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How do we judge? The role of values and meta-cognitive insight in the polarisation of attitudes about nuclear power

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Master Thesis – Environmental Psychology

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Abstract

Finding a solution for a sustainable and safe energy transition is a pressing issue in various societies, and therein the role of nuclear power is a hotly debated topic. Indeed, it is a polarised issue in the public, and also individuals tend to polarise in their viewpoints, radicalising their strongly opposing or approving attitude towards nuclear energy. Understanding this polarisation, its psychological roots and potential antagonists is the aim of this study. It was examined whether individuals' values relate to attitude polarisation about the topic of nuclear energy; more specifically, if egoistic and hedonic values are related to the polarisation of approving attitudes, and biospheric and altruistic values to the polarisation of opposing attitudes towards nuclear energy. The second hypothesis tested whether the cognitive characteristic of metacognition has a reducing impact on polarising shifts, moderating the former relationship between values and polarisation. An online questionnaire was conducted with a convenience sample of 349 international participants, of whom 86 have polarised. The study could not confirm the proposed hypotheses, though people with egoistic values seem to polarise their approving attitude towards nuclear energy. Whether metacognition could serve as an opponent to polarisation could not be tested as the regressions for the first hypotheses were not significant. Exploratory analyses showed that some values are related to the attitude towards nuclear power, and that the home country explains a significant proportion of these attitudes. Further analyses avoiding the limiting factors of this study are recommended, and the lack of significant predictors is discussed.

How do we judge? The role of values and meta-cognitive insight in the polarisation of attitudes about nuclear power

The debate surrounding nuclear power is as persistent as it is polarising. As nations pursue increasingly ambitious climate targets and seek to reduce reliance on fossil fuels, nuclear energy is once again framed as a potential solution to a complex global challenge (Buongiorno et al., 2019). Advocates cite its low greenhouse gas emissions, high energy output, and reliability, particularly compared to intermittent renewables such as wind or solar (Matthew, 2022). Critics, however, point to unresolved issues around nuclear waste, the catastrophic potential of accidents, and the long-term environmental and societal risks (Jacobson, 2024). This divide is not simply a matter of knowledge or politics but reflects deeper, value-laden processes that shape individual opinions. Thus, the key question is not just whether nuclear power is viable, but why attitudes towards it are becoming increasingly extreme, and what psychological mechanisms drive this polarisation.

Polarisation of attitudes towards nuclear power

But what exactly is polarisation? From a psychological perspective, intrapersonal polarisation refers to a shift in an individual's attitudes over time towards more extreme positions, often triggered by new information or social influence (Marino et al., 2024). These individual shifts collectively contribute to societal polarisation. A hallmark of polarised debates is a deepening divide in opinions, most starkly when two equally sized camps hold opposing views (Pless et al., 2023). This illustrates how psychological processes within individuals fuel a broader societal phenomenon – and problem: Polarisation is perceived to be intensifying across most Western societies and is widely seen as harmful. One study found that Americans across the political spectrum believe society would benefit from less political polarisation (Marino et al., 2024). This highlights that it is not only academics but also the general public who recognise the need for solutions. Since societal divides are ultimately

rooted in the radicalisation of individuals, mitigating intrapersonal polarisation is essential, particularly if public acceptance of nuclear power is to increase.

In recent years, public acceptance has become a critical factor in the success of energy policy (Steg et al., 2022; Perlaviciute & Steg, 2014). Regardless of how efficient or safe a technology may be, its implementation is unlikely to succeed without public support. This is especially true for nuclear energy, which has long been met with scepticism or outright opposition. Political efforts to expand nuclear infrastructure have often been derailed by public resistance and civic activism, leading to delays, cancellations, or costly regulatory hurdles (e.g. Deng et al., 2023; Koopmans & Duyvendak, 1995). In Germany, for example, the long-standing nuclear phase-out policy was backed by a large segment of the population, even amid rising energy demands and climate pressures (Bohdanowicz et al., 2023). In contrast, countries such as the Netherlands and the United Kingdom have sustained or renewed their commitment to nuclear energy, though not without public sensitivity (e.g. Price et al., 2023; De Groot & Steg, 2010; Pidgeon et al., 2008). These differences underscore that public opinion is not merely a background factor but a central force shaping national energy trajectories. Understanding the psychological mechanisms behind the growing divide in public acceptance or rejection of nuclear power is therefore crucial for policymakers, scientists, and communicators alike.

Values as polarising factors

Though nuclear energy is an established technology, public attitudes towards it remain ambivalent. Moreover, having extensive knowledge about a technology does not necessarily lead to stable attitudes (Görsch et al., 2025). This is a domain where factual knowledge often competes with emotionally charged beliefs, media narratives, and value systems. It thus exposes the limitations of the so-called "knowledge-deficit model" of science communication, which assumes that "unreasonable" behaviour and attitudes, like public

resistance, stems from lack of knowledge and can be overcome through the provision of information (Bodmer, 1986). In contrast, empirical research increasingly shows that people process information in ways that align with their existing attitudes and values—a phenomenon known as motivated reasoning (Taber & Lodge, 2006). Individuals are not passive recipients of facts, but active constructors of meaning, often seeking information that confirms their beliefs and rejecting what contradicts them (Rollwage et al., 2020). Indeed, a review on political polarisation concluded that the mere provision neutral information can often intensify, rather than reduce, polarisation (Taber & Lodge, 2006; Marino et al., 2024).

But does information on a topic automatically polarise a person's attitude? Not quite: Polarisation is not solely driven by external exposure, but also shaped by interindividual differences. Values as an important personal characteristic proves its relevance in attitude formation. According to value theory (Schwartz, 1992; De Groot & Steg, 2008), values are trans-situational goals that serve as guiding principles in life. Unlike specific beliefs or opinions, values are abstract, stable, and often drive emotions (Schwartz, 1992; Stern & Dietz, 1994; Enders & Lupton, 2020). They shape perceptions of what is important, desirable, or morally acceptable, thereby influencing both information processing and behaviour.

In environmental decision-making, four value orientations are especially relevant: egoistic, hedonic, altruistic, and biospheric (De Groot & Steg, 2008; Steg et al., 2014). Egoistic values focus on self-interest and personal resources such as wealth and status; hedonic values on pleasure and comfort. Altruistic values prioritise the welfare of others, while biospheric values emphasise protecting nature and the environment. These values influence not only preferences for energy sources but also perceptions of their risks and benefits (Perlaviciute & Steg, 2015; Steg et al., 2015; Mastop et al., 2014). Values also act as antennas for information: people with strong biospheric values, for example, are more

accepting of environmental policies and more likely to reduce bottled water use after seeing environmental campaigns than those without such values (Bolderdijk et al., 2013).

Research shows that individuals with strong biospheric and altruistic values are more likely to oppose nuclear power, perceiving it as a threat to environmental and societal well-being (Perlaviciute & Steg, 2015; Corner et al., 2011). They may focus on long-term ecological consequences, health risks, and the potential for catastrophic accidents. Conversely, those who endorse egoistic and hedonic values perceive nuclear energy in a more favourable light, highlighting its reliability and cost-effectiveness (Perlaviciute & Steg, 2015). This divergence in evaluative focus reflects the concept of value-based judgements (Steg et al., 2015), whereby individuals attend to and interpret information in a way that aligns with their core values (Druckman & McGrath, 2019; Caddick & Feist, 2021).

This pattern of reasoning is a hallmark of motivated reasoning, a cognitive bias that can result in polarisation (Hart & Nisbet, 2012). As Taber and Lodge (2006) demonstrated, people do not passively absorb information but instead engage in attitude bolstering via confirmation biases, particularly when confronted with contested topics. In their study, participants selectively accepted arguments that supported their views (confirmation bias) and critically scrutinised opposing ones (disconfirmation bias). As a result, exposure to balanced information did not moderate attitudes – it intensified them. This finding has been replicated across domains ranging from climate change to vaccination (Fischer et al., 2023; Said et al., 2021; Caddick & Feist, 2021). Additional research shows that value extremity, a very strong endorsement of a value, is connected to affective polarisation in political context, intensifying emotional responses to outgroup members (Enders & Lupton, 2021).

Taken together, values polarise affective responses, they shape and intensify attitudes, and most probably can also polarise them by guiding how information is processed. Since neutral information can polarise, values may be the underlying factor driving this shift.

Within the theoretical framework of this study, values are not only linked to baseline attitudes but also predict the direction and degree of polarisation in response to new information. For example, approving attitudes towards nuclear power become polarised when individuals grow even more strongly supportive over time. Likewise, opposing attitudes are polarised when individuals become increasingly resistant to nuclear energy and its implementation. In both cases, polarisation deepens existing positions, pushing them further in their original direction.This leads to the first set of hypotheses:

H1: Values are associated with the polarisation of attitudes toward nuclear energy.

H1a: Egoistic and hedonic values are associated with the polarisation of approving attitudes toward nuclear power.

H1b: Biospheric and altruistic values are associated with the polarisation of opposing attitudes toward nuclear power.

Meta-cognitive insight as counterbalancing force

When regarding this value-based processing of information, it is important to consider psychological mechanisms that can counterbalance the polarisation. One such mechanism is meta-cognitive insight – the ability to reflect on and critically evaluate one's own thought processes (Said et al., 2021; Fischer & Fleming, 2024). This concept refers to an awareness of one's thoughts and the capacity to question and regulate the cognitive strategies used in judgment and decision making. The level of confidence that own assessments and knowledge is true is an important feature of this characteristic: high metacognition reflects in a high sensitivity of confidence: ideally, personal confidence should be high in cases when the person is right in their judgement about the correctness of their own knowledge, and confidence should be low when individuals are not right in their judgement about the correctness of their knowledge (Fischer & Fleming, 2024). This prominent role of confidence is also evident in studies of biased information processing: the selective processing of

information that is consistent (vs. inconsistent) with own opinions is regulated via selective neural gating, which is stronger the more confident one is about their own opinions (Rollwage et al., 2020). This study concludes that metacognitive interventions can serve as a reducer to confirmation and disconfirmation biases. This bridges the research branches of motivated reasoning and metacognition, as meta-cognitive insight seems to play a critical role in overcoming cognitive biases, including motivated reasoning: Individuals with higher levels of meta-cognitive insight are more likely to engage in analytical thinking, consider alternative viewpoints, and recognise the limitations of their own knowledge (Said et al., 2021). These skills are particularly important when reflecting upon complex and contested issues, such as nuclear energy, where intuitive reactions may dominate deliberative reasoning.

Recent empirical research has begun to explore the role of meta-cognitive insight in attitude polarisation. Said et al. (2021) found that individuals with greater meta-cognitive insight were less susceptible to polarisation, even when exposed to ideologically loaded and moralised information. This suggests that meta-cognitive insight can act as a cognitive buffer, reducing the extent to which individuals process information through the lens of, for example, pre-existing values. Fischer and Fleming (2024) extended these findings by concluding that meta-cognitive insight may actually be diminished in contested topics, underlining that this ability is domain specific, and examining interindividual differences is highly important for those topics. In the context of nuclear power, meta-cognitive insight may help individuals to decouple their evaluative judgements from automatic value-based responses, leading to more balanced and less polarised attitudes. Building on these insights, this study proposes that meta-cognitive insight moderates the relationship between values and polarisation in the domain of nuclear energy. Specifically, it is hypothesised that:

H2: Higher meta-cognitive insight weakens the relationship between values and polarisation.

That is, individuals with greater meta-cognitive insight are expected to show less by values caused polarising shifts in their attitudes toward nuclear power, following exposure to new information. High metacognition is predicted to reduce the in H1a and H1b described relationships between values and polarisation.

The aim of this study

This study addresses several key gaps in the literature on attitude polarisation. Mostly, the potential of values as a contributor to polarisation is explicitly named and examined, as the links to both attitude formation and biased processing are already prevalent. The next clear step, namely to see whether it not just bolsters a given attitude but also intensifies it, is taken in this study.

Secondly, the interaction between values and meta-cognitive insight remains unexplored as well. While both constructs have been studied in isolation, no studies have examined how they operate in tandem to shape responses to information on contested topics. While values are said to form and strengthen opinions, meta-cognitive insight works in the opposite direction, conquering a blind bolstering of attitudes. Understanding an interaction is crucial for developing more effective interventions, whether educational, communicative, or policy-based, which contribute to an informed and open-minded public engagement.

Third, most studies on polarisation and especially motivated reasoning have focused on well-established topics such as climate change or vaccination, often in political frameworks (e.g. Marino et al., 2024; Pless et al., 2023; Fischer et al., 2023). Nuclear energy, while equally relevant and contested, has received comparatively less attention as a domain for investigating polarisation (Adams et al., 2012). Given the complexity of the issue, its historical context and its revival in current policy debates on decarbonisation and energy security, this absence is notable and should be overcome.

Additionally, much of the existing research conceptualises polarisation as an outcome following group processes like deliberation, or through elite cues (Wojcieszak, 2011; Adams et al., 2012). This study, in contrast, aims to show that they are not the only polarising sources – intraindividual processes like values or metacognition may be equally important.

The study adds to several strands of research within social, political, and environmental sciences, contributing to a more interdisciplinary perspective. Also within psychology, it integrates value theory with meta-cognitive frameworks, offering a model that accounts for both stable dispositional factors (values) and cognitive capacities (meta-cognitive insight). Moreover, it extends the literature on motivated reasoning by identifying a potential cognitive moderator that can attenuate polarisation. In summary, this study seeks to address the following overarching research question: How do values and meta-cognitive insight relate to the polarisation of attitudes toward nuclear energy?

To answer this question, the study develops and empirically tests a model that includes personal values (egoistic, hedonic, altruistic, and biospheric) as predictors of polarisation, and meta-cognitive insight as a moderator. The relationship of these variables is depicted in Figure 1.

Figure 1

Conceptual map of the hypotheses
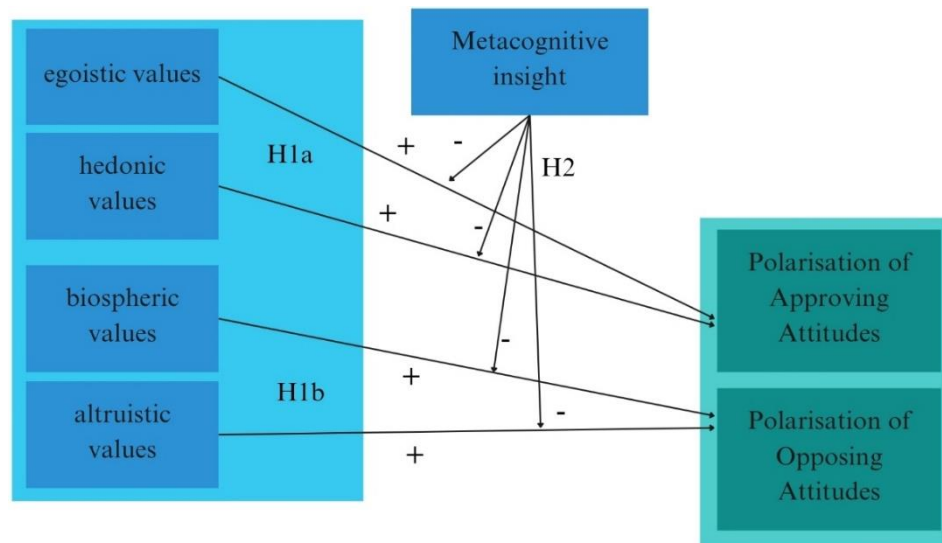
Note. H1a: Egoistic and hedonic values are associated with the polarisation of approving attitudes toward nuclear power. H1b: Biospheric and altruistic values are associated with the polarisation of opposing attitudes toward nuclear power. H2: Higher meta-cognitive insight weakens the relationship between values and polarisation.

Method

Participants & Procedure

A power analysis using G*Power, with an assumed alpha error-probability of .05, a power of .08 and an effect size of .02, results in a necessary amount of 395 participants minimum. Participants were recruited between March and May 2025, via personal networks, the SONA platform provided by the University of Groningen, and in public: on campus and in the city of Groningen. Only requirements for participation were being at least 18 years old, and speaking English. Participants were given a link to access the English questionnaire designed in Qualtrics. After giving consent to participation and the processing of personal data, the questionnaire started with an assessment of core values, followed by an indication of their attitude towards nuclear power (which will be referred to as T1) and the meta-cognitive

insight assessment. They then were provided with a set of balanced information about nuclear power, before filling in again the attitude scale (at time point T2) and finally indicating their home country. The process is shown in Figure 2.

Students participating via SONA were granted 0.4 SONA points after completion; besides no compensation was provided. In total, $N = 349$ people participated in the survey. The majority of participants indicated their home country as being the Netherlands ($n = 127$), followed by Germany ($n = 101$). The remaining participants belonged to a variety of countries worldwide, but no nation was represented by a relevant amount. As it was not necessary for this research, no more demographics were assessed. There was no experimental manipulation, deception, or randomisation used. The study was submitted to the fast track ethics procedure at the University of Groningen.

Figure 2

Order of the questionnaire
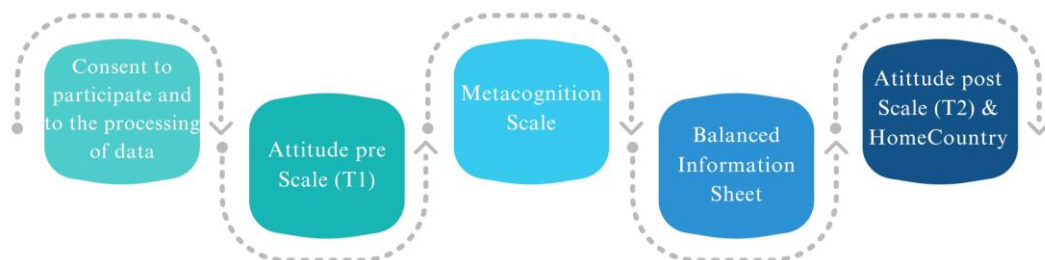
Measures

Polarisation

For the measure of the dependent variable, people's attitudes towards nuclear power were assessed following Perlaviciute & Steg's (2015) approach, as acceptability of a technology can well be used to reflect the general attitude towards it (e.g. Parkhill et al., 2013): agreement to four acceptability statements were asked, representing support for nuclear energy in two points of time in the questionnaire; T1 and T2. On a 7-point-scale (from 1 –

completely disagree to 7 – *completely agree*), participants express their support for these statements: "I find the use of nuclear energy acceptable", "I find it acceptable to build a new nuclear power station in my home country", "I find it acceptable that a part of the overall energy mix in my home country consists of nuclear energy", and "I find it acceptable to use more nuclear energy in my home country than is used now" (adapted from Perlaviciute & Steg, 2015). The responses are then averaged to form two attitude values for each measurement point T1 (M = 3.79; SD = 1.96; α = .97) and T2 (M = 4.01; SD = 1.92; α = .97).

To measure the intraindividual polarisation of attitudes after information provision (that is, from T1 to T2), the number 4 of the scale is defined as neutral middle. An attitude has polarised when a value at T2 is placed more towards an end of the scale in comparison to T1, veering away from the 4. This also applies to those who have changed their attitude from approving to opposing or vice versa, but formed a stronger attitude than before. That is because ultimately the individual developed a stronger opinion on nuclear power, being less moderate in their attitude, and finally contributing to the polarisation of society. To calculate a polarisation score, firstly it is checked whether a polarisation (a shift to more extreme attitudes than before) has happened:

$$\text{Polarisation} = \mid T2 - 4 \mid > \mid T1 - 4 \mid.$$

Because the hypotheses are covering polarisation, all those who depolarised, i.e., moved in their attitude more towards a more moderate stance, or did not change in their attitude at all, are labelled "NA" and excluded from the main analyses. When an approving attitude polarises, the polarisation value gets a positive prefix, while the polarisation of an opposing attitude is labelled with a negative prefix. This way, a *polarisation score* is defined for every person showing strength and direction of a polarisation.

Values

As for the independent variable, the validated value scale from Steg et al. (2014) is used, which includes 16 items in total: four each for altruistic and biospheric values, five for egoistic values, and three for hedonic values; they are reported in Appendix A. Participants got a list of values with short explanations and rated how important each value was as a guiding principle in their lives. They rated them on a 9-point scale, where −1 meant *opposed to my guiding principles*, 0 meant *not important*, and 7 meant *extremely important*. Then, the ratings for each set of items were averaged to create reliable scores for all values each. Descriptive statistics of all four value scales are reported in Table 1. Though the analysis revealed that dropping item V13, "HELPFUL: working for the welfare of others", would improve reliability of the altruistic values scale, this item was kept, as the improvement was only little (by .02 points) and the scale already proved reliable in former studies (e.g. Steg et al., 2014).

Table 1

Descriptive statistics of the four value scales

Value scale	n	M	SD	Cronbach's α
Biospheric	237	4.01	0.84	.72
Altruistic	235	4.09	0.87	.69
Hedonic	226	4.26	0.84	.80
Egoistic	284	3.17	0.84	.65

Meta-cognitive insight

A set of eight items assessing meta-cognition were used, following the set-up by Fischer et al. (2023). Research was carried out about the history, physical background and

common knowledge about nuclear energy, based on papers and national institutes (Clayton et al., 2024; Duda & Jimura, 2025; IEA, 2019; IEA, 2022; IRENA, 2024). The items were chosen to reflect a diversity of better known to lesser known facts around nuclear power, and are listed in Appendix A. Each item consists of one statement about nuclear power which the participants had to judge as true or false, and a certainty rating about this judgement, asking: "How certain are you that your answer is correct? Rate your confidence between "guessing" and "100% sure"". On a scale from 50 % to 100 %, they then could indicate their confidence regarding the previous true/false answer. A sample item is: "Nuclear power plants do not produce carbon dioxide or any other form of air pollution during operation". The descriptive statistics of the overall metacognition score and the confidence of correct and of incorrect answers are shown in Table 2, and the distribution of the metacognition scores is visualised in Figure 3. The individual item statistics are reported in Appendix B. The *metacognition score* for each participant is then reflected in the proportion of the averaged certainty of correct answers to the averaged certainty of uncorrect answers. A high score indicates high meta-cognitive insight:

$$\text{Metacognition} = \text{certainty correct} / \text{certainty uncorrect}.$$

Table 2

Descriptive statistics of the metacognition score and the confidence of correct and of incorrect answers across all participants

Scale	*M*	*SD*	1	2	3
1. Metacognition score	1.06	0.17	-		
2. Mean Confidence Correct	73.55	11.64	.43***	-	
3. Mean Confidence Incorrect	70.17	11.93	-.5***	.55***	-

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

Figure 3

Distribution of the metacognition scores
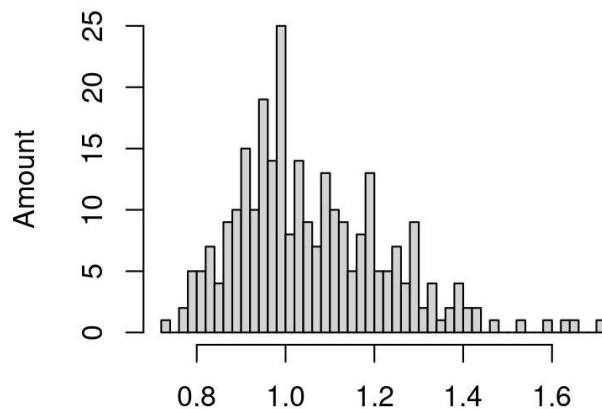
Balanced information sheet

Information regarding egoistic, hedonic, altruistic and biospheric aspects of nuclear power are provided. Based on the same research carried out for the Metacognition questionnaire, information about nuclear power was selected which can serve as arguments for and against the use of nuclear power, while stressing factors relevant for the four values each. Eight informative sentences were designed, holding a positive and a negative argument each for all four values. A sample item is: "Did you know, that…? ... the processes of mining, preparing and refining uranium, the resource to produce nuclear fuel, use energy and pollute CO_2." The sources for the information are given at the end of the questionnaire. All items are reported in Appendix A. The items were introduced with a disclaimer that participants should read the following true statements carefully, even though they seem familiar to them. At the end of the two pages each containing the statements, they had to press the "next page" arrow to proceed with the questionnaire.

Analysis plan

For this cross-sectional within-subjects design, the analyses were calculated in R (R Core Team, 2025). First, it was checked whether the data set might be corrupted by bots. The Q_RecaptchaScore provided by Qualtrics checked for that, but no score below 0.5 was

detected. All participants who did not give consent to participate or to the processing of data were excluded, leaving $N = 320$ participants. Descriptive analyses were carried out on the respective variables.

To see whether egoistic and hedonic values relate to polarisation of approving attitudes (H1a), and whether biospheric and altruistic values relate to polarisation of opposing attitudes (H1b), linear regression analyses were used. Therefore, the sample was split to form one sample with the polarisation of approving attitudes (Approval Group) and one with the polarisation of opposing attitudes (Opposition Group). Here, it is tested whether the approving polarisation scores relate to higher egoistic and hedonic values, and whether the opposing polarisation scores relate to strong biospheric and altruistic values.

To test for the second hypothesis, namely if metacognition moderates this former effect in a way that it reduces the polarisation (H2), it was planned to run moderated regression analyses, but as the regressions for H1a and H1b turned out to be insignificant, it is not suitable to run moderated regressions. For the sake of requirements of a master thesis, they are nevertheless reported in Appendix C. Assumption checks where carried out and, where necessary, data transformed to meet the assumtions, which are both reported in Appendix C as well.

Exploratory analyses were calculated in the end, checking whether the home country was related to 1) polarisation of attitudes or 2) attitudes itself by using t-tests each. Additionally, it was examined whether 3) values and attitudes are related, calculating simple linear regressions, and whether the sort of attitude shift, i.e. polarisation, depolarisation or no shift, was related to 4) metacognition scores by running an ANOVA (analysis of variances). Also, simple linear regressions were used to check whether the overall direction of a shift in attitudes, i.e. whether an attitude has become more opposing or approving than before, is

related to the four values. Lastly, simple linear regressions were run to check whether metacognition relates to 6) values and 7) an extreme initial attitude.

Results

Overview

Descriptive analyses were carried out first on all variables. The descriptive statistics of the four value scales in each subsample Approval and Opposition Group are reported in Table 3. They show that the values were comparable to those of the overall sample (see Table 1), though from the scales used (egoistic and hedonic values in the Approval Group, and biospheric and altruistic values in the Opposition Group), egoistic values have the highest sample size.

Table 3

*Descriptive statistics of the four value scales in each subsample*

Value scale	Approval Group			Opposition Group		
	n	*M*	*SD*	*n*	*M*	*SD*
Biospheric	35	3.78	0.88	36	4.07	0.77
Altruistic	40	4.17	0.82	36	4.21	0.79
Hedonic	33	4.31	0.88	33	4.49	0.69
Egoistic	44	3.25	0.78	41	3.38	0.66

The distributions of attitudes at T1 and T2, respectively, can be seen in Figure 4. When comparing the attitudes in T1 and T2, 86 participants have polarised by the aforementioned definition, 90 have depolarised, and 94 did not change in their attitude. Those 86 polarised participants were given a *polarisation score*: a negative prefix indicates a polarisation of opposing attitudes, and a positive prefix indicates polarisation of approving

attitudes, while the value presents the strength of polarisation. The distribution of the polarisation scores are depicted in Figure 5.

Figure 4

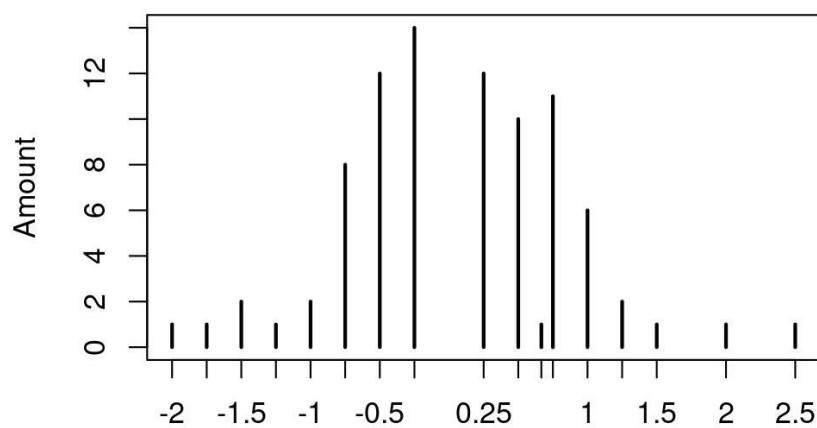*The attitudes towards nuclear power at T1 and T2, respectively*
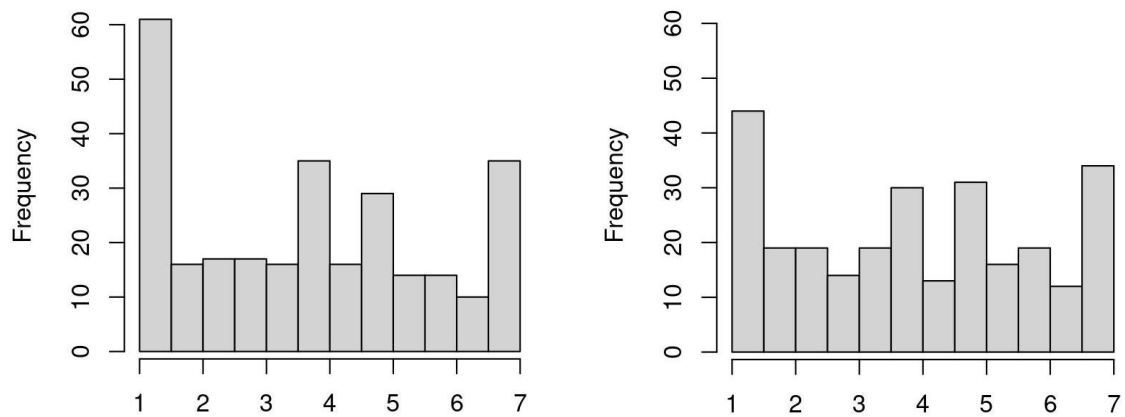
Note. T1 is depicted on the left, T2 is depicted on the right. 1 – completely disagree; 7 – completely agree.

Figure 5

Distribution of Polarisation Scores

Correlations of all four values and the attitude scales T1 and T2 are reported in Table 4. It shows that biospheric values are negatively related to attitudes, and egoistic values

positively, though that only held true at T1. Concluding, the pre-assumption that values and attitudes are related is partially met.

Table 4

Correlations of the four value scales and the attitude scales T1 & T2

Value scale	1	2	3	4	5	6
1. Biospheric	-					
2. Altruistic	.39***	-				
3. Hedonic	.18*	.18*	-			
4. Egoistic	.14*	.14*	.21**	-		
5. attitude T1	- .16*	- .11	.05	.12*	-	
6. attitude T2	- .18**	- .18	.03	-.11	.92***	-

Note. *** p < .001, ** *p* < .01, * p < .05.

Relationship between values and polarisation

The shift in people's attitudes from T1 to T2 in the Approval Group ($n = 44$) can be seen in Figure 6. For the first hypothesis H1a, the regression analysis with log-transformed polarisation as dependent variable and egoistic and hedonic value as independent variables shows significant effects of egoistic values ($\beta = 0.19$, $p < .05$), but not of hedonic values ($\beta = -0.03$, $p = .696$). The stronger the egoistic values are, the more do approving atittudes polarise. The overall regression was not statistically significant, however (Adjusted $R^2 = .1$, $F(2, 30) = 2.79$, $p = .078$), so that the hypothesis cannot be supported.

Figure 6

The shift of attitudes in the Approval Group, ordered by size
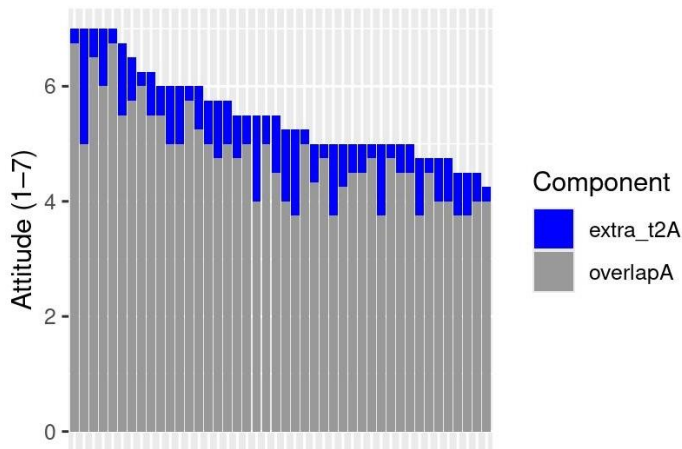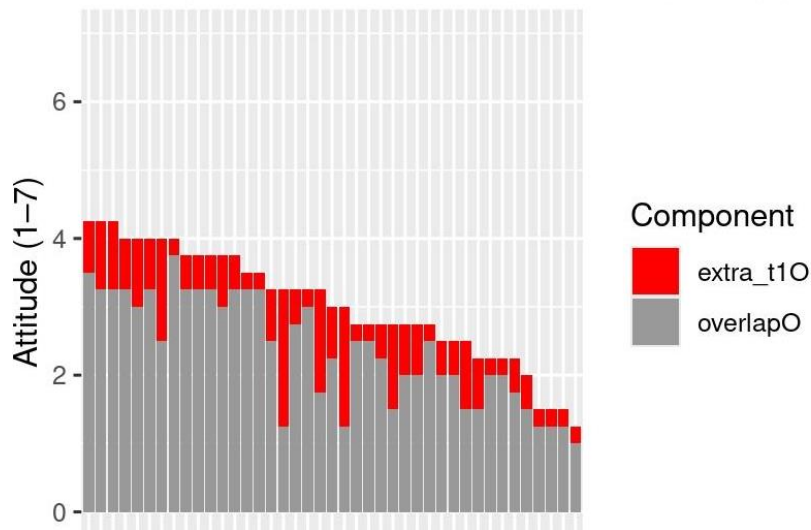

Note. The x-axis reflects the participants, the y-axis the attitude strength. *extra_t2A* = the increase in the attitude at T2. *overlapA* = the proportion of the attitude that did not change.

Hypothesis H1b was tested the same way, with Polarisation of the Opposition Group ($n = 41$) as dependent variable and biospheric and altruistic values as independent variables. The regression analysis reveals no significant effects for neither the log-transformed biospheric values (β = -0.14, p = .474) nor log-transformed altruistic values (β = -0.17, p = .332). The model was not significant (Adjusted R^2 = .02, $F(2, 29)$ = 1.24, p = .304).[1] The hypothesis could not be confirmed – whether people had high altruistic or biospheric values did not influence their polarisation of opposing attitudes towards nuclear energy. The shift in people's attitudes from T1 to T2 in the Opposition Group can be seen in Figure 7.

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[1] Assumption checks revealed that multivariate normality is violated for this specific model. Assumption checks for all models are reported in Appendix C.

Figure 7

The shift of attitudes in the Opposition Group, ordered by size

Note. The x-axis reflects the participants, the y-axis the attitude strength. *extra_t1O* = the decrease in the attitude at T2. *overlapO* = the proportion of the attitude that did not change.

Exploratory analyses

Seven exploratory analyses were carried out to look into possible further relationships. First, a t-test with the full sample size was carried out with the home country as predictor, which had two levels: 1 (Germany; $n = 101$) and 2 (Netherlands; $n = 127$), and 1) polarisation as dependent variable, which used, as both opposing and approving attitudes are included, the absolute value of polarisation, ignoring the direction. Participants from other countries were not included in this analysis as no other country formed a group being big enough on its own. The descriptive statistics of both groups are seen in Table 5. The test was not significant ($t(56.03) = -1.85$, $p = .055$, 95% CI [-0.35, 0.01]). There is no difference in polarisation between Germans and Dutch. Also, when using 2) the attitude scales at T1 and T2 as dependent variable each, the t-tests revealed that the home country served as a good predictor, indicating that Dutch have a more positive attitude towards nuclear power than

Germans ($t(211.93) = -9.94$, $p < .001$, 95% CI [-2.59, -1.73] and $t(214.11) = -9.2$, $p < .001$, 95% CI [-2.44, -1.58], respectively).

Table 5

Descriptive statistics in the home country Groups Germany and Netherlands

Group	Attitude T1		Atttitude T2		(absolute) Polarisation Score	
	M	*SD*	*M*	*SD*	*M*	*SD*
Germany	2.52	1.65	2.73	1.64	0.5	0.34
Netherlands	4.68	1.6	4.74	1.63	0.67	0.39

Also, to see more clearly whether 3) values have an influence on the attitudes toward nuclear power, eight regression analyses in the full sample with each value as one predictor, and the T1 and T2 attitudes as dependent variable each, were carried out. For T1, biospheric ($\beta = -0.36$, $p < .05$) and egoistic ($\beta = 0.28$, $p < .05$) values were significant predictors. The stronger the biospheric values, the less approving is the attitude towards nuclear power, while strong egoistic values are related to more approving attitudes. For T2, only the biospheric ($\beta = -0.39$, $p < .01$) values were significant. Strong biospheric values are related to less approving atittudes. The complete statistics are reported in Appendix D. Following this result, values and attitudes towards nuclear power are partly related, strengthening this pre-assumption of the main analyses.

Additionally, it was examined whether 4) metacognition relates to the kind of shift in attitudes, calculating an ANOVA with the metacognition score and the kind of attitude shift (1 – *polarised*, 2 – *stayed the same*, 3 – *depolarised*) in the full sample. The results indicated that there was no significant difference in the metacognition scores between the three attitude

shift groups, $F(2, 263) = 1.72$, $p = .181$, $\eta^2 = .01$. Whether people have high or low metacognition does not relate to their attitude shift behaviour.

It was further examined whether 5) a shift in attitudes to either a more approving or opposing (or the same) attitude than before is related to the four values, ignoring whether this shift was polarising or depolarising, using the full sample. This was done by subtracting the T1 attitude from the T2 attitude so that, in the end, a positive *shift score* indicated a shift to more approving attitudes, and a negative shift score reflects an attitude shift to more opposition, compared to the attitude T1. This score was used as dependent variable, and the values formed the predictors in the four analyses each. The simple linear regression analyses calculated for this purpose did not show any significance ($p > .05$ for all four values); their statistics are listed in Appendix D.

Additionally, four regression analyses in the full sample were run to check whether 6) metacognition and values relate to each other, using simple linear regression analyses with the metacognition score as dependent variable and each value as predictor, respectively. Those were not significant ($p > .05$ for all four values). The statistics can be found in Appendix D.

Lastly, to explore 7) whether an extreme attitude relates to low metacognition, regression analyses were carried out with the metacognition score as dependent variable and the extremity of the initital attitude as predictor. The latter was calculated by splitting the sample based on whether the attitude at T1 was above or below 4 (people indicating a 4 were excluded as this reflects the opposite of an extreme view). This generated two subsamples with opposing ($n = 182$) or approving ($n = 158$) views at T1, which were then coded so that higher values represent stronger attitudes. Both linear regression analyses with each subsample did not reveal any significance ($p > .05$, respectively). The statistics of the regressions are shown in Appendix D.

Discussion

This study aimed to explore whether values relate to a polarisation of attitudes about nuclear energy and whether metacognition moderates this relationship, reducing polarising effects. Three hypotheses were examined: first, whether egoistic and hedonic values relate to the polarisation of approving attitudes; second, whether biospheric and altruistic values relate to the polarisation of opposing attitudes; and lastly, whether these relationships are moderated by metacognitive insight.

No hypothesis could be confirmed, as none of the regressions were significant, and a moderation analysis for hyopthesis two was not carried out. Nevertheless, in a model with egoistic and hedonic values, the former had a unique significant effect on the polarisation of approving attitudes. The model itself was not significant, so the interpretation of this result must be done very carefully. Exploratory analyses gave some insight into the relationships between those varaibles, and revealed the importance of home countries.

The relationship between values and polarised attitudes

Though the analyses could not confirm what was presumed, the results were also not indicating an opposing relationship. The fact that the number of polarised participants in the study was too small to actually detect effects should be kept in mind when searching for an explanation of the results. Indeed, when exploratory checking the relationships between values and attitudes in the full sample, the results followed other studies in replicating that biospheric and egoistic values play a role in forming attitudes towards nuclear power (Perlaviciute & Steg, 2015, De Groot et al., 2013).

It may be that values shape the attitude but do not change them per se, which is also supported by the exploratory finding 5) that no attitude shift is related to values. Other factors might be more responsible for attitude shifts, like response biases in ways that people feel triggered to either reaffirm (e.g. consistency bias; Leising, 2011) or rethink (demand

characteristics; Orne, 1962) their attitudes after the information provision. Also, the social process of deliberation (Wojcieszak, 2011), in which people actively debate and engage with others, and are also being faced with contrary opinions, has since long been subject to debate of whether it contributes to polarisation or depolarisation (Lindell et al., 2017), probably driving attitude shifts more than information provision.

Another factor often examined in the context of polarisation is the political dimension of opinions. Political ideology was not taken into account in this study, though being a proved predictor of (environmentally related) attitudes and polarisation (e.g. Gromet et al., 2013). The polarisation observed here can well be caused to some extent by political ideologies, as nuclear energy is often debated about in political contexts (e.g. Brouard & Guinaudeau, 2015; Ylönen et al., 2017).

The only significant effect in this study was caused by egoistic values; it is probably an exceptional value in being able to cause polarisation. People with strong egoistic values might feel attacked on a very personal level when being exposed to counterarguments, as egoistic values are centered around the individual, inducing a need to protect what is their own, also their attitudes. Hedonic values, also belonging to the self-enhancement values, might not have this unique protecting effect, because the topic of nuclear power is less obviously related to hedonic features like convenience or pleasure, not threatening these values as directly as it might threaten egoistic features like pricing.

Additionally, though the acceptability judgements of nuclear power are more ambivalent than of other established energy technologies (Görsch et al., 2025), it must be acknowledged that nuclear power is a long-known matter in society, so that attitudes might have formed and strengthened too much already to be changed so quickly (Görsch et al., 2025).

It is also worth mentioning that the majority of people in this study did not polarise in their attitudes. In fact, the proportion between those who have polarised, depolarised and who have kept the very same attitudes were roughly the same. That follows the proportions of a study carried out by Said et al. (2021) examining the effect of metacognition on polarisation in the topics of climate change and nanotechnology, though in their study the polarised proportion was even smaller. The assumed effect of information provision as a polarising factor should therefore be questioned, as there are inconsistent results whether the mere provision of information about a contested topic triggers polarisation or depolarisation (e.g. Taber & Lodge, Lord et al., 1979, Vinokur & Burnstein, 1978, Gromet et al., 2013). Probably, it does both with the same likelyhood, as it could be observed in this study. The information might also not seem to be reliable despite the provision of reliable sources, as the material was framed in a very general way, probably hurting a need for preciseness and therefore rather inducing disbelief than reflection about the information.

Metacognition as a moderator in polarising shifts

If metacognition causes the diverse reactions on information provision could not be determined in this study. A factor that could prevent showing effects of metacognition still is the somewhat opposing finding that especially people with radical views tend to have low metacognitive insight when it comes to the polarised topic over which one holds the radical opinion (Rollwage et al., 2018), though no relationship between the strength of an attitude and the metacognitive insight could be found in the exploratory analysis 7. However, there might be issues with the operationalisation of metacognition which will be discussed more in the limitation section. Those could have impacted the metacognition score so severely that potential effects of metacognition could not show. Nevertheless, it seems that there is a more complex interaction in the relationship between polarisation and metacognition, whereas people with already extreme views also tend to polarise most (Taber & Lodge, 2006) and

display at the same time impairment in metacognitive sensitivity (Rollwage et al., 2018), so that this depolarising characteristic (Said et al., 2021) can not necessariliy work where it is needed most. This complexity has not yet been taken into consideration in this study, so it is worth taking another look at this interaction.

Further relationships between values, metacognitive insight and polarisation

Additionally, the exploratory analyses were useful to provide valuable background insights into the relationship between the examined variables. While metacognition, as measured in this study, could not prove influence to attitudes of nuclear power, values indeed were related to them. The regressions underlines the pre-assumptions that egoistic and biospheric values were related to the attitudes towards nuclear power. In addition, a national sense of belonging plays a strong role as well when it comes to the attitude towards nuclear power, offering alternative non-psychological explanations of attitude formation and shift processes. This is not suprising, as the topic is globally very politicised (e.g. Brouard & Guinaudeau, 2015; Ylönen et al., 2017), and the politics and therefore attitudes of the Netherlands and Germany have taken quite different courses; the Germans being more opposed to nuclear power, ultimately also due to their call for the "Energiewende" (Wang & Kim, 2018; Jahn & Korolczuk, 2012).

Further exploratory analyses could not confirm that metacognition might be impaired by extreme attitudes, neither that it is related to any attitude shifts. Whether the aforementioned methodological flaws are the reason for that finding should be tested further.

Theoretical implications

This study can be seen as a valuable start of studying the relationship between values, polarisation about nuclear power, and metacognition. Being first to explore the relationship not just between values and polarisation, but also including potential mitigators for polarising shifts, means offering an encouraging model of relationships that should be considered in

future research as well, not at least because metacognition could, due to its complexity, need a more thorough theoretical understanding and exploration of its potential to reduce extremising attitudes in individuals. Further, the study highlighted the significance of egoistic values in polarising atittudes, an important finding for value research stressing that egoistic values might in some contexts have unique characteristics in not just shaping, but also extremising attitudes.

Practical implications

Practical implications should be taken with care from this study, as not all results were clear enough to rely on them. Nevertheless, the assumption that nuclear power is a contested topic with a roughly 50/50 %-distributed attitude holds in this study, making it clear that the matter must be handled with care, and that there is an urgent need for understanding the underlying psychological factors causing this divide. Most prominent when regarding the results are egoistic values in the polarisation shifts. If one aims to depolarise the debate around nuclear power, they should make sure that people do not feel attacked in their personal lifes, e.g. that prices would increase, as those with high egoistic values might pay especially attention to those matters and hold on to their opinion even stronger.

Also, that people do change their attitude even on such a long-known topic in diverse directions after being confronted with information must be absorbed attentively, as it shows the importance with what and how people are being informed. Anything is not better than nothing when trying to depolarise people. In this study, two thirds of the participants changed in their attitude (either polarised or depolarised), in contrast to the study by Görsch et al. (2025), in which "acceptability judgements of established technologies only slightly changed" (p. 10). These diverse findings mirror the complexity of the topic and the variety of related (and probably still unexplored) factors that one will be confronted with when intending e.g. a deliberation round to depolarise or to gain approval for a nuclear project.

Limitations and future research suggestions

This study has some limitations that will be discussed in the following. First, the sample size was too small, not just when comparing it to the demanded 395 observations, but also when looking at the actual sample sizes used in the analyses. As less than a third of the participants have polarised, the calculations were carried out with roughly 40 observations each in the Approval and Opposition Group, which is insufficient to draw reliable conclusions or to see effects. Potential effects of the variables may have been hidden due to low sample sizes, especially as several predictors were added to one model. Future studies should ensure to reach a sufficient sample size in order to be able to see effects.

Secondly, the operationalisation of some variables might not have been ideal. First, the attitude scale might not have been the suitable tool for this matter. In polarised topics, people tend to already have extreme attitudes, for which cases a Likert scale offers no option to indicate a polarised attitude of an already extreme attitude, though this population tends to polarise the most likely (Taber & Lodge, 2006). That this might be relevant is already reflected in the distribution of attitudes in Figure 4, as the attitutes indicated most often where those on the far ends of the scale – who can not indicate a shift towards a more extreme stance. Due to this fact, the study first was supposed to also include a self-report-polarisation scale, as suggested by Wojcieszak (2011), which was finally not included due to repetitiveness and practicality. Using that scale would be a valuable addition in further research as polarisation of those holding extreme views can be detected beyond the borders of a Likert scale.

Also, the attitude scale was not labelled exhaustively; only the 7 and 1 got a caption: that can result in people thinking that 3 is already slight agreement, and so the operationalisation of polarisation, with the formulas used in this study, might not accurately reflect participants' attitude shift; using the 4 as middle is artificial and not communicated to

the participants. This flaw can easily be prevented in future studies, in order to separate a polarisation process from other kinds of attitude shifts.

A last note on the operationalisation of variables concerns the metacognition scale. As there is no validated scale to use because metacognitive ability is domain specific (Fischer & Fleming, 2024; Fischer et al., 2019), the scale had to be created without blue prints. Probably, the chosen items were not variable enough to reflect a diversity of responses and therefore certainties, as the latter was in the majority of items spread across the whole scale rather than showing a trend towards one side. For future studies, it is advised to pre-test the scale, being able to improve their differential potential.

Lastly, as the assumtions for the regression calculated for H1b were violated, and all measures to solve this (transformation of skewed variables and potentially deleting outliers) failed, it is questionnable whether a multiple linear regression was in fact the right choice for checking this hypothesis. But as the predictors of the model were correlated (see Table 4), a correlation was not feasible either.

Conclusion

Taken together, the study used a promising model of to date unstudied relationships between variables relevant to understand individual polarisation dynamics. Polarisation as a psychological phenomenon is still not fully understood in research while contributing to a pressing issue in societies, calling for practical understanding. This study adds to this understanding in stressing the importance of core values in attitude formation and giving insights into the dynamics of it, the fluctuation and proportion of polarisation in diverse populations. It is noteworthy that people in this study have shifted their attitudes due to yet unexplored reasons, polarising and depolarising in the same amount.

Though values were not significantly related to these processes, egoistic values seem to be important in polarising attitudes towards nuclear power nevertheless, and exploratory

analyses could back findings for values being related to the attitude towards nuclear power. Probably values are not inducing polarisation, though, and other psychological forces are at play that have caused the majority of participants to shift in their attitudes.

Metacognition meanwhile is largely unexplored in this context, though connecting the research branches makes sense regarding their theoretical implications. Both polarisation and metacognititon are procedures linked to the processing and incorporation of information. The need for understanding the psychological mechanisms that could drive polarisation is clear when regarding how motivated reasoning can be induced, reduced and contributing to polarisation. This study took a first step towards linking the concepts and combining them in a model that can also be of practical use, although the results of the underpowered study do not provide any significant results, and the operationalisation might also need improvements to detect relationships between metacogniton, values and polarising attitudes. Replicating and improving this study design along the suggested lines is strongly recommended.

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Appendix A

Questionnaire material

Value scale

Below you will find 16 values. Behind each value there is a short explanation concerning the meaning of the value. Could you please rate how important each value is for you **AS A GUIDING PRINCIPLE IN YOUR LIFE?** The rating scale is as follows: 0 means the value is *not important at all*; it is not relevant as a guiding principle in your life 3 means the value is *important* 6 means the value is *very important* -1 means the value is *opposed* to the principles that guide you 7 means the value is of *supreme importance* as a guiding principle in your life; ordinarily there are no more than two such values Your scores can vary from -1 up to 7. The higher the number (-1, 0, 1, 2, 3, 4, 5, 6, 7), the more important the value is as a guiding principle in YOUR life. Try to distinguish as much as possible between your ratings of the values by using different numbers.

Table A1

The items and their response options of the value scale.

	Opposed to my values	Not important	Important					Very important	Of supreme importance
V1: EQUALITY: equal opportunity for all	-1	0	1	2 3 4	5			6	7
V2: RESPECTING THE EARTH: harmony with other species	-1	0	1	2 3 4	5			6	7
V3: SOCIAL POWER: control	-1	0	1	2 3 4	5			6	7

over others, dominance								
V4: PLEASURE: joy, gratification of desires	-1	0	1	2	3	4 5	6	7
V5: UNITY WITH NATURE: fitting into nature	-1	0	1	2	3	4 5	6	7
V6: A WORLD AT PEACE: free of war and conflict	-1	0	1	2	3	4 5	6	7
V7: WEALTH: material possessions, money	-1	0	1	2	3	4 5	6	7
V8: AUTHORITY: the right to lead or command	-1	0	1	2	3	4 5	6	7
V9: SOCIAL JUSTICE: correcting injustice, care for the weak	-1	0	1	2	3	4 5	6	7
V10: ENJOYING LIFE: enjoying food, sex, leisure, etc.	-1	0	1	2	3	4 5	6	7
V11: PROTECTING THE ENVIRONMENT: preserving nature	-1	0	1	2	3	4 5	6	7
V12: INFLUENTIAL: having an impact on people and events	-1	0	1	2	3	4 5	6	7
V13: HELPFUL: working for the welfare of others	-1	0	1	2	3	4 5	6	7

V14: PREVENTING POLLUTION: protecting natural resources	-1	0	1 2 3 4 5	6	7
V15: SELF-INDULGENT: doing pleasant things	-1	0	1 2 3 4 5	6	7
V16: AMBITIOUS: hard-working, aspiring	-1	0	1 2 3 4 5	6	7

Attitude Scale

Next, we want to know about your attitudes towards nuclear power as an energy source. We refer to nuclear power plants built for the purpose of providing energy. Nuclear weapons and alike are not implied here. Please indicate to what extend you agree with the following statements. If you are not feeling comfortable with answering certain questions, you can skip them.

Table A2

The items and their response options of the attitude scale.

Item	1 completely disagree	2 3 4 5 6 7 completely agree
I find the use of nuclear energy acceptable.		
I find it acceptable to build a new nuclear power station in my home country.		
I find it acceptable that a part of the overall energy mix in my home country consists of nuclear energy.		

I find it acceptable to use more nuclear energy in

my home country than is used now.

Metacognition Scale

In the following, we want to test how much you know already about nuclear energy. You will be provided with statements which can be either true or false. Please indicate what you believe the correct answer is (true or false), and in the following, rate your certainty that you are correct with your answer. If you choose the left side, 50, this indicates that you are not certain at all, and you were guessing. When you choose 100, this means that you are totally confident that your answer is correct.

Table A3

The items and their correct answers of the metacognition scale

Item	Correctness	Confidence
Nuclear power plants do not produce carbon dioxide or any other form of air pollution during operation.	True	How certain are you that your answer is correct? Rate your confidence between "guessing" and "100% sure"
The majority of uranium is mined in countries of the african continent.	False	
Russia accounts for roughly 40% of uranium processing worldwide.	True	
Of the 31 reactors that commenced construction since the beginning of 2017,	False	

the majority is of european design.	
You can only use uranium and no other elements to fuel a nuclear power plant.	False
After the Chernobyl accident, a radioactive cloud travelled around the earth, leading to contaminated soil and agricultural products in several european countries.	True
After the Fukushima accident, people are finally allowed to live in the immediate surrounding of the destroyed power plant again.	False
Nuclear energy has been produced since the 1970s.	False

Balanced Information Sheet

You will now be provided with some facts and information about nuclear power as it is now. All information is based on reliable sources (like the international energy agency) and reflect real-world facts. If you are interested in the source of the facts, there will be a reference list after the questions. Please read all statements carefully, even if some of the information does not seem to be new to you.

Did you know that...?

... a typical nuclear facility producing 1,000 megawatts of electricity takes up about one square mile of space. Comparatively, a wind farm producing the same amount of energy takes 360x more land area, and a large-scale solar farm uses 75x more space.

... the processes of mining, preparing and refining uranium, the resource to produce nuclear fuel, use energy and pollute CO_2.

... electricity from nuclear power will be cheap and reliable for decades to come, so that energy can be affordable for everyone.

... a final solution for storing nuclear waste safely for all humans (present and in future) has not been found yet, so that all current solutions are vulnerable to natural disasters, civil disruptions or political decisions.

... reaching the climate goals without the use of nuclear power would cost the world millions of Dollars more than with life extension of existing nuclear power plants and construction of new ones for the necessary baseline electricity in the grid.

… many projects building nuclear power plants take much longer and cost more than initially estimated (see chart). Delays are often between 5 and 13 years more than estimated construction time, and costs usually double to quadruple for new reactor types.

... for a country being able to use 100% renewable energy sources right now, the consumption and production of energy needs to be aligned, as not enough storage solutions exist in most countries up to now. This requires citizens to not use energy when there is low production, e.g. after sunset.

... as nuclear power can always provide a flexible baseline electricity in the grid, no change in energy consumption behaviour, e.g. when to cook, charge the devices and watch TV, is needed.

Home Country

Lastly, we want to know what you consider being your home country. This is not necessarily the country you have a passport from or where you were born, but which country is most important for you in terms of being at home.
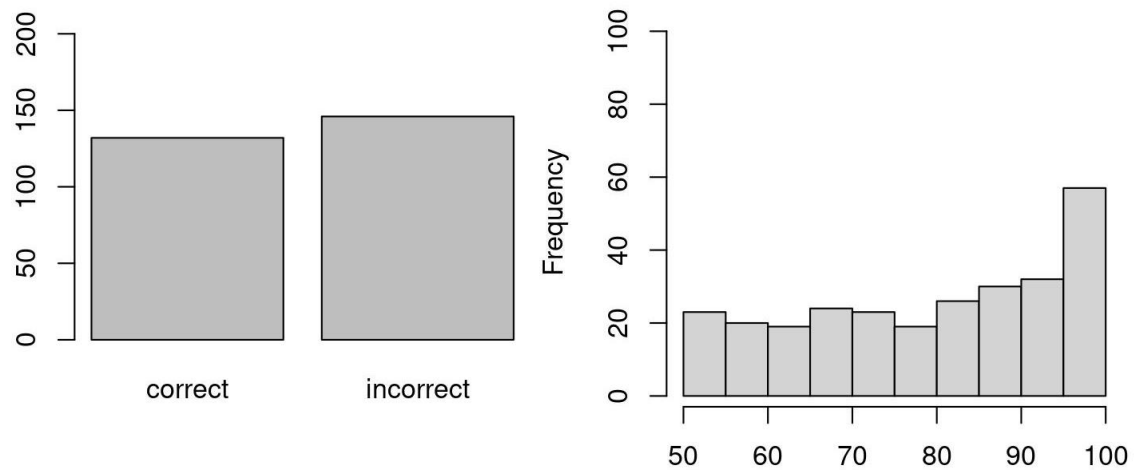
Germany   Netherlands   Other (indicate)

Appendix B

Descriptive statistics of the eight metacognition items
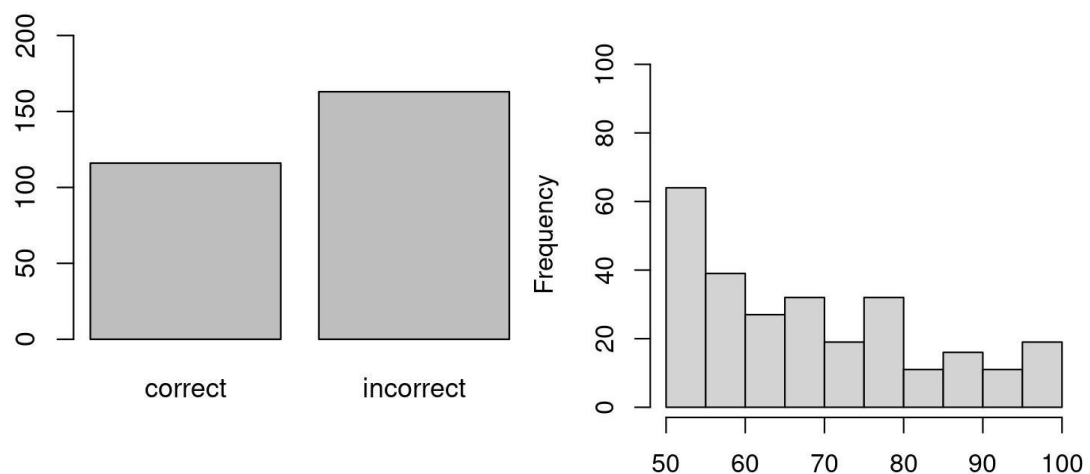
Figure B1

Distribution for item 1 correctness and certainty

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B2
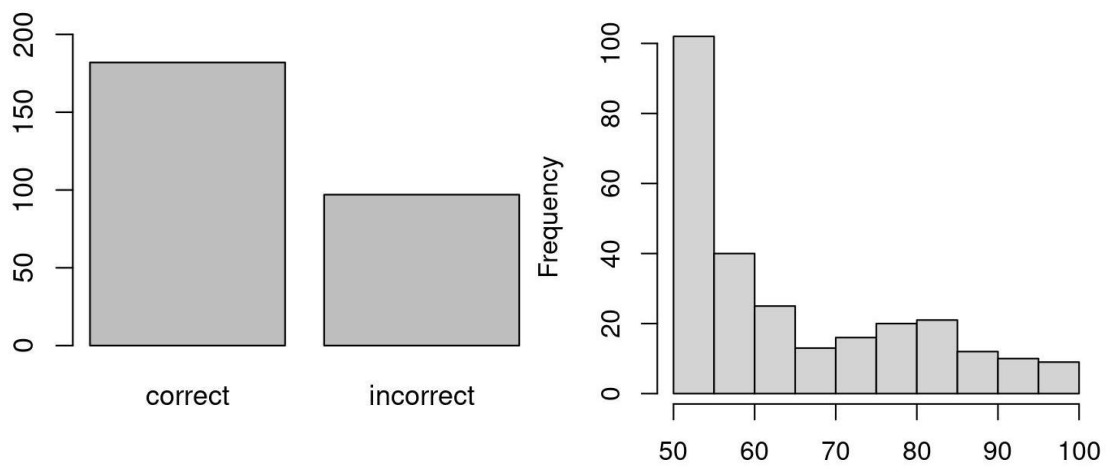
Distribution for item 2 correctness and certainty

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B3

Distribution for item 3 correctness and certainty

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B4

Distribution for item 4 correctness and certainty

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.
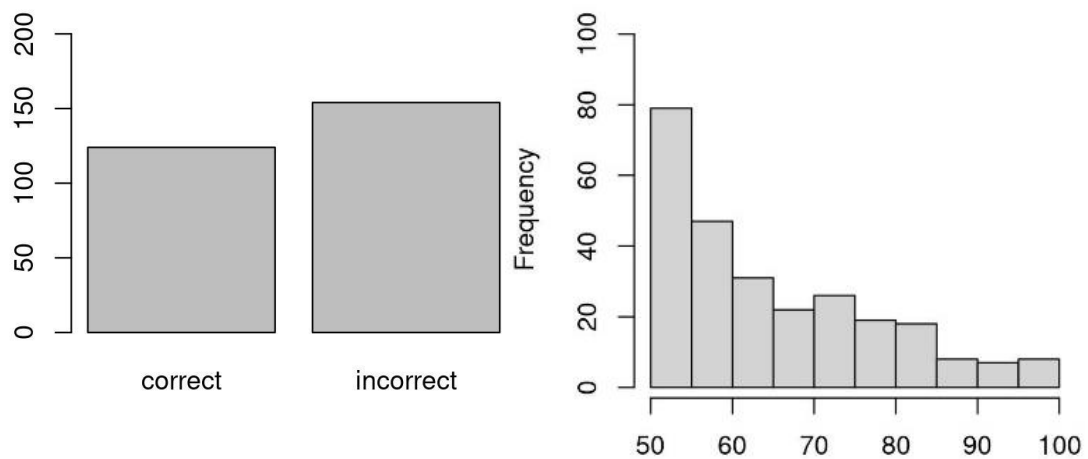
Figure B5

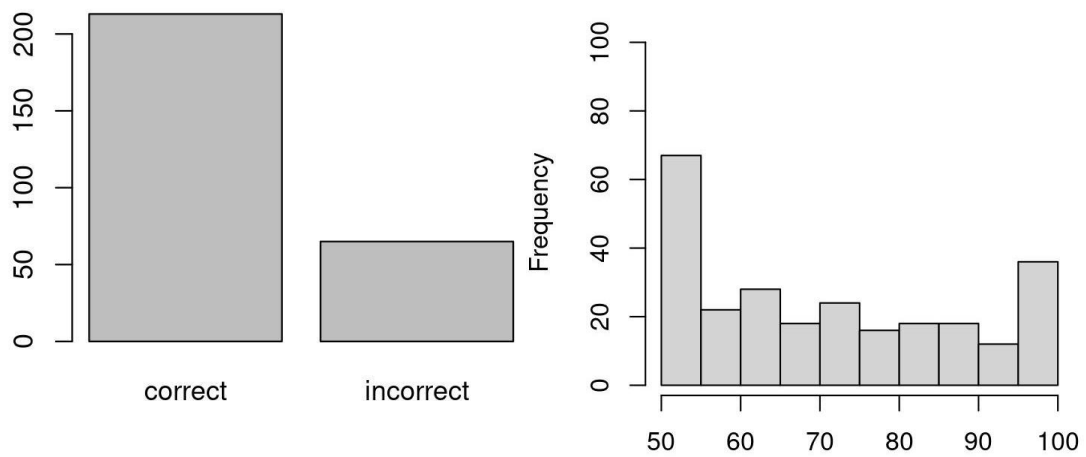*Distribution for item 5 correctness and certainty*

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B6

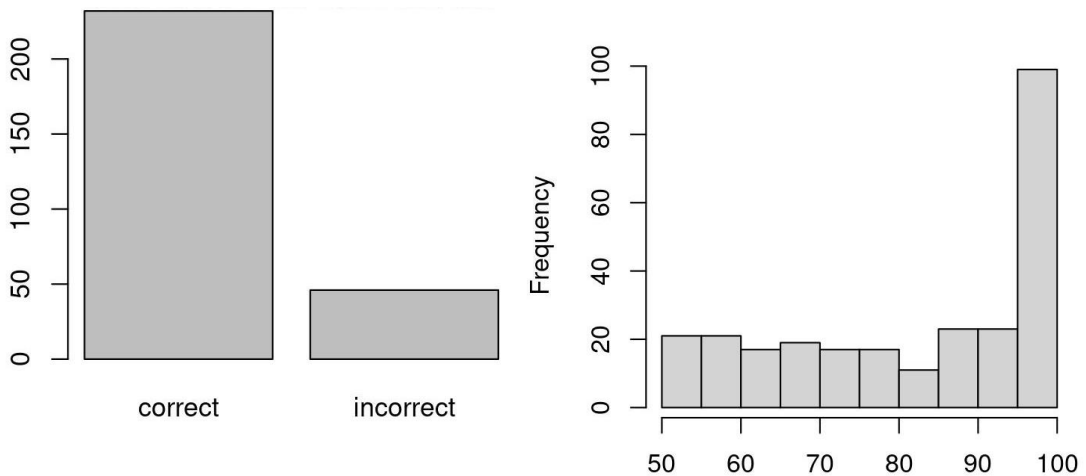*Distribution for item 6 correctness and certainty*

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B7

Distribution for item 7 correctness and certainty

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of

certainty ratings from 50% to 100% certainty is depicted on the right.

Figure B8

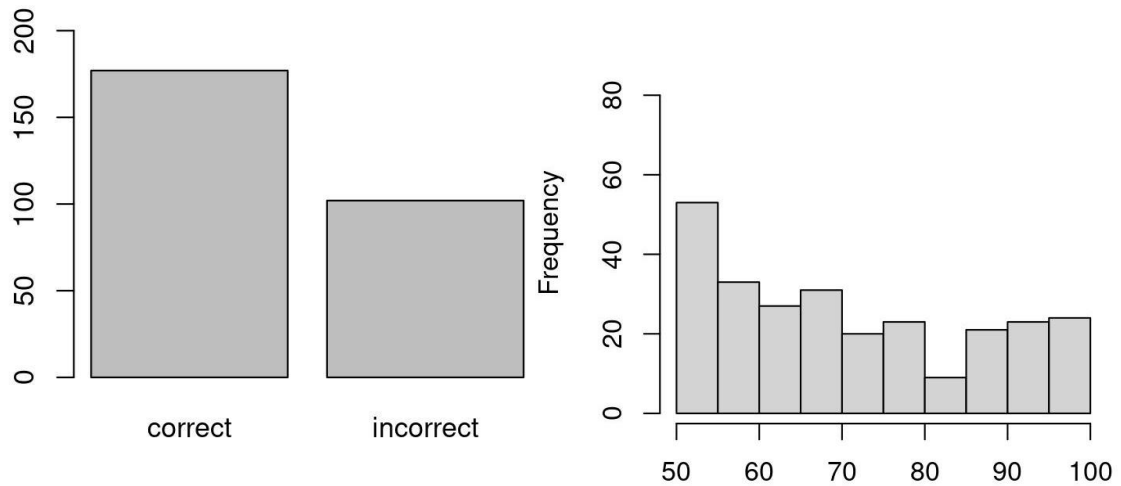*Distribution for item 8 correctness and certainty*
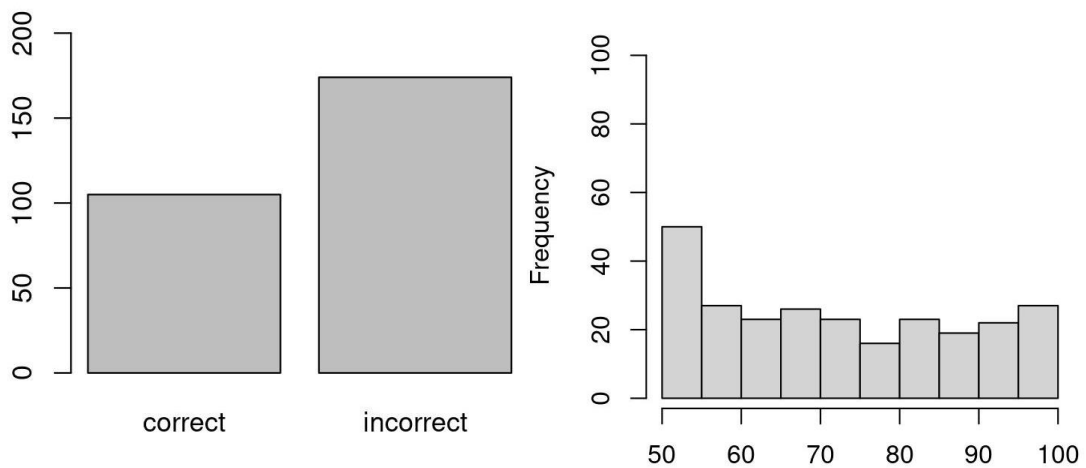

Note. Amounts of correct vs. incorrect responses are depicted on the left side; amount of

certainty ratings from 50% to 100% certainty is depicted on the right.

Appendix C

Further details on the main analyses

Hypothetic moderated regressions: Effect of metacognitive insight

Following the ethics request, moderator analyses were calculated despite the lack of significance of the former analyses, to comply with the requirements of a master thesis. Moderated regressions were calculated with interaction terms, using centered data to avoid multicollinearity. Two analyses were carried out this way, for the one for the egoistic scale and the hedonic scale calculated in the Approval Group and the one for the biospheric and altruistic scales in the Opposition Group, each with Polarisation as the DV, and the metacognition score as the moderator.

The two moderator analyses showed no effect of metacognition, nor a main effect of one of the predictors, in both groups. Following this result, metacognition does mot moderate the effect of values on polarisation, and hypothesis 2 can not be confirmed. The statistics are reported in Tables C1 and C2, respectively.

Table C1

Moderated multiple linear regression in the Approval Group

Effect	Estimate	*SE*	*t*	*p*
Intercept	- 0.33	.46	- 0.73	.47
Hedonic Values	0.02	.06	0.33	.74
Egoistic Values	0.08	.06	1.36	.19
Metacognition Score	0.31	.3	1.02	.32
Interaction hedonic x MCScore	- 0.33	.38	- 0.87	.39
Interaction egoistic x MCScore	0.16	.41	0.39	.70

Note. $R^2 = .19$, Adjusted $R^2 = .03$, $F(5, 25) = 1.17$, $p = .35$, dependent variable: log-transformed Polarisation.

Table C2

Moderated multiple linear regression in the Opposition Group

Effect	Estimate	SE	t	p
Intercept	1.79	.36	4.95	< .001
Biospheric Values	- .002	.07	- 0.23	.82
Altruistic Values	- 0.05	.06	- 0.83	.41
Metacognition Score	0.24	.3	0.81	.43
Interaction biospheric x MCScore	0.73	.49	1.49	.15
Interaction altruistic x MCScore	0.02	.4	0.04	.97

Note. $R^2 = .21$, Adjusted $R^2 = .05$, $F(5, 26) = 1.36$, $p = .27$, dependent variable: log-transformed Polarisation.

Assumption checks

For hypothesis H1a, the assumptions were met after a log-transformation of the dependent variable polarisation. The linear relationship was tested by plotting the variables against each other. As the sample size was quite small and the scale used was a Likert Scale, linearity is hard to observe in these plots. The variance inflation factor was below 5, which is why the data is not suffering by multicollinearity. The errors are independent too, as the Durbin-Watson-Test statistics are between 1.5 and 2.5. When plotting the fitted values against the residuals, a pattern with a roughly horizontal line resulted, and together with an insignificant Breusch-Pagan-Test, this shows homoscedasticity. Multivariate normality was tested with both a Q-Q plot and the Shapiro-Wilk-Test, which was insignificant, so it can be assumed that the residuals are normally distributed.

For hypothesis H1b, the same tests were run, but the log-transformation did not help this time to solve the violated multivariate normality. A short test showed that removing

influential cases did not change that fact, so that all observations were kept and it was accepted that one assumption is violated.

For the two moderator analyses for H2 (Appendix C), the same tests were used, and after log-transformation, all assumptions are met, solving multivariate linearity of the second model.

Appendix D

Further details on the exploratory analyses

Statistics of the exploratory analyses 3)

Table D1

Simple linear regression of the biospheric values

Effect	Estimate	*SE*	*t*	*p*
Intercept	5.26	.62	8.53	< .001
Biospheric Values	-0.36	.15	-2.39	.02

Note. R^2 = .02, Adjusted R^2 = .02, $F(1, 231) = 5.69$, $p = .02$, dependent variable: attitude T1 scale.

Table D2

Simple linear regression of the hedonic values

Effect	Estimate	*SE*	*t*	*p*
Intercept	3.18	.67	4.73	< .001
Hedonic Values	0.12	.16	0.78	.43

Note. R^2 = .003, Adjusted R^2 = -.002, $F(1, 221) = 0.61$, $p = .44$, dependent variable: attitude T1 scale.

Table D3

Simple linear regression of the altruistic values

Effect	Estimate	SE	t	p
Intercept	4.94	.61	8.08	< .001
Altruistic Values	-0.25	.15	-1.73	.09

Note. $R^2 = .01$, Adjusted $R^2 = .01$, $F(1, 229) = 2.99$, $p = .09$, dependent variable: attitude T1 scale.

Table D4

Simple linear regression of the egoistic values

Effect	Estimate	SE	t	p
Intercept	2.89	.46	6.33	< .001
Egoistic Values	0.28	.14	2	.046

Note. $R^2 = .02$, Adjusted $R^2 = .01$, $F(1, 277) = 4.02$, $p = .05$, dependent variable: attitude T1 scale.

Table D5

Simple linear regression of the biospheric values

Effect	Estimate	SE	t	p
Intercept	5.59	.6	9.34	< .001
Biospheric Values	-0.39	.15	-2.67	.008

Note. $R^2 = .03$, Adjusted $R^2 = .03$, $F(1, 223) = 7.12$, $p = .008$, dependent variable: attitude T2 scale.

Table D6

Simple linear regression of the hedonic values

Effect	Estimate	SE	t	p
Intercept	3.64	.67	5.47	< .001
Hedonic Values	0.07	.15	0.43	.67

Note. $R^2 = .001$, Adjusted $R^2 = -.004$, $F(1, 213) = 0.19$, $p = .67$, dependent variable: attitude T2 scale.

Table D7

Simple linear regression of the altruistic values

Effect	Estimate	SE	t	p
Intercept	5	.62	8.14	< .001
Altruistic Values	-0.22	.15	-1.51	.13

Note. $R^2 = .01$, Adjusted $R^2 = .01$, $F(1, 221) = 2.3$, $p = .13$, dependent variable: attitude T2 scale.

Table D8

Simple linear regression of the egoistic values

Effect	Estimate	SE	t	p
Intercept	3.22	.46	7.07	< .001
Egoistic Values	0.25	.14	1.77	.08

Note. $R^2 = .01$, Adjusted $R^2 = .01$, $F(1, 267) = 3.14$, $p = .08$, dependent variable: attitude T2 scale.

Statistics of the exploratory analyses 5)

Table D9

Simple linear regression of the biospheric values

Effect	Estimate	*SE*	*t*	*p*
Intercept	0.21	.26	0.84	.4
Biospheric Values	-0.02	.06	-0.25	.801

*Note. $R^2 = 0$, Adjusted $R^2 = -.004$, $F(1, 223) = 0.006$, $p = .8$, dependent variable: shift score.

Table D10

Simple linear regression of the altruistic values

Effect	Estimate	*SE*	*t*	*p*
Intercept	0.1	.25	0.4	.693
Altruistic Values	0.01	.06	0.1	.919

*Note. $R^2 = 0$, Adjusted $R^2 = -.005$, $F(1, 221) = 0.01$, $p = .919$, dependent variable: shift score.

Table D11

Simple linear regression of the hedonic values

Effect	Estimate	*SE*	*t*	*p*
Intercept	0.37	.28	1.32	.189
Hedonic Values	-0.05	.07	-0.79	.433

*Note. $R^2 = .003$, Adjusted $R^2 = -.002$, $F(1, 213) = 0.62$, $p = .43$, dependent variable: shift

score.

Table D12

Simple linear regression of the egoistic values

Effect	Estimate	SE	t	p
Intercept	0.48	.18	2.58	.01
Egoistic Values	-0.1	.06	-1.83	.07

Note. $R^2 = .012$, Adjusted $R^2 = .009$, $F(1, 267) = 3.35$, $p = .07$, dependent variable: shift score.

Statistics of the exploratory analyses 6)

Table D13

Simple linear regression of the biospheric values

Effect	Estimate	SE	t	p
Intercept	1.02	.05	19.42	< .001
Biospheric Values	0.01	.01	0.51	.61

Note. $R^2 = .001$, Adjusted $R^2 = -.003$, $F(1, 227) = 0.26$, $p = .61$, dependent variable:

metacognition score.

Table D14

Simple linear regression of the altruistic values

Effect	Estimate	SE	t	p
Intercept	0.96	.06	17.16	< .001
Altruistic Values	0.02	.01	1.84	.067

Note. $R^2 = .015$, Adjusted $R^2 = .011$, $F(1, 224) = 3.4$, $p = .067$, dependent variable:

metacognition score.

Table D15

Simple linear regression of the hedonic values

Effect	Estimate	*SE*	*t*	*p*
Intercept	1.13	.06	19.03	< .001
Hedonic Values	-0.02	.01	-1.3	.196

*Note. R^2 = .008, Adjusted R^2 = .003, $F(1, 217)$ = 1.68, p = .2, dependent variable: metacognition score.

Table D16

Simple linear regression of the egoistic values

Effect	Estimate	*SE*	*t*	*p*
Intercept	1.04	.04	25.34	< .001
Egoistic Values	0.01	.01	0.59	.555

*Note. R^2 = .001, Adjusted R^2 = -.002, $F(1, 272)$ = 0.35, p = .555, dependent variable: metacognition score.

Statistics of the exploratory analyses 7)

Table D17

Simple linear regression of the initially approving atittude

Effect	Estimate	*SE*	*t*	*p*
Intercept	0.95	.1	9.98	< .001
Biospheric Values	0.02	.02	1.34	.18

*Note. R^2 = .015, Adjusted R^2 = .007, $F(1, 115)$ = 1.8, p = .183, dependent variable: metacognition score.

Table D18

Simple linear regression of the initially opposing attitude

Effect	Estimate	*SE*	*t*	*p*
Intercept	1.03	.03	30.45	< .001
Altruistic Values	0.02	.02	0.91	.363

Note. R^2 = .006, Adjusted R^2 = -.001, $F(1, 137)$ = 3.4, p = .363, dependent variable:

metacognition score.