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Maria Ojala, Sonja Palmo & Sohvi Nuojua

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Trying to live sustainably in a not so sustainable society: dialectical thinking and black-and-white thinking are important for climate engagement among late adolescents

Maria Ojala[a,b], Sonja Palmo[a] and Sohvi Nuojua[a]

[a]Frontiers of Arctic and Global Resilience (FRONT) and Teacher Education School and Society (TESS), Faculty of Education and Psychology, University of Oulu, Oulu, Finland; [b]School of Behavioural, Social and Legal Sciences (Psychology), Örebro University, Örebro, Sweden

ABSTRACT

Young people use different thinking strategies to deal with conflicts related to climate engagement. The aim of this study was to investigate whether dialectical thinking, i.e. being able to transcend conflicting thoughts, and black-and-white thinking, i.e. either-or-thinking, are associated with climate engagement, and whether these possible connections remain significant when controlling for well-known predictors of climate engagement (gender, parental descriptive norms, attitudes, perceived knowledge, outcome expectancy and trust in science). Additionally, we investigate if these thinking strategies moderate the relationships between perceived knowledge and climate engagement as well as attitudes and climate engagement. Using survey data from two cohorts of late adolescents, Study 1 focuses on climate-friendly food choices ($N=470$) and Study 2 on climate-friendly behavior in general ($N=559$). Dialectical thinking was positively, and black-and-white thinking negatively, associated with climate engagement, in most cases also when including control variables. Higher levels of dialectical thinking strengthened the relationship between knowledge and engagement, implying that it might narrow the gap between knowledge and engagement among adolescents. We conclude that considering these thinking strategies in climate education could be important for climate engagement.

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Conflicts; thinking strategies; climate-friendly behavior; dialectical thinking; black-and-white thinking; climate education

1. Introduction

Societal actors at all levels – the macro-, meso- and micro-level – need to take part in mitigating climate change (Capstick, Khosla, and Wang 2021). One important group to include in these efforts is young people; they are the future leaders of society and influential citizens and consumers of today. Young people are highly concerned about climate change (Chiw and Ling 2019; Fløttum, Dahl, and Rivenes 2016; Gifford and

CONTACT Sonja Palmo sonja.palmo@oulu.fi Frontiers of Arctic and Global Resilience (FRONT) and Teacher Education School and Society (TESS), Faculty of Education and Psychology, University of Oulu, Oulu, FI-90014 Finland.
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Comeau 2011; Hickman et al. 2021; Jones and Davison 2021; Lewandowski et al. 2024), but they do not necessarily make more sustainable choices than older generations (Gifford and Comeau 2011; Jones and Davison 2021; Mead et al. 2012). Currently, most studies examining factors that promote climate engagement focus on adults. In this study, we concentrate on the important, yet understudied group of late adolescents. To get more knowledge about which factors could promote sustainable living in this age group is important for improving climate education and communication.

We take on a novel approach by focusing on one potential but less-studied predictor of climate engagement: thinking strategies that young people use to deal with conflicts when wanting to live more sustainably – in this case, more climate-friendly – in a not so sustainable society. Conflicts related to low outcome expectancy, i.e. feeling that one's climate actions do not matter, are prevalent among young people, even when they have positive attitudes towards and much knowledge about climate-friendly behaviors (Ballantyne, Wibeck, and Neset 2016; Jones and Davison 2021; Ojala 2022a, 2022b). Earlier qualitative studies have identified two main thinking strategies young people use to deal with these conflicts: black-and-white thinking, i.e. either-or-thinking, and dialectical thinking, i.e. the ability to transcend conflicting thoughts. These thinking strategies seem to be present among young people regarding climate-friendly food choices (Ojala 2022b) and sustainable behaviors more broadly (Ojala 2022a). Additionally, a pilot study with university students showed that black-and-white thinking had negative, and dialectical thinking positive, relations to making climate-friendly food choices (Ojala and Anniko 2020). No quantitative study has, however, focused on senior high-school students, nor has any study controlled for other well-known predictors of climate engagement, such as gender, descriptive norms and, importantly, outcome expectancy, to find out the possible unique influence of these thinking strategies. Investigating the importance of these thinking strategies is vital since they could be relatively easy to target in education to promote transformative learning and climate engagement (see Ojala 2022a, 2022b). Thus, this study could give valuable insights that teachers could utilize when educating about sustainability issues.

The aim is to investigate connections between thinking strategies and climate-friendly food choices (Study 1) and climate engagement in general (Study 2) by using data from survey studies with two cohorts of Swedish adolescents. We also investigate whether these thinking strategies moderate the expected associations between attitudes and perceived knowledge, on the one hand, and climate engagement, on the other.

We focus on private-sphere climate engagement, that is climate-friendly choices and behaviors that young people practice in everyday life, as well as attempts to influence others to be more climate engaged. Food choices contribute to climate change through both how food is produced and how it is transported, and making more climate-friendly food choices is one of the most efficient ways to fight the climate threat in everyday life (Nielsen et al. 2021). Although collective climate engagement, such as joining a climate organization or taking part in demonstrations, is vital for mitigating climate change, general private-sphere climate engagement, that we focus on in our second study (i.e. food choices, transportation, energy use and social influence), is also important for mitigating climate change, both because these behaviors have impact at an aggregated level (Nielsen et al. 2021; Schulte et al. 2020) and through their potential to influence social norms about how to live (Ojala 2022b).

1.1. Black-and-white thinking

The first way in which young people deal with conflicts related to climate engagement is by using black-and-white thinking (Ojala 2022a). Black-and-white thinking is a rigid cognitive style in which one makes assessments in terms of binary and mutually exclusive 'good-or-bad' opposites (Beck et al. 1979). Black-and-white thinking is related to perfectionism, and together these two tendencies can impede problem-solving efforts (He 2016). While mostly being studied among clinically depressed individuals, black-and-white thinking has also been found to reinforce and maintain feelings of hopelessness among general populations[1] (Alford and Beck 1997; Allen 2006; Beck et al. 1979; Burns 1999). In the general population, however, black-and-white thinking is more situation-specific (Babayan 2015; Kumari and Blackburn 1992; Younesi and Bahrami 2009; Zhang 2008), for example,concerning whether climate actions matter or not (Ojala 2022a).

In a qualitative study, Ojala (2022a) found that black-and-white thinking was quite common among young people who considered climate change to be important and who wanted to live more sustainably, but also experienced a lot of conflicts, foremost related to low outcome expectancy. Furthermore, Ojala and Anniko (2020) found that in a group of university students black-and-white thinking (arguing, e.g. that if not *all* people or countries are doing something about climate change [a conflict] there is *no point at all* in being engaged oneself [solution through black-and-white thinking], or if one is not *perfect* regarding eating more climate-friendly [a conflict] then there *is no point* in continuing trying [solution through black-and-white thinking]) was negatively related to climate-friendly food choices. Besides leading to low outcome expectancy and feelings of helplessness and hopelessness, black-and-white thinking could be a way to avoid responsibility by demanding unrealistic perfectionism (Allen 2006; Beck et al. 1979).

1.2. Dialectical thinking

An alternative way of thinking about, and dealing with, complex sustainability issues is to use dialectical thinking (Ojala 2022a, 2022b). Baumrind (2005, p. 22) defines dialectical thinking as: 'to emphasize a unity of opposites and to attempt to synthesize thesis and antithesis'. A core element in dialectical thinking is to embrace complexity by transcending dichotomies and conflicts. Dialectical thinkers tolerate contradictory information (Spencer-Rodgers et al. 2018). Opposites are not seen as problematic and contradictory but are used as building blocks for development, transformation and creative problem-solving (Basseches 2005; Kuczynski and Parkin 2007; O'Connor et al. 2025).

Dialectical thinking is a kind of postformal thinking; a developmental stage that is particularly significant in the late teenage years and early adulthood (Wu and Chiou 2008; Yang, Wan, and Chiou 2010). Some young people of this age start to think in a more holistic and flexible manner, which includes the ability to embrace perspectives that contrast with one another (Labouvie-Vief 2006; Sinnott 1998). Different life experiences, where one confronts and deals with conflicts between ideals and reality, contribute to challenging the idealistic black-and-white thinking that is relatively

common in the teenage years, and can lead to the development of postformal thinking (Wu and Chiou 2008).

Ojala's (2022a) study found that young adults who saved household energy despite a high degree of ambivalence used reasoning similar to dialectical thinking. They, for example, claimed that although their energy saving behavior is not going to 'solve' the climate problem [a conflict], they can at least be a part of the solution by being role models [solution through dialectical thinking]. Hence, they acknowledged both negative and positive aspects of energy-saving but went beyond this conflict by emphasizing a third element like 'one can at least be a role model' or 'someone needs to take the first step'. Dialectical thinking is relatively commonly used by young people actively trying to make climate-friendly food choices in everyday life (Ojala 2022b). In addition, a pilot study by Ojala and Anniko (2020) showed that dialectical thinking was a more potent predictor of climate-friendly food choices (positive predictor) than black-and-white thinking (negative predictor) among university students. However, there is need for studies exploring whether these relationships exist among late adolescents, regarding other kinds of climate engagement and when controlling for more well-known predictors of climate engagement.

1.3. Control variables and possible interactions

We also investigate whether black-and-white thinking and dialectical thinking have unique relationships to both climate-friendly food choices and climate-friendly behavior in general when controlling for already well-known predictors, which offers insights into the relative importance of these thinking strategies and thereby gives information about the practical relevance of targeting these thinking strategies in education.

Regarding already well-known predictors, young people with more positive environmental attitudes tend to be more engaged in pro-environmental behaviors (Meinhold and Malkus 2005), including food waste avoidance (Viccaro et al. 2023). Similarly, knowledge is an important antecedent of climate-friendly behavior among young people (Fielding and Head 2012; Kolenatý, Kroufek, and Činčera 2022), including climate-friendly food choices (McInnes, Carstairs, and Cecil 2023). We therefore include attitudes and perceived knowledge as control variables in our study. While being important in predicting pro-environmental behavior, the explanatory power of both attitudes (e.g. Meinhold and Malkus 2005) and knowledge (e.g. Fielding and Head 2012; Heeren et al. 2016) varies from small to large. Even if perceived knowledge about what actions to take to mitigate climate change is high and attitudes toward these actions are positive, one might also need to be able to deal constructively with conflicts related to, for example, low outcome expectancy (Ojala 2022b)[2]. Thus, we investigate whether the use of dialectical thinking strengthens, and the use of black-and-white thinking weakens, the relationships between perceived knowledge and climate engagement, and attitudes and climate engagement.

Social norms, especially descriptive norms, is one of the most potent predictors of pro-environmental behavior (Goldstein, Cialdini, and Griskevicius 2008). The young people who perceive that their parents make climate-friendly choices to a high degree are more inclined to make these choices themselves (Lawson et al. 2019; Senbel, Ngo, and Blair 2014); thus, we also control for parental descriptive norms. Although friends

are important influencers, parents seem to have the strongest impact on children's pro-environmental behavior in this age group (Evans, Otto, and Kaiser 2018; Stevenson, Peterson, and Bondell 2019).

Additionally, we control for gender and trust in climate science, the latter only in Study 2. Gender is an important factor in explaining climate-friendly food choices; for instance, willingness to restrict meat consumption and avoid food waste are more prevalent among women (Gotschi et al. 2009; Mäkiniemi and Vainio 2013; Tobler, Visschers, and Siegrist 2011). Women are also more engaged in climate-friendly behavior in general among adults (Elert and Lundin 2022) and young people (Korkala, Hugg, and Jaakkola 2014). Furthermore, trust in climate science is a vital factor for everyday climate engagement among adults (Cologna et al. 2024; Cologna and Siegrist 2020; Joffe-Nelson, Van Riper, and Stedman 2024) and for collective engagement and sustainable consumption among young people (Vainio and Paloniemi 2014; Wallis and Loy 2021).

Finally, we control for outcome expectancy in both studies to make sure that our measure of thinking strategies does not merely reflect outcome expectancy beliefs but explains some unique variance in climate engagement. Outcome expectancy concerns expectations about whether a behavior will lead to a desired outcome or not (Bandura 1977). Outcome expectancy has been found to be positively associated with climate engagement (Collado and Evans 2019; Gregersen et al. 2021). The conceptual difference between outcome expectancy and dialectical thinking is that dialectical thinking is about perceiving a conflict and transcending it with a third element (Baumrind 2005). Thus, dialectical thinking is more of an active process where one deals with conflicts, while outcome expectance is more of a static view or state about whether it is possible to influence climate change or not. From a theoretical perspective, these two concepts should, however, be rather closely related.

1.4. Conflicts and thinking strategies in an educational context

The thinking strategies in focus of this study could be important for sustainability and climate education. Many researchers claim that educating about climate change is not only about transferring facts about the problem, but about, for example, promoting action competence, including promoting different kinds of climate engagement (Olsson, Gericke, and Boeve-de Pauw 2022; Sziva et al. 2026) and transformative learning (Boström et al. 2018; Wals 2010). According to the action competence approach, students need to learn competences to mitigate climate change, both in the private sphere and as citizens (Mogensen and Schnack 2010; Olsson, Gericke, and Boeve-de Pauw 2022). Transformative learning goes one step further by emphasizing learning for profound social change where unsustainable perspectives, habits, norms and structures are challenged (Boström et al. 2018; Wals 2010).

One way to promote both the action competence approach to learning and transformative learning is to face, critically discuss and learn from the conflicts that arise when trying to live more sustainably in the rather unsustainable society we live in today (see Ojala 2022b; Trott 2021). However, if young people use black-and-white thinking to deal with these conflicts, it could lead to helplessness and giving up, while dialectical thinking instead has been argued to open learning processes and to be connected to agency and hope (Ojala 2022a). Therefore, challenging

black-and-white thinking and promoting dialectical thinking might be vital preconditions for succeeding with these learning approaches. However, empirical support in the form of quantitative studies focusing on these thinking strategies among senior high-school students is still missing.

1.5. Aim and research questions

The aim of the present study is to investigate whether and how the two thinking strategies, black-and-white thinking and dialectical thinking, are associated with climate engagement. We present no hypotheses due to limited research on this topic. Our research questions are the following:

RQ1: Are there significant associations between black-and-white thinking and dialectical thinking, on the one hand, and climate-friendly food choices and climate-friendly behavior in general, on the other hand?
RQ2: Are there significant associations between gender, descriptive norms (parents), attitudes, trust in science (only Study 2), outcome expectancy and perceived knowledge (the control variables), on the one hand, and climate-friendly food choices and climate-friendly behavior in general, on the other hand?
RQ3: Do black-and-white thinking and dialectical thinking have unique associations with reported climate-friendly food choices and climate-friendly behavior in general when including the above-mentioned control variables in regression models?
RQ4: Do dialectical thinking and black-and-white thinking moderate the relationships between perceived knowledge, on the one hand, and climate-friendly food choices and climate-friendly choices in general, on the other?
RQ5: Do dialectical thinking and black-and-white thinking moderate the relationships between attitudes toward climate-friendly choices, on the one hand, and climate-friendly food choices and climate-friendly choices in general, on the other?

3. Study 1

We use data from survey studies with two cohorts of Swedish late adolescents. The first study focuses on climate-friendly food choices. In addition to exploring dialectical thinking and black-and-white thinking as predictors of climate-friendly food choices, we investigate whether these thinking strategies are potential moderators between attitudes and climate-friendly food choices and between perceived knowledge and climate-friendly food choices.

3.1. Materials and methods

3.1.1. Participants and procedures

A sample of 480[3] Swedish high school students participated in this study by filling in an online survey. A total of six participants were excluded because of straight lining ($n = 3$), being older than 30 years ($n = 2$) or not completing the survey ($n = 1$). The mean age of the participants was 17.91 (SD = 0.68), with 90.6% of the

participants being 17 or 18 years old at the time of the study. Regarding self-reported gender, 58.4% of the participants identified as girls ($n = 277$) and 40.7% as boys ($n = 193$). Due to a very limited number of participants identifying as nonbinary (0.8%), these participants ($n = 4$) were excluded from the analyses. The final sample size was 470 participants.

The survey was distributed in eight high schools during regular school hours by trained test leaders. Teachers were not present in the classrooms. The collection of data took place from late 2019 to early 2020. Schools from small, medium and large communities in Sweden were targeted and the students came from different study-program orientations. Still, the sample should be seen as a convenience sample. Students were informed about ethics and the aim of the study. They did not receive any rewards and those who decided not to participate did schoolwork instead. The study was conducted following ethical guidelines stated in the Declaration of Helsinki. The study was accepted by the Swedish National Ethics committee (2019–03857).

3.1.2. Measures

Climate-friendly food choices (CFFC) was captured with an 8-item scale originally developed by Mäkiniemi and Vainio (2013). Participants were asked to rate on a 7-point scale (1 = Never; 2 = Less than once a year; 3 = Once or a few times a year; 4 = Once or a few times every six months; 5 = Once or a few times a month; 6 = Once or a few times a week; 7 = Almost every day or daily) how often they do the following things for climate reasons. Items included statements such as 'I try to choose food that has as little negative impact on climate as possible' and 'I avoid eating meat'. All Cronbach's alphas, means, and standard deviations are reported in Table 1.

A measure of *dialectical thinking* and *black-and-white thinking* was developed based on Ojala and Anniko (2020) and earlier qualitative studies (Ojala 2022a, 2022b). Participants were instructed to report their thoughts about climate-friendly food choices on a 5-point Likert-scale (1 = Does not apply at all; 5 = Applies very well). Dialectical thinking was measured with 10 items, black-and-white thinking with 6 items. The thinking strategies were captured by presenting a conflict (foremost related to low outcome efficacy) followed by a solution. For example: 'Even though many people don't care about eating in a climate-friendly way [a conflict], I can at least act as a role model and do my best [solution through dialectical thinking]' and 'If I'm not absolutely sure that my food choices affect the climate [a

Table 1. Descriptive Statistics and Correlations for Study Variables. Study 1.

Variable	*α*	*M*	*SD*	1	2	3	4	5	6	7	8
1. CFFC	.82	4.31	1.39	–							
2. BWT	.82	2.13	0.79	−0.44***	–						
3. DT	.89	3.79	0.76	.54***	−0.55***	–					
4. Knowledge	.81	3.36	0.95	.34***	−0.24***	.22***	–				
Attitudes	.82	3.43	0.81	.54***	−0.46***	.60***	.33***	–			
5. Norms	.74	3.02	1.00	.36***	−0.13**	.18***	.17***	.22***	–		
6. OutExp	.81	3.24	0.91	.31***	−0.35***	.49***	.12*	.42***	.16***	–	
7. Gender [a]				−0.32***	.26***	−0.35***	−0.01	−0.25***	−0.02	−0.30***	–

Note. $N = 470$. α = Cronbach's alpha for scale internal consistency reliability. *$p < .05$. **$p < 0.01$ ***$p < .001$.
[a]0 = young women, 1 = young men.

Table 2. Principal component analysis (PCA) for measures of thinking strategies.

	Rotated components	
Variable	Component 1	Component 2
1. Even though it is not certain that whether people throw away food or not has a large impact on the climate, I think it is good that I'm still doing my part.	**.75**	.01
2. Even though we can't see the climate impacts of our food choices today, they will have an effect on the climate in the future.	**.75**	−0.02
3. Although many people still don't make climate-smart food choices, more and more people have started to eat climate-friendly.	**.73**	.18
4. Even though many countries do not take the climate threat seriously, Sweden can act as a role model with regard to this.	**.73**	−0.07
5. If I don't always bother to think about making climate-smart food choices, I'll just try again at another time.	**.71**	.00
6. Even if the food choices I make don't make much of a difference, when many individuals do something small in their daily lives, the climate impacts become significant.	**.70**	−0.08
7. Although not enough people eat in a climate-friendly way, I usually think that someone has to take the first step.	**.69**	−0.07
8. Even though many people don't care about eating in a climate-friendly way, I can at least act as a role model and do my best.	**.68**	−0.07
9. Even if I can't be absolutely sure that my food choices have an effect on the climate, it is a bad excuse for not caring.	**.64**	−0.03
10. The fact that I am not perfect when it comes to climate-friendly food choices cannot be used as an excuse to do nothing at all.	**.63**	−0.03
11. Unless you have complete evidence that the food you choose is climate-friendly, you might as well forget about it.	.03	**.78**
12. Unless all people start to eat in a climate-friendly way, there is no point in me making climate-friendly food choices.	−0.07	**.75**
13. If I don't eat climate-friendly most of the time, there is no point trying to do it sometimes.	.05	**.73**
14. Unless all countries take the climate threat seriously there is no point in us Swedes making climate-smart food choices.	−0.08	**.68**
15. If I'm not absolutely sure that my food choices affect the climate, there is no point in me trying to make climate-friendly food choices.	.03	**.69**
16. There is no point in thinking about avoiding food waste unless everyone is doing so.	−0.09	**.66**

Note. Direct Oblimin rotation. Significant loadings in bold.

conflict], there is no point in me trying to make climate-friendly food choices [solution through black-and-white thinking]'. All items for both scales are reported in Table 2.

We conducted a principal component analysis (PCA) to investigate whether we can find two factors that correspond to the theoretical concepts of dialectical thinking and black-and-white thinking. The sampling adequacy was acceptable (KMO =0.92), and Bartlett's test of sphericity demonstrated that correlation between items was large enough for PCA ($\chi^2(120) = 2734.63$, $p < 0.001$). The PCA revealed two components that explained 51.58% of variance; component one Eigenvalue = 6.43 (variance explained = 40.16%) and component two Eigenvalue = 1.83 (variance explained = 11.42%). All measures loaded on one of the two components (Table 2). Component one was made up of items related to dialectical thinking, while the second factor represented black-and-white thinking.

Perceived knowledge was measured with three questions developed for this study: 'I have good knowledge of what food to choose that is good for the climate', 'I know what food to eat to reduce climate impact' and 'I have too little information to be able to make climate-friendly food choices (reversed)'. The participants were asked to respond on a 5-point scale (1 = Does not apply at all; 5 = Applies very well).

Parental descriptive norms were measured with two items ('My mother/father often eats climate-friendly') adapted from Pedersen, Grønhøj, and Thøgersen (2015). The two statements were responded on a 5-point scale (1 = Does not apply at all; 5 = Applies very well).

Attitudes toward climate-friendly food choices was measured with two items with a stem question 'My attitude toward making climate-friendly food choices is' followed by the participants being asked to estimate on a 5-point scale how positive or negative their attitude is (1 = Extremely negative; 5 = Extremely positive) and an alternative describing how favorable the participants think making climate-friendly food choices is (1 = Extremely unfavorable; 5 = Extremely favorable). The measure is adapted from Sparks et al. (2001).

Finally, *outcome expectancy* was measured with two questions adapted from Mead et al. (2012). One of the questions measured sense of individual-level outcome expectancy ('To what extent do you believe that your food choices can have a positive impact on climate issues [i.e. reduce climate impacts]?'), while the other measured sense of outcome expectancy on a collective level ('To what extent do you believe that the food choices of Swedish people can have a positive impact on climate issues [(i.e. reduce climate impacts]?'). Participants were asked to respond to these statements on a 5-point Likert scale (1 = Not at all; 5 = Very much).

4.1.3. Statistical analyses

To explore connections between variables of interest in RQ1 and RQ2, we conducted correlation analyses using Pearson's correlation coefficient (see Table 1). We used hierarchical regression analyses to assess whether the possible associations between thinking strategies and CFFC hold when considering control variables (RQ3). Finally, we conducted regression analyses with interaction terms included (Aiken and West 1991) to investigate whether dialectical thinking and black-and-white thinking moderate relations between perceived knowledge and CFFC (RQ4) as well as attitudes and CFFC (RQ5). For significant interaction effects, simple slopes analysis was used to further investigate these associations separately for those with high and low levels of dialectical thinking and black-and-white thinking (RQ4, RQ5).

Statistical program IBM SPSS Statistics 29.0.1.1 (IBM SPSS Statistics, Armonk, NY) was used for all statistical analyses, excluding simple slopes analysis, which was conducted with linear models in computer program jamovi 2.5.6 (The jamovi project 2024), using GAMLj module (Gallucci 2019, 2020). All the variables were standardized.

4.2. Results

4.2.1. Are there significant associations between thinking strategies and climate-friendly food choices? (RQ1)

Results of the correlation analyses show that CFFC correlates positively with dialectical thinking ($r = 0.54$, $p < 0.001$) and negatively with black-and-white thinking ($r = -0.44$, $p < 0.001$), indicating that young people high on dialectical thinking are more, and those high on black-and-white thinking are less likely to make climate-friendly food choices. The correlation regarding dialectical thinking is of a large, and the correlation concerning black-and-white thinking is of a medium, effect size (Cohen 1988).[4]

4.2.2. Are there associations between control variables and climate-friendly food choices? (RQ2)

Table 1 shows that CFFC is positively connected to perceived knowledge about climate-friendly food choices ($r = 0.34$, $p < 0.001$), attitudes toward climate-friendly food choices ($r = 0.54$, $p <. 001$), outcome expectancy ($r = 0.31$, $p < 0.001$) and descriptive norms (parents) ($r = 0.36$, $p < 0.001$). Thus, the more the young people perceive they have knowledge, the more positive attitudes they have, the more they believe in the impacts of the choices they and the Swedish people in general make, and the more they state that their parents make climate-friendly food choices, the more probable it is that they will make climate-friendly food choices. The correlations between food choices, perceived knowledge, outcome expectancy and descriptive norms were of a medium effect size, while the correlation with attitudes was of a large effect size (Cohen 1988). In addition, young women reported making more climate-friendly food choices than young men ($r = -0.32$, $p < 0.001$).

Although outside the research question, it is worth mentioning that gender was also statistically significantly associated with both thinking strategies, with young men being more likely to use black-and-white thinking ($r = 0.26$, $p < 0.001$) and young women more likely to use dialectical thinking ($r = -0.35$, $p < 0.001$), with the former having a small and the latter having a medium effect size (Cohen 1988).

4.2.3. Are the thinking strategies unique predictors of climate-friendly food choices? (RQ3)

We conducted a hierarchical regression analysis to examine the unique effects of black-and-white thinking and dialectical thinking on CFFC (see Table 3). In the first step, gender was entered, explaining 10% of the variance in CFFC (Adj. $R^2 = 0.10$, $F(1, 468) = 53.63$, $p < 0.001$). In the second step, all other control variables were added, including descriptive norms (parents), attitudes, outcome expectancy, and perceived knowledge. All control variables together explained 42% of the variance of CFFC (Adj.

Table 3. Summary of a hierarchical regression model predicting climate-friendly food choices. Study 1.

			95 % CI			
Effect	B	*SE*	*LL*	*UL*	*p*	R^2
Step 1					<.001	.10
Gender[a]	−0.65	.09	−0.83	−0.48	<.001	
Step 2					<.001	.42
Gender[a]	−0.43	.08	−0.58	−0.28	<.001	
Descriptive norms (parents)	.24	.04	.16	.31	<.001	
Attitudes	.36	.04	.28	.44	<.001	
Knowledge	.18	.04	.11	.25	<.001	
Outcome expectancy	.04	.04	−0.04	.12	.340	
Step 3					<.001	.47
Gender[a]	−0.32	.08	−0.47	−0.18	<.001	
Descriptive norms (parents)	.23	.04	.16	.30	<.001	
Attitudes	.23	.05	.14	.32	<.001	
Knowledge	.16	.04	.09	.23	<.001	
Outcome expectancy	−0.04	.04	−0.12	.04	.346	
Black-and-white thinking	−0.11	.04	−0.19	−0.03	.009	
Dialectical thinking	.23	.05	.13	.33	<.001	

Note. $N = 470$. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.
[a]0 = young women, 1 = young men.

R^2 = 0.42, F(5, 464) = 67.73, $p < 0.001$). In the third step, adding black-and-white thinking and dialectical thinking to the model explained an additional 5% of the variance (ΔR^2 = 0.05, $\Delta F(2, 462) = 20.92$, $p < 0.001$). Both thinking strategies were unique predictors of climate-friendly food choices (see Table 3). The final model explained 47% of the variance of climate-friendly food choices (Adj. R^2 = 0.46, F(7, 462) = 58.51, $p < 0.001$). All values of Variance Inflation Factor (VIF) were under the value of 5 (ranging from 1.07 to 2.06), suggesting that multicollinearity is not an issue in the model (Shrestha 2020).

4.2.4. Do the two thinking strategies moderate the relation between knowledge and climate-friendly food choices? (RQ4)

To explore whether the two thinking strategies moderate the relationship between perceived knowledge and CFFC, we conducted two additional hierarchical regression analyses separately for each thinking strategy. The regression table is available in the Supplementary Material. In the first regression model, we examined moderation effects of dialectical thinking. The model shows that the interaction term *perceived knowledge * dialectical thinking* was significant ($B = 0.07$, 95% CI [0.01; 0.13], $p = 0.018$), explaining an additional 1% of the variance (ΔR^2 = 0.01, $\Delta F(1, 462) = 5.66$, $p = 0.018$) and indicating that dialectical thinking moderates the relationship between perceived knowledge and CFFC even when controlling for control variables. In total, the model explained 47% of the variance in CFFC (Adj. R^2 = 0.46, F(7, 462) = 58.18, $p < 0.001$).

Results of simple slopes analysis show that perceived knowledge predicted CFFC significantly and positively for young adults with both high and low levels of dialectical thinking, but the relationship was stronger for those with high levels of dialectical thinking ($B = 0.25$, 95% CI [0.15; 0.36], $p < 0.001$) compared to those with low levels of dialectical thinking ($B = 0.11$, 95% CI [0.03; 0.20], $p = 0.008$; see Figure 1). This moderation effect illustrates that the use of dialectical thinking strengthens the positive relation between perceived knowledge and CFFC.

Next, we conducted the same procedure for black-and-white thinking. Interaction term *perceived knowledge * black-and-white thinking* was not significant (B = –0.04, 95% CI [–0.11; 0.03], p = 0.235; $\Delta R^2 < 0.01$, $\Delta F(1, 462) = 1.41$, $p = 0.235$) when the control

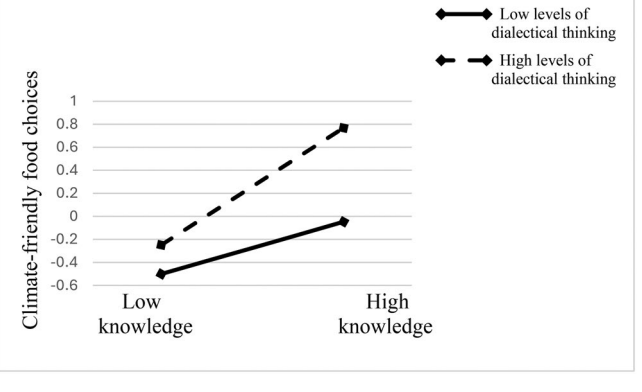

Figure 1. High degree of dialectical thinking strengthens the relationship between perceived knowledge and climate-friendly food choices. Study 1.
Note. High levels of dialectical thinking (High DT) = Mean + 1-SD; Low levels of dialectical thinking (Low DT) = Mean-1-SD.

variables were included in the model. The final model explained 45% of the variance in CFFC (Adj. R^2 = 0.44, F(7, 462) = 53.20, $p < 0.001$).

To summarize, the results indicated that dialectical thinking had a statistically significant, although quite small, moderation effect on the relationship between perceived knowledge and CFFC, while black-and-white thinking did not have a moderation effect in this context.

4.2.5. Do the two thinking strategies moderate the relation between attitudes and climate-friendly food choices? (RQ5)

Next, we explored whether black-and-white thinking and dialectical thinking are moderators in the relationship between attitudes and CFFC (see table in Supplementary Material). First, we explored the moderation effect of dialectical thinking by entering the interaction term *attitudes * dialectical thinking* to the last step of the model. The interaction term was not significant ($B = 0.02$, 95% CI [−0.04; 0.07], $p = 0.496$; $\Delta R^2 < 0.01$, $\Delta F(1, 462) = 0.46$, $p = 0.496$) when controlling for gender, parental descriptive norms, outcome expectancy, and perceived knowledge. The final model explained 46% of the variance in CFFC (Adj. R^2 = 0.45, F(7, 462) = 56.80, $p < 0.001$).

In the second model, we added the interaction term *attitudes * black-and-white thinking* to the model. The interaction term was not statistically significant (B = −0.01, 95% CI [−0.07; 0.05], $p = 0.666$; $\Delta R^2 < 0.01$, $\Delta F(1, 462) = 0.19$, $p = 0.666$), and the final model explained total of 45% of the variance of CFFC (Adj. R^2 = 0.44, F(7, 462) = 52.89, $p < 0.001$).

The results indicate that neither dialectical thinking nor black-and-white thinking moderates the relationship between attitudes and CFFC.

5. Study 2

In the second study, we explore whether the two thinking strategies are related to climate-friendly behavior in general. Furthermore, we explore whether thinking strategies moderate the associations between attitudes and perceived knowledge, on the one hand, and climate-friendly behavior, on the other.

5.1. Materials and methods

5.1.1. Participants and procedure

A sample of 619 Swedish high-school students participated in this study by filling in an online survey. Forty-three persons (6.9%) were excluded from the analyses because they completed the survey in under 7 min ($n = 12$; 1.9%), had a lot of missing values ($n = 19$; 3.1%) or showed an obvious response pattern (e.g. straight lining; $n = 12$; 2.0%). The mean age of the participants was 17.34 years (SD = 0.90), with 72.4% of the participants being 17 or 18 years old. About 57.8% reported identifying as girls ($n = 333$) and 39.2% as boys ($n = 226$). As only 2.8% of the participants reported identifying as nonbinary, these participants were excluded from the analyses due to the small number of respondents in this category ($n = 16$). Additionally, one person was excluded from the analytical sample due to missing background information. Thus, the final sample size in Study 2 was 559 participants.

Participants were recruited from 14 schools in small, medium, and large communities across central and south of Sweden, and we included students from different study programs at the senior high school level. As in Study 1, this study should be seen as based on a convenience sample. Data collection took place in 2023 between March and October. Trained test leaders collected data in classrooms during regular school hours. Teachers were not present. The participants received information about the study's aims and about ethical matters. Participation was voluntary, and participants did not receive any incentives. Students who did not want to participate engaged in regular schoolwork. The study was approved by the Swedish National Ethics Committee (2022–06822).

5.1.2. Measures

Black-and-white thinking, dialectical thinking, perceived knowledge, attitudes, outcome expectancy, and descriptive norms were measured using items similar to Study 1; however, the items were phrased to measure climate-friendly behavior more generally (see Table 4 and Supplementary Material). The Cronbach's alphas, means, and standard deviations are reported in Table 5.

Table 4. Confirmatory factor analysis for measures of thinking strategies. Study 2.

	Factor loading	
Variable	1	v
Factor 1: Dialectical thinking		
1. Even though it is not certain that trying to live more climate-friendly has any large impact on the climate, I think it is good that I'm doing my part anyway.	**.72**	
2. Even though we can't see the climate impacts of our climate-smart choices today, they will have an effect on the climate in the future.	**.53**	
3. Although many people still don't make climate-smart choices, more and more people have started to live climate-friendly.	**.30**	
4. Even though many countries do not take the climate threat seriously, Sweden can act as a role model with regard to this.	**.66**	
5. If I don't always bother to think about making climate-smart choices, I'll just try again at another time.	**.59**	
6. Even if the choices I make don't make much of a difference, when many individuals do something small in their daily lives, the climate impacts become significant.	**.56**	
7. Although not enough people live climate-friendly, I usually think that someone has to take the first step.	**.67**	
8. Even though many people don't care about living in a climate-friendly way, I can at least act as a role model and do my best.	**.73**	
9. Even if I can't be absolutely sure that my choices have an effect on the climate, it is a bad excuse for not caring.	**.64**	
10. The fact that I am not perfect when it comes to climate-friendly choices cannot be used as an excuse not to do anything at all.	**.60**	
Factor 2: Black-and-white thinking		
11. Unless you have complete evidence that the choices you make in your everyday life are climate-friendly, you might as well forget about it.		**.67**
12. Unless all people behave in a climate-friendly way, there is no point in me trying to live climate-friendly.		**.81**
13. If I don't behave climate-friendly most of the time, there is no point to try to do it sometimes.		**.63**
14. Unless all countries take the climate threat seriously there is no point in us Swedes living more climate-smart.		**.70**
15. If I'm not absolutely sure that my choices in everyday life affect the climate, there is no point in me trying to make climate-friendly food choices.		**.65**
16. There is no point in thinking about living in a more climate-smart way unless everyone is doing so.		**.77**

Note. Significant loadings on bold.

Table 5. Descriptive statistics and correlations for study variables. Study 2.

Variable	*α*	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. CFB	.87	2.97	0.75	–								
2. BWT	.86	2.05	0.76	−0.35***	–							
3. DT	.86	3.75	0.64	.59***	−0.62***	–						
4. Knowledge	.68	3.55	0.74	.36***	−0.36***	.43***	–					
5. Attitudes	.91	3.35	0.88	.64***	−0.49***	.66***	.41***	–				
6. Trust	.93	4.86	0.93	.50***	−0.53***	.70***	.44***	.63***	–			
7. Norms	.81	3.16	0.97	.46***	−0.30***	.41***	.30***	.46***	.39***	–		
8. OutExp	.76	3.35	0.90	.45***	−0.42***	.56***	.31***	.55***	.50***	.39***	–	
9. Gender[a]	–	–	–	−0.27***	.19***	−0.31***	−0.14**	−0.31***	−0.31***	−0.15***	−0.29***	–

Note. $N = 559$. α = Cronbach's alpha for scale internal consistency reliability. *$p < .05$. **$p < 0.01$ ***$p < .001$. [a]0 = young women, 1 = young men.

Climate-friendly behavior was measured with a 13-item scale developed by Ojala (2013). The participants were asked to respond to the question 'How often do you do the following things for climate or environmental reasons? Choose the answer that best applies to you' on a 5-point Likert-scale (1 = Almost never; 5 = Almost always). The items concerned individual private-sphere behaviors and items about interpersonal influence (e.g. 'Avoid flying', 'Try to get my parents [or equivalent] to behave more climate-friendly', 'Think about not buying things I don't really need').

In addition to the control variables included in Study 1, we included a measure of trust in science. *Trust in climate scientists and experts* was measured with a scale consisting of 7 items (e.g. 'I have trust in climate scientists when they claim that climate change is a serious problem', 'I have trust in scientific experts when they give advice on more climate-friendly transport methods'). Participants responded to the statements on a 6-point scale (1 = Does not apply at all; 6 = Applies very well).

To investigate whether we could find similar factors as we did in Study 1, we conducted a confirmatory factor analysis (CFA) with jamovi Computer Software, Version 2.5.6 (The jamovi project 2024), using maximum likelihood as an estimation method. Missing data was addressed using full information maximum likelihood (FIML). All included goodness of fit indices indicated a good fit of the CFA model (CFI = 0.93, TLI = 0.92, RMSEA = 0.06; 90% CI = [0.06, 0.07]). Covariance matrix is available in the Supplementary Material. The model confirms our expectation of two substantively distinct but intercorrelated factors that theoretically correspond to the concepts of black-and-white thinking and dialectical thinking, in line with results of the PCA conducted for Study 1.

5.1.3. Statistical analyses

Analyses were conducted similarly to Study 1, using IBM SPSS Statistics 29.0.1.1 for correlation and regression analyses, and using GAMLj module (Gallucci 2019, 2020) in jamovi (The jamovi project 2024) for simple slopes analyses. All variables were standardized.

5.2. Results

5.2.1. Are there significant associations between thinking strategies and climate-friendly behavior? (RQ1)

Results of correlation analysis show that climate-friendly behavior was positively related to dialectical thinking ($r = 0.59$, $p < 0.001$), and negatively associated with black-and-white thinking ($r = -0.35$, $p < 0.001$), indicating that the more the young people use dialectical thinking the more probable it is that they behave more climate-friendly in general, and the more they use black-and-white thinking the less likely it is that they behave climate-friendly. In line with the results of Study 1, the effect size for dialectical thinking is large, while it is of a medium strength for black-and-white thinking (Cohen 1988).

5.2.2. Are there associations between control variables and climate-friendly behavior? (RQ2)

Climate-friendly behavior correlated positively with all control variables: perceived knowledge about climate-friendly behavior ($r = 0.36$, $p < 0.001$), attitudes toward

climate-friendly behavior ($r = 0.64$, $p < 0.001$), trust in science ($r = 0.50$, $p < 0.001$), outcome expectancy ($r = 0.45$, $p < 0.001$), and parental descriptive norms ($r = 0.46$, $p < 0.001$). The effect sizes were large for attitudes and trust, and medium for the other control variables (see Cohen 1988).

Gender correlated negatively with climate-friendly behavior ($r = -0.27$, $p < 0.001$), indicating that young women report more climate-friendly behavior than young men. Furthermore, gender correlated with both thinking strategies, with young men using more black-and-white thinking ($r = 0.19$, $p < 0.001$) and young women using more dialectical thinking ($r = -0.31$, $p < 0.001$).

5.2.3. Are the thinking strategies unique predictors of climate-friendly behavior? (RQ3)

We investigated with a hierarchical regression whether the thinking strategies are unique predictors of climate-friendly behavior. In the first step, gender was entered to the model as a control variable, explaining 8% of the variance in climate-friendly behavior (Adj. $R^2 = 0.07$, $F(1, 557) = 44.91$, $p < 0.001$). In the second step, descriptive norms, trust in science, attitudes, outcome expectancy, and perceived knowledge were added, and all control variables together explained 46% of the variance of the outcome variable (Adj. $R^2 = 0.46$, $F(5, 552) = 78.98$, $p < 0.001$). First, similar to Study 1, we conducted a regression model with both thinking strategies added in the third step. Adding both thinking strategies in the model explained additional 3% of the variance ($\Delta R^2 = 0.03$, $\Delta F(2, 550) = 13.53$, $p < 0.001$), and the final model explained 49% of the variance of climate-friendly behavior (Adj. $R^2 = 0.48$, $F(8, 550) = 65.31$, $p < 0.001$) (see Supplementary Material). Results of this model indicate that, similar to our finding in Study 1, both dialectical thinking and black-and-white thinking are the unique predictors of climate-friendly behavior. However, contrary to Study 1, black-and-white thinking showed a positive coefficient that could not be explained by a multicollinearity issue (VIF values ranged from 1.15 to 2.82; Shrestha 2020), suggesting a suppression effect (i.e. an effect that occurs when including a predictor in the multiple regression model has a reversing effect on another predictor's relationship with the dependent variable; Hodson and Prusaczyk 2024). Additionally, we investigated whether trust in climate science (a new control variable for Study 2) could have influenced the result regarding black-and-white thinking, but removing this control variable did not change the result. Thus, to enable reliable inferences regarding the relationship between the two thinking strategies and climate-friendly behavior, we examined the two thinking strategies in two separate alternative models by adding only one thinking strategy at a time in the third step of each model.

In the first alternative model, black-and-white thinking was not a significant predictor of climate-friendly behavior ($\Delta R^2 < 0.01$, $\Delta F(1, 551) = 0.39$, $p = 0.535$), with the final model explaining 46% of the variance of climate-friendly behavior (Adj. $R^2 = 0.46$, $F(7, 551) = 67.68$, $p < 0.001$) (Table 6). The second alternative model, in turn, showed that adding dialectical thinking increased the explanatory power of the model by 2% ($\Delta R^2 = 0.02$, $\Delta F(1, 551) = 21.68$, $p < 0.001$) (Table 7). This model explained a total of 48% of the variance in the outcome variable (Adj. $R^2 = 0.48$, $F(7, 551) = 73.33$, $p < 0.001$). These results suggest that dialectical thinking is a robust positive predictor of climate-friendly behavior across different models. Black-and-white thinking, on the

Table 6. Summary of a Hierarchical Regression Model Predicting Climate-Friendly Behavior. Study 2.

			95 % CI			
Effect	B	*SE*	*LL*	*UL*	*p*	R^2
Step 1					<.001	.08
Gender[a]	−0.55	.08	−0.71	−0.39	<.001	
Step 2					<.001	.46
Gender[a]	−0.13	.07	−0.26	.00	.058	
Descriptive norms (parents)	.18	.04	.11	.25	<.001	
Trust	.09	.04	.02	.17	.042	
Attitudes	.42	.05	.33	.51	<.001	
Perceived knowledge	.07	.04	−0.00	.14	.059	
Outcome expectancy	.07	.04	−0.01	.15	.080	
Step 3					<.001	.46
Gender[a]	−0.13	.07	−0.26	.01	.059	
Descriptive norms (parents)	.18	.04	.11	.25	<.001	
Trust	.10	.05	.01	.18	.034	
Attitudes	.42	.05	.33	.51	<.001	
Perceived knowledge	.07	.04	.00	.14	.052	
Outcome expectancy	.07	.04	−0.01	.15	.069	
Black-and-white thinking	.02	.04	−0.05	.10	.535	

Note. $N = 559$. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.
[a]0 = young women, 1 = young men.

Table 7. Summary of a Hierarchical Regression Model Predicting Climate-Friendly Behavior. Study 2.

			95 % CI			
Effect	B	*SE*	*LL*	*UL*	*p*	R^2
Step 1					<.001	.08
Gender[a]	−0.55	.08	−0.71	−0.39	<.001	
Step 2					<.001	.46
Gender[a]	−0.13	.07	−0.26	.00	.058	
Descriptive norms (parents)	.18	.04	.11	.25	<.001	
Trust	.09	.04	.00	.17	.042	
Attitudes	.42	.05	.33	.51	<.001	
Perceived knowledge	.07	.04	−0.00	.14	.059	
Outcome expectancy	.07	.04	−0.01	.15	.080	
Step 3					<.001	.48
Gender[a]	−0.11	.07	−0.24	.03	.112	
Descriptive norms (parents)	.17	.04	.10	.24	<.001	
Trust	.00	.05	−0.09	.09	.995	
Attitudes	.36	.05	.27	.45	<.001	
Perceived knowledge	.05	.04	−0.02	.12	.175	
Outcome expectancy	.03	.04	−0.05	.11	.449	
Dialectical thinking	.23	.05	.13	.32	<.100	

Note. $N = 559$. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.
[a]0 = young women, 1 = young men.

other hand, seems to be sensitive to model specification, making the interpretation of its role as an independent predictor of climate-friendly behavior less clear.

5.2.4. Do the two thinking strategies moderate the relation between perceived knowledge and climate-friendly behavior? (RQ4)

We conducted two additional regression models to explore separately whether dialectical thinking and black-and-white thinking moderate the relationship between perceived knowledge and climate-friendly behavior, while controlling for gender, trust,

descriptive norms, attitudes, outcome expectancy and perceived knowledge (see table in Supplementary Material).

To explore the possible moderation effect of dialectical thinking, in a third step in the hierarchical regression model we entered the interaction term *perceived knowledge * dialectical thinking* into the model, finding a statistically significant moderation effect ($B = 0.06$, 95% CI [0.00; 0.12], $p = 0.036$; $\Delta R^2 < 0.01$, $\Delta F(1, 550) = 4.44$, $p = 0.036$). The final model explained 49% of the variance in climate-friendly behavior (Adj. $R^2 = 0.48$, $F(8, 550) = 65.12$, $p < 0.001$).

Simple slopes analysis was conducted to investigate further the detected statistically significant interaction effect (Aiken and West 1991). Results indicate that perceived knowledge predicted climate-friendly behavior for young people high on dialectical thinking ($B = 0.10$, 95% CI [0.02; 0.19], $p = 0.019$) but not for those with low levels of dialectical thinking ($B = -0.02$, 95% CI [−0.11; 0.07], $p = 0.736$; see Figure 2), suggesting that perceived knowledge predicts climate-friendly behavior only for those who use dialectical thinking to a larger extent, which is in line with the results from Study 1.

Thereafter, we explored the moderation effects of black-and-white thinking on the relationship between perceived knowledge and climate-friendly behavior. When controlling for other variables the interaction term *perceived knowledge * black-and-white thinking* was significant ($B = -0.07$, 95% CI [−0.13; −0.01], $p = 0.017$; $\Delta R^2 = 0.01$, $\Delta F(1, 550) = 5.75$, $p = 0.017$). The final model explained a total of 47% of the variance in climate-friendly behavior (Adj. $R^2 = 0.46$, $F(8, 550) = 60.45$, $p < 0.001$).

Simple slopes analysis indicated that perceived knowledge significantly predicted climate-friendly behavior for participants with low levels of black-and-white thinking ($B = 0.14$, 95% CI [0.05; 0.23], $p = 0.003$), but not for those with high levels of black-and-white thinking ($B < 0.01$, 95% CI [−0.09; 0.09] $p = 0.984$; see Figure 3). This moderation effect implies that among those who report they have good knowledge about which behaviors are climate-friendly, those who use black-and-white thinking to a low degree are more inclined to be climate-engaged than those high on black-and-white thinking.

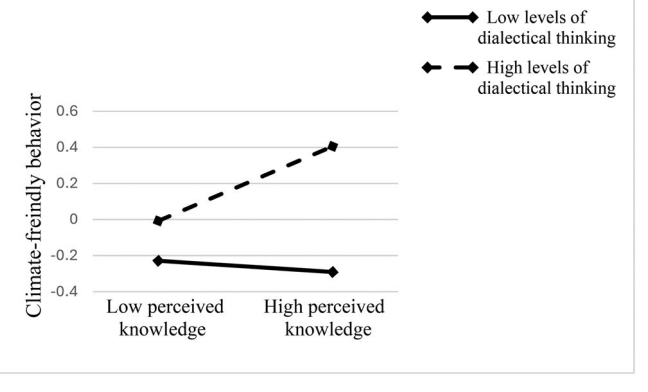

Figure 2. High degree of dialectical thinking strengthens the relationship between knowledge and climate-friendly behavior. Study 2.
Note. High levels of dialectical thinking (High DT) = Mean + 1-SD; Low levels of dialectical thinking (Low DT) = Mean-1-SD.

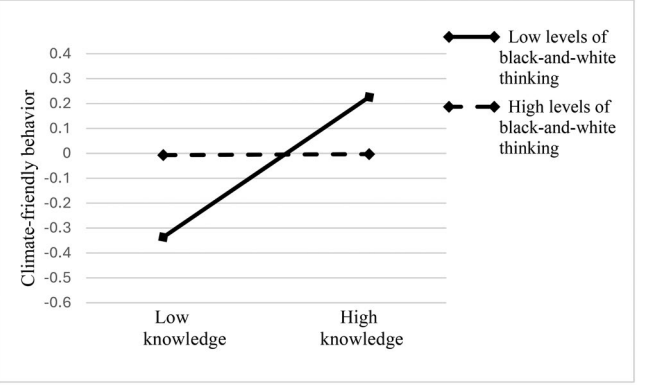

Figure 3. Low degree of black-and-white thinking strengthens the relationship between perceived knowledge and climate-friendly behavior. Study 2.
Note. High levels of black-and-white thinking (High BWT) = Mean + 1-SD; Low levels of black-and-white thinking (Low BWT) = Mean-1-SD.

In conclusion, both dialectical thinking and black-and-white thinking have quite small, yet significant moderation effects in the relationship between perceived knowledge and climate-friendly behavior in general.

5.2.5. Do the two thinking strategies moderate the relation between attitudes and climate-friendly behavior? (RQ5)

Similarly to Study 1, we conducted two additional regression analyses to explore whether dialectical thinking and black-and-white thinking moderate the relationship between attitudes toward climate-friendly behavior and climate-friendly behavior in general (see table in Supplementary Material). In the regression model exploring the moderation effects of dialectical thinking the interaction term *attitudes * dialectical thinking* was not significant ($B = 0.04$, 95% CI [−0.01; 0.09], $p = 0.106$; $\Delta R^2 < 0.01$, $\Delta F(1, 550) = 2.62$, $p = 0.106$) when controlling for gender, parental descriptive norms, trust in science, perceived knowledge, attitudes, and outcome expectancy. The final model explained 49% of the variance in climate-friendly behavior (Adj. $R^2 = 0.48$, $F(8, 550) = 64.68$, $p < 0.001$).

However, the interaction term *attitudes * black-and-white thinking* was significant ($B = -0.07$, 95% CI [−0.12; −0.01], $p = 0.014$; $\Delta R^2 = 0.01$, $\Delta F(1, 550) = 6.12$, $p = 0.014$), suggesting a very small but significant moderation effect of black-and-white thinking in the relationship between attitudes and climate-friendly behavior, when controlling for all the other variables. The final model explained 47% of the variance in the outcome variable (Adj. $R^2 = 0.46$, $F(8, 550) = 60.54$, $p < 0.001$).

We examined this interaction effect further using a simple slopes analysis. Results indicated that while there was a significant positive relationship between attitudes and climate-friendly behavior at both levels of black-and-white thinking, the relationship was stronger for young adults who are low on black-and-white thinking ($B = 0.50$, 95% CI [0.39; 0.60], $p < 0.001$) compared to those with high levels of black-and-white thinking ($B = 0.36$, 95% CI [0.25; 0.46], $p < 0.001$; see Figure 4). The result indicates that using black-and-white thinking weakens the relationship between positive attitudes toward climate-friendly behavior and climate-friendly behavior in general.

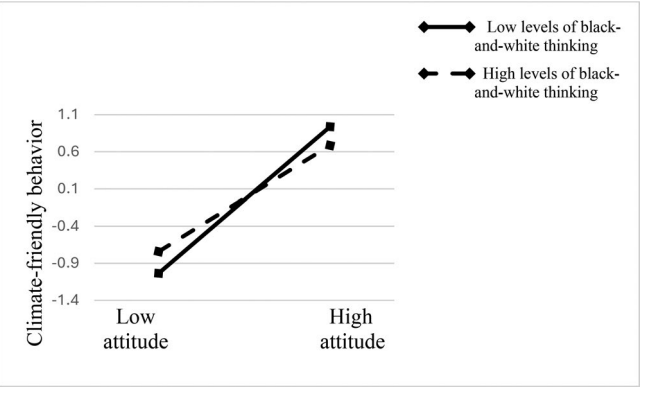

Figure 4. Low degree of black-and-white thinking strengthens the relationship between attitudes and climate-friendly behavior. Study 2.
Note. High levels of black-and-white thinking (High BWT) = Mean + 1-SD; Low levels of black-and-white thinking (Low BWT) = Mean-1-SD.

6. Discussion

The results of our two studies demonstrate that the two thinking strategies – black-and-white thinking and dialectical thinking – used to deal with behavioral conflicts had significant associations with both climate-friendly food choices and climate-friendly behavior in general. The positive associations between dialectical thinking and climate engagement remained significant in both studies when controlling for gender, descriptive norms (parents), outcome expectancy, perceived knowledge, and attitudes, as well as trust in climate scientists in Study 2, as did the negative association between black-and-white thinking and climate engagement in Study 1. These results suggest that dialectical thinking might be a constructive thinking strategy in the context of dealing with conflicts related to living more climate-friendly. Furthermore, among the late adolescents who used dialectical thinking to a higher degree, the relationship between perceived knowledge and the measures of climate engagement was in both studies stronger compared to the group that used this strategy less. Our studies also indicate that, based on the pilot study by Ojala and Anniko (2020), we have taken an important initial step to create a valid and reliable measure of dialectical thinking and black-and-white thinking, with both subscales relating to the outcome variables in expected ways, falling into two factors in both a PCA and a CFA, and having good internal consistencies.

6.1. Black-and-white thinking, dialectical thinking, and relations to climate-engagement

Results from both our studies show that black-and-white thinking was negatively related to both measures of climate engagement, suggesting that it could be a less constructive thinking strategy. Results from Study 1 show that this negative relationship between black-and-white thinking and climate-friendly food choices remains significant when controlling for other important factors. These outcomes support and extend results from an earlier interview study with late adolescents (Ojala 2022a),

and a quantitative pilot study with university students (Ojala and Anniko 2020). In Study 2, black-and-white thinking was reliably related to climate-friendly behavior only when not controlling for other predictors: first we included the two thinking strategies in the same regression model, but encountered a suppression effect where dialectical thinking interfered with the predictive validity of black-and-white thinking, flipping its sign from negative to positive (Hodson and Prusaczyk 2024). Although the detected suppression effect may simply be a statistical artifact, it signifies that more research is needed regarding the relationship between black-and-white thinking and climate engagement and implies that one should be careful to include the two thinking strategies in the same model.

Black-and-white thinking indicates a tendency to think in terms of absolutes, without acknowledging shades of gray, and, in studies outside the context of climate change, this way of thinking has been associated with experiences of hopelessness and helplessness (Alford and Beck 1997; Allen 2006; Beck et al. 1979; Burns 1999), possibly explaining why this thinking strategy was negatively related to climate engagement. Possible mediators of this kind, including hopelessness or low hope regarding climate change, ought to be investigated in future studies.

Besides indicating a less mature and less cognitively complex way of dealing with conflicts (see O'Connor et al., 2025), black-and-white thinking could be seen as an emotion-focused coping strategy. Through black-and-white thinking, negative emotions such as ambivalence concerning climate engagement are avoided by pushing responsibility to others and using perfectionism as an excuse for not acting (see Ojala and Anniko 2020). Thus, black-and-white thinking may be an obstacle in climate education, both in education aiming at promoting climate engagement in everyday life, which our empirical studies focus on, and potentially also in education aimed at transformative change (see Ojala 2022b). To avoid this, climate educators can help make young people aware of these strategies and show that there are other more constructive strategies to cope with these kinds of conflicts (O'Connor et al. 2025; Ojala 2022a, 2022b). Future studies should investigate whether black-and-white thinking is also negatively related to more collective behaviors and indicators of transformative learning.

The consistent results about the positive association between dialectical thinking, i.e. being able to acknowledge and transcend conflicts, and climate engagement support theoretical ideas (Lewis, Haase, and Trope 2020) and results from qualitative studies (Ojala 2022a, 2022b) as well as a quantitative pilot study with university students (Ojala and Anniko 2020). Wanting and trying to live more climate-friendly in a society that is rather unsustainable is a complex task, and as dialectical thinking is a more complex thinking strategy where integrating conflicting thoughts is central, investigating the potential of promoting this way of thinking in future studies could provide us with important information on how climate education could help young people deal with this complexity more constructively (see Ojala 2022a, 2022b). In addition, it would be interesting in future studies to investigate whether dialectical thinking, besides being positively related to climate engagement, is also related to hope concerning climate change, i.e. perceiving that there is still a possibility to mitigate climate change. Ojala (2022a) argued that dealing constructively with conflicts related to trying to live more climate-friendly through, for instance, dialectical thinking, could be seen as a form of agency work related to hope concerning climate change.

6.2. Moderating effects of the two thinking strategies

Our results also show that dialectical thinking consistently, and black-and-white thinking in Study 2, moderated the relationship between perceived knowledge and climate engagement. The most robust result was that there was a stronger relationship between perceived knowledge and both measures of climate engagement among the late adolescents who used dialectical thinking to a high degree. This result indicates that the ability to think dialectically, that is to acknowledge conflicts and transcend them with a third element (Baumrind 2005), might help young people translate their knowledge about making climate-friendly choices, whether in relation to food or in general, into action. However, as our studies are of a cross-sectional design, and our moderation analyses largely exploratory, more research is needed to confirm the directions of these relationships. In addition, the detected interaction effects were small in magnitude, which limits their practical importance and implications. Yet, the current work encourages future studies to investigate the interplay of dialectical thinking, perceived knowledge, and climate engagement further, and to ultimately investigate whether integrating elements of dialectical thinking in climate education could help narrow the well-known gap between knowledge and behavior (Meinhold and Malkus 2005).

Black-and-white thinking only worked as a moderator in Study 2, indicating that this thinking strategy weakens the relationship between perceived knowledge and climate-friendly behaviors in general. This could imply that black-and-white thinking is only vital regarding the relationship between perceived knowledge and general climate-friendly behavior, not food choices, but this could also be a spurious result. Future studies are needed to investigate this further.

Neither of the two thinking strategies moderated the relationship between attitudes and climate-friendly food choices. In addition, concerning the relationship between attitudes and climate-friendly behavior in general, only black-and-white thinking had a moderating effect, suggesting that young people with lower levels of black-and-white thinking are more likely to translate their positive attitudes toward climate-friendly behaviors into action. Nevertheless, this significant result needs to be interpreted with caution, and we need more studies covering these presumably complex relationships between attitudes, behavior, and thinking strategies.

Our challenge to detect significant moderation effects could reflect more general difficulties to detect interactions due to the need for very big sample sizes to not to miss interactions that are present in the population (i.e. commit a type 2 error) (McClelland and Judd 1993).

6.3. Limitations, strengths, and future studies

Regarding limitations of our studies, the first is related to using self-reported measures for climate engagement. Some people may be inclined to respond in a socially favorable way, decreasing the validity of our measures. A meta-analysis by Kormos and Gifford (2014) revealed that while in general the association between self-reported and actual pro-environmental behavior is strong, some caution is warranted when interpreting results from studies using self-reported measures.

Second, the use of a cross-sectional study design does not allow us to draw conclusions about the directions of the found associations. Third, we only measure perceived knowledge instead of objective knowledge, because objective measures of knowledge take a lot of space in a survey and could make young people feel that the survey is a school exam, potentially impacting their answers on the other measures. When interpreting the results, one should bear in mind that we focus on perceived knowledge.

Fourth, the results can only be generalized to senior high-school students living in Sweden. As our two studies only concern private-sphere behaviors and interpersonal influence, the results cannot be generalized to collective, civic, or political climate action. Future studies should be conducted in other cultural contexts and focus on collective climate action as well. In addition, the school context may have had some influence on our results, as the students within the same school or class may share factors (e.g. teachers or school culture) that affect their responses regarding, for example, thinking strategies or climate engagement. Clustering by school or class could be addressed with the estimation of intraclass correlations or accounted for with cluster-robust or multilevel models (Stapleton, McNeish, and Yang 2016), which was not possible in the current work as school and class identifiers were not retained to ensure the anonymity of the participants. Therefore, the reported standard errors and confidence intervals may be underestimated and should be interpreted with caution.

Lastly, our samples consisted of late adolescents who most probably still live with their parents. As young people are highly influenced by the choices of their parents (e.g. Lawson et al. 2019), we controlled for parental descriptive norms. However, late adolescents may also be influenced by the choices of their peers (e.g. Senbel, Ngo, and Blair 2014), which was not accounted for in this study.

Despite these limitations, the current studies have several strengths. First, to the best of our knowledge, this is the first quantitative research that covers black-and-white thinking and dialectical thinking and their unique relationships to reported climate engagement among late adolescents. Second, our studies draw conclusions from two samples of late adolescents focusing on related yet distinct behavioral outcomes. Having similar results in both studies provides support for our findings both in the context of climate-friendly food choices and climate-friendly behavior more generally. Furthermore, controlling for well-known predictors of pro-environmental behavior shows that especially dialectical thinking, but also black-and-white thinking in Study 1, have unique relationships with climate engagement and, therefore, are vital to investigate further in educational intervention studies. Furthermore, our results suggest that promoting dialectical thinking could help young people to translate their knowledge about climate-friendly choices into action.

Since this article focuses on two novel predictors of climate engagement, black-and-white thinking and dialectical thinking, it raises many new questions for future research. Although private-sphere climate engagement is important for mitigating climate change (e.g. Schulte et al. 2020), in future studies it would be interesting to investigate these thinking strategies in relation to conflicts regarding collective engagement to explore how they relate to continued engagement. In future quantitative studies, it would also be valuable to include possible emotions, like guilt and frustration, that young people feel in relation to behavioral conflicts. How young people cope with these emotions could also be important for whether climate engagement is continued.

6.4. Practical implications for education

Our results show that dialectical thinking is positively and black-and-white thinking negatively related to private-sphere climate engagement, including interpersonal influence. To work with agency to promote engagement is a vital part of the action competence approach to sustainability education (Mogensen and Schnack 2010; Olsson, Gericke, and Boeve-de Pauw 2022). Although we do not capture casual relationships in our study, one way to apply the action competence approach in climate education could be to promote dialectical thinking and critically discuss black-and-white thinking. Obviously, individual thinking strategies cannot substitute for institutional, political, or structural change. However, as young people are the future leaders of society, practicing dialectical thinking could make them more open to confront, critically discuss, and learn from the conflicts that arise when trying to live more sustainably in our current unsustainable society and, thereby, could promote transformative learning (Lewis, Haase, and Trope 2020; Ojala 2022b; Trott 2021). The possible positive role of dialectical thinking for promoting agency and transformative learning among young people would be interesting to investigate further in future intervention studies.

Earlier intervention studies show that dialectical thinking can be promoted in educational contexts through debates (Li et al. 2021) and argumentation mapping (Darmawansah, Hwang, and Lin 2024). Furthermore, problem-based learning, that is working with and discussing real-world problems in school, could be beneficial for dialectical thinking as a form of postformal thinking (Wynn, Ray, and Liu 2019). Promoting dialectical thinking among adults has also been found to reduce the tendency to use black-and-white thinking (O'Connor et al. 2025). Our studies indicate the potential utility of promoting dialectical thinking and challenging black-and-white thinking in the context of climate engagement, and future empirical studies are needed to investigate possible ways to address these strategies in climate education.

Institutional review board statement

Both studies presented in this paper were conducted in accordance with the Declaration of Helsinki and approved by the Swedish National Ethics Committee (2019–03857 [Study 1] and 2022–06822 [Study 2]).

Notes

1. Hopelessness can be conceptualized as '…a dysphoric state that involves the loss of expectation that adversity will yield and better days will come' (Bailey 2018, p.39).
2. See also Collado and Evans (2019) for arguments about the importance of outcome expectancy in these relationships.
3. A power analysis using pamlj module (Gallucci 2024) in jamovi (The jamovi project 2024) indicated approximately 115 participants were needed for detecting $r = .30$ correlations with statistical power of 90% (given $\alpha = .05$, two-sided), using a conservative expectation based on earlier research (Ojala and Anniko 2020).
4. Cohen (1988) considers correlations of $r > 0.1$ to be small, $r > 0.3$ to be medium and $r > 0.5$ to be large.

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Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Disclosure statement

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Author contributions

CRediT: **Maria Ojala**: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing; **Sonja Palmo**: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing; **Sohvi Nuojua**: Formal analysis, Supervision, Writing – review & editing.

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Notes on contributors

Maria Ojala, PhD, is a full professor of Socio-ecological Resilience at University of Oulu, in the FRONT (Frontiers of Arctic and Global Resilience) program. She also is Associate Professor in Psychology at Örebro University, Sweden. Her empirical research mainly focuses on quantitative and qualitative studies about how young people feel, cope, learn, and act concerning global sustainability issues, with a focus on climate change. In addition, she has written theoretical articles about hope and critical emotional awareness and implications for ESE and climate change education.

Sonja Palmo, M. Psych, is a doctoral researcher at the University of Oulu. Her research interests in the field of environmental and climate psychology include individual and collective climate engagement, emotions related to environmental problems, and coping with climate change.

Sohvi Nuojua, PhD, is a postdoctoral researcher and university teacher at the University of Oulu. Her research interests center around environmental psychology (e.g. nature connectedness, climate emotionality, and sustainability perceptions) and other themes in applied psychology (e.g. exercise psychology).

ORCID

Maria Ojala http://orcid.org/0000-0002-6613-5974
Sonja Palmo http://orcid.org/0000-0002-9282-8686
Sohvi Nuojua http://orcid.org/0000-0003-4438-8978

Data availability statement

The data is not publicly available due to that ethical approvals (2019–03857 [Study 1], 2022–06822 [Study 2]) do not include publicly accessible data, but can be shared with qualified users upon request.

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