (care for the good of all people, tolerance, care for the environment, unity with nature, justice, equality, wisdom, peace), (5) Self-direction (independence in thinking and choosing the action, creativity, freedom, autonomy in choosing own goals), (6) Hedonism (seeking pleasure, sensual gratification, indulging yourself), (7) Achievement (personal success achieved by demonstrating competence in accordance with social standards), (8) Power (social status and prestige, control and dominance over other people and resources), (9) Security (social order, personal, family and national security), and (10) Stimulation (seeking new things [quest for novelty/for newness], striving for an exciting and varied life). For a detailed description see Schwartz (2012). In the last decade, Schwartz and his team introduced additional values by dividing some of these values into subtypes. However, this does not mean that it is necessary to introduce them for analysis. As it was highlighted by Schwartz, the basic values should be perceived as a continuum of motivations, rather than discrete constructs. The partition of this continuum into separate values of groups of values, is arbitrary and depends largely on the researcher (Schwartz et al., 2012). Therefore, we decided to conduct our research based on the original ten values.

As Sagiv and Schwartz (2000, p. 178) note, "*The crucial content aspect that distinguishes among values is the type of motivational goal they express*". Their main idea assumes a circular motivational structure of values. This theory of values explicates a dynamic relationship of conflict and congruity among them. The closer any two values are to each other in either direction around the circle, the more similar their underlying motivations are to each other. The more distant any two values are, the more antagonistic are their underlying motivations. Additionally, values close to each other within the circle can be clustered into four meta-types of values: (1) Openness to change (Self-Direction, Stimulation, Hedonism) which is motivationally opposed to (2) Conservation (Conformity, Tradition, Security) and (3) Self-enhancement (Achievement, Power, Hedonism) which is opposed to (4) Self-Transcendence (Benevolence, Universalism). As can be seen, values are understood here as cognitive-motivational constructs: their main and distinguishing features are that they are beliefs linked inextricably to affect and they refer to goals that are desired and that motivate action (Schwartz, 2012).

Outline of the present study

As mentioned above, the current study investigates the relation between Schwartz's values and anti-scientific beliefs regarding vaccines, climate change and creationism. Although our research is of exploratory nature, we made some predictions based on the content specificity of values. We also base our predictions on the results of various studies linking some predictors of anti-science with Schwartz's values. We assumed that acceptance and respect for the customs and beliefs of one's own culture or religion (Tradition) and adjustment to the assessments and norms of the social environment (Conformity) can lead to skeptical attitudes toward scientific discoveries, especially those which contradict the traditional or intuitive understanding of the world. Furthermore, Tradition and Conformity positively correlate with such predictors of anti-science as religiousness (Huismans, 1994), right-wing authoritarianism (Feldman, 2008), and conspiratorial thinking (Raab, Kammerl, & Carbon, 2016). In contrast, we expected that creativity, freedom, independence in thinking (Self-Direction) as well as concern for the environment, unity with nature and wisdom (Universalism) may facilitate acceptance for science. These predictions are reinforced by research which indicates that these values correlate with such predictors of belief in science as liberalism and left-wing orientation. The preference for political liberalism correlates most positively with Universalism and Self-Direction, and negatively with Tradition (Schwartz, 1996). Left-wing voters prefer Universalism, Benevolence and Self-Direction (Caprara, Vecchione, & Schwartz (2009, 2010). In particular, Universalism has a higher priority for people with a left-wing political orientation than for those with a right-wing orientation (Caprara et al., 2009; Devos, Spini, & Schwartz, 2002; Linderman & Verkasalo, 2005). Based on the above assumption, we predicted that for orthogonal meta-types of values, anti-scientific beliefs may correlate positively with Conservation and negatively with Openness to Change and Self-Transcendence.

Since we did not want education or intelligence to be a confounding variable (as mentioned above, there exists a lot of evidence that cognitive and educational issues are associated with anti-scientific beliefs), we decided to conduct the research on university students, who have a more homogeneous educational background and are expected to represent a higher-than-average level of intelligence.

2. METHOD

Our study was conducted using the Ariadna Nationwide Research Panel – a company specialized in polling of large representative samples for the purpose of research. Participants were 509 students (297 female, 212 male) aged 18-55 years (M = 22.76, SD = 3.93). Students were randomly recruited form various faculties. Fifty-four were studying humanities, 108 were students of exact sciences, 106 of medical/biological sciences and 231 of social sciences.

We used two groups of measures. The first one was the Portrait Values Questionnaire (PVQ). This 40-item inventory (Schwartz, 2005) identifies the aforementioned 10 basic values, defined in terms of their central goal. The items are rated on a scale from 1 (*very much like me*) to 6 (*not like me at all)*. The PVQ has an established validity in a Polish sample (Cieciuch & Schwartz, 2012) with Cronbach's alphas ranging from α = .62 for Conformity and Self-direction to α = .80 for Hedonism. The second measure (Total Anti-science) consisted of three items with answers on a scale from 0 (I don't agree at all) to 10 (I completely agree) that reflected science skepticism: attitudes on vaccination rejection, climate change denial, and creationism: "The risk of negative consequences for children due to vaccination is greater than the benefits for their health". "I believe that the climate is always changing, and what we are seeing now is only natural fluctuations" and "Man was created by God in a form like the present one about 8 thousand years ago", respectively.

3. RESULTS

Preliminary analyses indicated that histograms for all three anti-scientific opinions were positively skewed – a predictable result since a lot of participants did not demonstrate such anti-scientific beliefs (the number of participants who strongly disagreed with these beliefs was N = 236 for Vaccine Rejection, N = 111 for Climate Change Denial, and N = 164 for Creationism, out of a N = 509 sample). The beliefs of the remaining participants were more or less evenly distributed. Therefore, the Total Anti-science measure was also positively skewed (skewness = .297, SE = .108). No data exclusions were made. Raw data is available from the corresponding author upon reasonable request.

The first analysis concerned correlations between anti-science and the four orthogonal metatypes of Schwartz's values: (1) Openness to change (Self-Direction, Stimulation, Hedonism), (2) Conservation (Conformity, Tradition, Security), (3) Self-Enhancement (Achievement, Power, Hedonism) and (4) Self-Transcendence (Benevolence, Universalism). Kendall's tau-b correlations were used due to a lack of normal distribution. It turned out that the total antiscientific beliefs positively correlated with Conservation (τ = .182, p < .001) and negatively with Self-Transcendence (τ = -.224, p < .001) and Openness to change (τ = -.074, p = .015), but did not significantly correlate with Self-Enhancement. More specifically, Vaccine Rejection negatively correlated with Openness to Change (τ = -.130, p < .001) and Self-Transcendence (τ = -.274, p < .001), but not Conservation or Self-Enhancement. Climate change denial positively correlated with Conservation (τ = .171, p < .001) and negatively with Self-Transcendence (τ = -.154, p < .001), but not Openness to change or Self-Enhancement. Creationism positively correlated with Conservation (τ = .187, p < .001) and negatively with Self-Transcendence (τ = -.142, p < .001) and Openness to change (τ = -.069, p = .03), but did not correlate with Self-Enhancement. Results are presented in Table 1.

Table 1. Correlations between Schwartz's metatypes and anti-scientific beliefs.

		Vaccine Rejection	Climate Change Denial	Creationism	Total Antiscience
Openness to change	τ	**-.130**	.002	**-.069**	**-.074**
	p	<.001	.957	.030	.015
Conservation	τ	.084	**.171**	**.187**	**.182**
	p	.010	<.001	<.001	<.001
Self-Enhancement	τ	-.020	.057	-.013	.009
	p	.534	.071	.682	.770
Self-Transcendence	τ	**-.274**	**-.154**	**-.142**	**-.224**
	p	<.001	<.001	<.001	<.001

We then investigated the correlations between Schwartz's values and anti-science, as well as individual anti-scientific beliefs. Kendall's tau-b correlations were used due to a lack of normal distribution.

The Total anti-scientific beliefs positively correlated with Conformity (τ = .150, p < .001), Tradition (τ = .291, p < .001) and Power (τ = .114, p < .001), and negatively correlated with Benevolence (τ = -.139, p < .001), Self-Direction (τ = -.195, p < .001), Achievement (τ = -.091, p = .004) and Universalism (τ = -.281, p < .001). Again, no significant correlations were present with Stimulation, Hedonism and Security.

More specifically, Vaccine Rejection positively correlated with Tradition (τ = .216, p < .001) and Power (τ = .127, p < .001), and negatively correlated with Benevolence (τ = -.234, p < .001), Self-Direction (τ = -.241, p < .001), Achievement (τ = -.131, p < .001), Security (τ = -.074, p = .027) and Universalism (τ = -.283, p < .001). It did not significantly correlate with Conformity, Stimulation or Hedonism.

Climate Change Denial positively correlated with Conformity (τ = .132, p < .001), Tradition (τ = .223, p < .001), Security (τ = .068, p = .035) and Power (τ = .122, p < .001), and negatively with Self-Direction (τ = -.082, p < .001) and Universalism (τ = -.240, p < .001). It did not significantly correlate with Benevolence, Stimulation, Hedonism or Achievement.

Creationism positively correlated with Conformity (τ = .170, p < .001) and Tradition (τ = .278, p < .001), negatively correlated with Benevolence (τ = -.089, p = .007), Self-Direction (τ = -.187, p < .001), Achievement (τ = -.082, p = .013) and Universalism (τ = -.174, p < .001), and did not correlate with Stimulation, Hedonism, Security or Power.

Additionally, the three anti-scientific beliefs were significantly correlated with each other: Vaccine Rejection correlated with Climate Change Denial at τ = .342, p < .001 and with Creationism at τ = .355, p < .001, and so did Climate Change Denial with Creationism at τ = .290, p < .001, indicating that various anti-scientific beliefs may have similar individual underpinnings. Results are presented in Table 2.

We also wanted to investigate the possible differences between value profiles of participants who exhibited lower vs. higher antiscientific beliefs. Therefore we dichotomized the Total Anti-science variable at the median (Mdn = 3.0, M = 3.18, SD = 2.26), resulting in 243 participants with pro-scientific beliefs (below median) and 266 participants with more anti-scientific beliefs (above or equal to median). In order to obtain value hierarchies and remove within-subject uniform response bias, we ipsatized the participants' responses to the PVQ questionnaire. We then ran a profile analysis comparing ipsatized value profiles of groups with Lower (below median) and Higher (median or above) antiscientific beliefs. Please note that due to ipsatization, values below 0 mean "below average" and values above zero are "above average".

It turned out that value profiles significantly differed for the two groups (F(1,507) = 40.714, p < .001, η^2_p = .074). Profiles were nonparallel (interaction term Values x Group was significant at F(5.534, 2805.694) = 35.390, p < .001, η^2_p = .065 with Greenhouse-Geisser epsilon correction for sphericity at ε = .615). The profile plot is presented in Figure 1.

Pairwise comparisons (Bonferroni corrected) showed that participants with Higher anti-scientific beliefs cared more about Conformity (M = -.100, SE = .045 vs. M = -.496, SE = .047, p < .001), Tradition (M = -.268, SE = .049 vs. M = -1.011, SE = .051, p < .001) and Power (M = -.512, SE = .058 vs. M = -.919, SE = .061, p < .001) than those with Lower anti-scientific beliefs. Conversely, those with Lower anti-scientific beliefs cared more about Benevolence (M = .457, SE = .037 vs. M = .260, SE = .036, p < .001), Self-Direction (M = .628, SE = .039 vs. M = .292, SE = .037, p < .001), Achievement (M = .206, SE = .044 vs. M = .043, SE = .042, p = .007) and Universalism (M = .715, SE = .036 vs. M = .132, SE = .035, p < .001) than those with Higher anti-scientific beliefs. There were no significant differences for Stimulation (p = .575), Hedonism (p = .960) or Security (p = .130).

4. DISCUSSION

In Schwartz's view, values shape our attitudes, beliefs and are the basis of our evaluations. We evaluate people, behavior, events, etc. positively when when they promote or protect the achievement of our valued goals, and negatively when they hinder or threaten this achievement (see Schwartz, 2012, p. 16). The aim of the current research was to analyze the relationship between preferred values and science skepticism measured as the attitude toward three phenomena: vaccination, climate change and the origin of humans.

It turned out that anti-scientific beliefs about these three phenomena were significantly and positively correlated with each other. This positive relationship can be

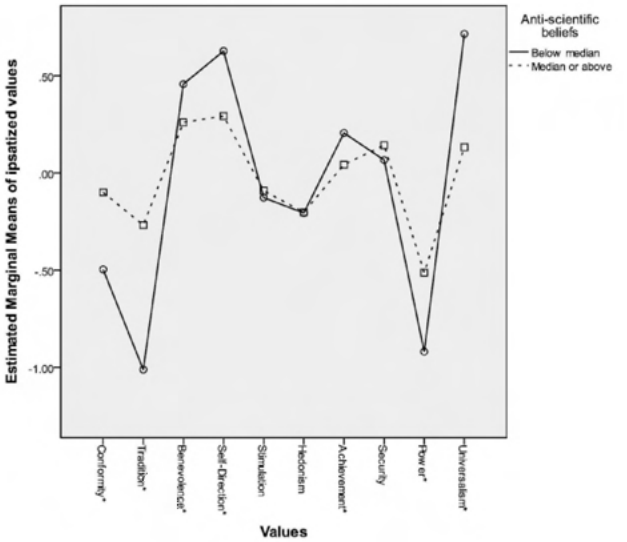

Figure 1. Profile plot of ipsatized values between Lower and Higher anti-scientific beliefs

Note. *indicates differences significant at p < .05 (Bonferroni corrected).

Table 2. Correlations between Schwartz's values and anti-scientific beliefs

		Vaccine Rejection	Climate Change Denial	Creationism	Total Anti-science
Climate Change Denial	Kendall's τ	**.342**			
	p	.000			
Creationism	Kendall's τ	**.355**	**.290**		
	p	.000	.000		
Total Antiscience	Kendall's τ	**.629**	**.621**	**.626**	
	p	<.001	<.001	<.001	
Conformity	Kendall's τ	.064	**.132**	**.170**	**.150**
	p	.057	<.001	<.001	<.001
Tradition	Kendall's τ	**.216**	**.223**	**.278**	**.291**
	p	<.001	<.001	<.001	<.001
Benevolence	Kendall's τ	**-.234**	-.050	**-.089**	**-.139**
	p	<.001	.126	.007	<.001
Self-Direction	Kendall's τ	**-.241**	**-.082**	**-.187**	**-.195**
	p	<.001	.011	<.001	<.001
Stimulation	Kendall's τ	-.043	.025	.010	-.003
	p	.206	.438	.773	.928
Hedonism	Kendall's τ	-.054	.043	-.008	-.008
	p	.110	.186	.819	.809
Achievement	Kendall's τ	**-.131**	-.024	**-.082**	**-.091**
	p	<.001	.466	.013	.004
Security	Kendall's τ	**-.074**	**.068**	.005	.003
	p	.027	.035	.887	.916
Power	Kendall's τ	**.127**	**.122**	.055	**.114**
	p	<.001	<.001	.095	<.001
Universalism	Kendall's τ	**-.283**	**-.240**	**-.174**	**-.281**
	p	<.001	<.001	<.001	<.001

a reflection of more general distrust in science. Total anti-scientific beliefs (the average score for the three attitudes) is significantly positively linked to Tradition, Conformity and Power values. Moreover, when looking at the profiles of value hierarchies, these three values were significantly more preferred by participants with Higher anti-scientific beliefs than by participants with Lower anti-scientific beliefs. The anti-scientific beliefs negatively correlated with Benevolence, Self-Direction, Achievement and Universalism values. The four mentioned values were also significantly more preferred by participants with Lower anti-scientific beliefs than by participants with Higher anti-scientific beliefs. In terms of meta-types of values, total antiscientific beliefs were positively correlated with Conservation and negatively with Self-Transcendence and Openness to change.

Let us consider the role of individual values in shaping attitudes toward each of the three anti-scientific attitudes. It turns out that Tradition is positively associated with all three anti-scientific beliefs: vaccine rejection, climate change denial and creationism. Power and Conformity values correlate positively with two beliefs each: Power with climate change denial and vaccine rejection, Conformity with climate change denial and creationism. Three values: Self-Direction, Universalism and Benevolence have a negative relationship with each of these beliefs (i.e. they are associated with pro-scientific beliefs).

Our hypothesis about the relationship of Tradition and Conformity values with science skepticism has been confirmed. Both values are associated with the motivation of an individual to submit to a social environment, oriented

toward maintaining the cultural-religious *status quo*. Hedonism and Stimulation are in an axiological conflict with Tradition and Conformity values. It turns out that the immediate enjoyment of pleasure, joy of life (Hedonism), as well as the search for experiences, exciting, adventurous, and challenging life (Stimulation) are not related with the attitude toward science.

Self-Direction is manifested in creativity, independence, cognitive curiosity; here, cognitive interests intersect with the self-creation of one's own life. In the circular values model, Self-Direction has a common border with Universalism. The latter value includes reflection on the world, unity with nature, protecting the environment. These motivational characteristics and goals associated with these values make it possible to understand why said values shape the attitude of acceptance of scientific knowledge. It also turns out that Benevolence, associated with the motive of responsibility and caring for people close to oneself, shapes an attitude incompatible with anti-scientific beliefs.

Results of our research are consistent with various studies on the relationship between values and other predictors of science skepticism. These include religiousness, political conservatism, hierarchical worldview and conspiracy theories. Tradition and Conformity values strongly positively correlate with religiousness (Huisman, 1994; Fontaine, Duriez, Luyten, Corveleyn, & Hutsebaut, 2005), as well as with right-wing authoritarianism and hierarchical worldview (Feldman, 2008). Research also shows that people with right-wing orientation score higher in Power value than left-wing supporters (Devos et al., 2002; Linderman & Verkasalo, 2005). In Raab, Kammerl and Carbon's work (2016), it turned out that constructing conspiracy theories regarding the LGBT community was positively correlated with Conservation values (Tradition, Conformity). In contrast Self-Transcendence values (Universalism and Benevolence) and Openness for change (Self-Direction and Stimulation) were negatively correlated with supporting conspiracy theories regarding the LGBT community. Hedonism and Stimulation values, on the other hand, are negatively correlated with important predictors of anti-science, i.e. religiousness (Huismans, 1994; Fontaine et al., 2005) and right-wing political orientation (Feldman, 2008). Current research shows that Hedonism and Stimulation are not related to anti-scientific attitudes.

We compared value profiles of participants who exhibited lower and higher anti-scientific beliefs. Interestingly, the profiles of value hierarchies were quite similar in these two groups (even though they were not parallel). The most preferred values in both groups were Self-Direction, Benevolence and Universalism, while the least preferred were Tradition and Power. Let us add that the observed hierarchy of values is consistent with the results of other studies on groups of Polish students (Cieciuch, 2010; Maciuszek, 2016).

However, the two studied groups differed in their preferences for certain values. Tradition, Conformity and Power were significantly more preferred in the group with higher anti-scientific beliefs than in the more pro-scientific group. The latter group preferred Self-Direction, Benevolence and Universalism significantly more. This means that the key values for anti-science do not have to occupy a high position in one's individual hierarchy of all values in order to become a predictor of science rejection. The results indicate that the attitude toward science is not shaped by a certain pattern of value hierarchy, but by a certain level of acceptance of five key values - Conformity and Power leading to more anti-science and Self-Direction, Benevolence and Universalism preventing it.

5. LIMITATIONS

Using the one item measure for each of the three anti-scientific beliefs may be considered a limitation of the study. Usually these kinds of measures are criticized for the lack of content validity due to criterion deficiency, and unreliability. However, single-item measures are an acceptable way of measuring opinions, as long as the constructs are concrete, unidimensional and have high semantic redundancy. It applies to the beliefs we focused on (Fischer, Matthews, Gibbons, 2015). Beliefs are in general easily declaratively accessible, while the need for complex measures applies mainly to tacit or implicit knowledge and phenomena.

We conducted the research on a large but homogeneous sample, consisting solely of students. This reduces the generalizability of the presented results. Moreover, the use of a question concerning attitudes toward vaccination of children may be a limitation of the study, as the majority of our respondents were not parents. However, we wanted to find an indicator of attitude toward vaccination that would not be mediated by participants own negative experience with vaccination (e.g. fever of a recently vaccinated child). Therefore, we decided that this question, although addressed to students who do not have children, would reflect their attitude toward vaccination in general.

CONCLUSIONS

Our research has indicated the role of motivational roots of science skepticism. Moreover, in Schwartz's theory, values as representations of motivational goals can be treated as a stable aspect of personality; they are not easily changed. They may even be inherited to some extent (Uzefovsky, Döring, & Knafo-Noam, 2016). Strongly established individual differences in value preferences can have a greater impact on anti-scientific attitudes than environmental factors or personal experience related to an educational profile. Our research also indicates that this may be the case; there was no main between-group effect of participants' area of education on anti-scientific beliefs. The aim of our further research will be to find moderators and mediators for the influence of values on attitudes toward science.

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