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When sustainability aligns with adolescent motives: development and validation of the Sustainability Motive-Alignment Scale (SMAS)

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ABSTRACT

The sustainability motive-alignment hypothesis posits that adolescents will be motivated to act sustainably when they view sustainable behavior as aligned with their motives for autonomy and peer status. Based on this hypothesis, we developed the Sustainability Motive-Alignment Scale (SMAS), a brief self-report scale of individual differences in sustainability motive-alignment. In four studies across two relatively individualistic (U.S., Netherlands) and two relatively collectivistic countries (China, Colombia), the SMAS was reliable and valid as a single-factor scale; measurement invariant in terms of age and genders but measurement noninvariant in terms of culture, suggesting cultural differences in adolescents' construals of sustainability motive-alignment; and positively associated with measures of sustainable attitudes, norms, self-efficacy, behavior, and climate change knowledge. Thus, sustainability motive-alignment can be assessed as a conceptually distinct psychological dimension underlying adolescents' sustainable tendencies. We hope that our brief, psychometrically sound instrument will spark developmentally informed research on the psychological underpinnings of adolescent sustainability.


Introduction

Human activity is the root cause of the ecological crisis. As youth are the consumers, voters, and policy makers of the future, understanding and fostering their engagement in sustainability is a central component of efforts to transition into more sustainable ways of living. We define sustainability as all forms of eco-friendly behavior, that is, as behavior that either benefits the environment, or harms the environment as little as possible (Steg & Vlek, 2009). We rely on a recently proposed and developmentally informed approach to adolescent sustainability: the motive-alignment hypothesis (Thomaes et al., 2023). The hypothesis posits that adolescents will be motivated to act sustainably when they construe sustainable behavior as fulfilling core adolescent motives for autonomy and social status. Here, we present four studies on the development and validation of a scale that assesses individual differences in such motive-alignment, the Sustainability Motive-Alignment Scale (SMAS).

The puzzle of adolescent sustainability

Adolescence is the developmental period that begins with the onset of puberty (typically ages 10–12) and ends with the transition into adult societal roles (10–15 years later; Dahl et al., 2018). As a group, adolescents are concerned about state of our natural environment, even more so than adults (Corner et al., 2015; Hickman et al., 2021). Indeed, nearly 70% of youth worldwide view climate change as a global emergency, a higher percentage than that of older age groups (United Nations Development Programme, 2021). And yet, this does not mean that adolescents consistently act on their environmental concerns. In fact, research suggests that, compared to children and adults, adolescents are less inclined to behave sustainably as they go about their daily lives (Diamantopoulos et al., 2003; Evans et al., 2007; Krettenauer et al., 2020; Otto et al., 2019). What are the psychological barriers that keep adolescents from acting on their environmental concerns?

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To explain the psychological underpinnings of adolescent sustainability, pioneering work has applied theories about adult sustainability to samples of adolescents (e.g. the Theory of Planned Behavior, the Norm Activation Model, and the Social Identity Model of Pro-Environmental Action; de Leeuw et al., 2015; Klöckner & Blöbaum, 2010; Wallis & Loy, 2021). Such research has found that adolescent sustainability depends on a constellation of factors, including personal values, norms, identity processes, competences, control beliefs, and situational constraints. What is still lacking, however, is an understanding from the perspective of adolescent psychology—the psychological features and processes that are salient and consequential in adolescence, specifically.

We argue that research and policy to understand and promote sustainable behavior can be strengthened by leveraging core adolescent motives. While educational programs to promote adolescent sustainability can reasonably effectively instill knowledge, raise awareness, and encourage sustainable behaviors that are relatively easy to engage in (e.g. waste recycling; van de Wetering et al., 2021), their benefits tend to be more limited and short-lived when compared to similar programs targeting children (Liefländer et al., 2013; Liefländer & Bogner, 2014). A developmentally informed approach can help better understand and cultivate sustainability in adolescence.

The motive-alignment hypothesis

The motive-alignment hypothesis (Thomaes et al., 2023) is a developmentally informed approach positing that adolescents will be motivated to engage in sustainable behavior insofar as they construe such behavior as aligned with the fulfillment of motives that are especially salient in adolescence. The hypothesis focuses on two core adolescent motives—those for autonomy and peer status (LaFontana & Cillessen, 2010; Steinberg, 2014; Yeager et al., 2018). In adolescence, the autonomy motive drives the pursuit of agency and relative independence from parents and adult authority figures (Deci & Ryan, 2000; Meeus, 2018; Steinberg, 2014). Similarly, the status motive drives the pursuit of respect and acknowledgment from peers (LaFontana & Cillessen, 2010). Although the autonomy and status motives are relevant to individuals of all ages, they are especially salient and consequential during adolescence. This is partly due to biology: in both males and females, puberty involves steep increases in testosterone levels

(Braams et al., 2015) and in dopaminergic activity (Crone & Dahl, 2012). Testosterone fosters aspirational, competitive, and sometimes antagonistic behaviors associated with status pursuit (Casto & Edwards, 2016). Dopaminergic activity increases reward sensitivity, and fosters the novelty-seeking, exploratory behavior associated with autonomy pursuit (Crone & Dahl, 2012). Accordingly, adolescents have a strong need to be respected, heard, and seen.

The autonomy and status motives comprise the predominant psychological backdrop against which adolescents make sense of their social worlds and interpret others' expectations of and behaviors toward them. When adolescents perceive adults as steering their behavior in ways that constrain their agency or disrespect their perspectives, or when they perceive other authority figures (e.g. politicians, CEOs) as doing things that misalign with their ideals, they often express reactance: They may reject, confront, or rebel against them. While such reactance involves a level of risk (e.g. in some cases, it leads to oppositional problems, family conflict, or confrontations that result in disciplinary action), it can also take productive directions. For instance, it can empower adolescents' societal engagement or attract them to impactful societal movements that challenge the status quo (Braungart & Braungart, 2001; Duell & Steinberg, 2019; Pfundmair et al., 2021; Wray-Lake, 2019; Yeager et al., 2018). Indeed, adolescence is a period when individuals become especially sensitive to issues of justice, and start to grapple with how they can contribute to society (Fuligni, 2019). In adolescence, social justice concerns emerge at the juncture of adolescents' desire for autonomy and status. As a case in point, the 2018 emergence and subsequent worldwide success of the Fridays For Future movement against climate change illustrates how adolescents can self-organize to make a meaningful societal impact and tip the scales of environmental injustice. To be sure, engagement in sustainability, including environmental activism, is often fostered in the family (Grønhoj & Thøgersen, 2017), yet peer endorsement of such behaviors appears at least as important, if not more (de Leeuw et al., 2015; Wallis & Loy, 2021).

Thus, insofar as adolescents believe that sustainable behavior is a viable means to express their autonomy and gain peer status, they should be more motivated to engage in such behavior. Conversely, they may be less likely to engage in such behavior when they view sustainability as an enforced chore, irrelevant to their status. The aim of the present research is to create a

scale that captures individual differences in how adolescents construe sustainability.

Cross-cultural differences

It is possible that the motive-alignment hypothesis is more applicable in some cultures than in others. Although the motives for autonomy and status likely are universal (Anderson et al., 2015; Deci & Ryan, 2000; Nalipay et al., 2020), it is possible that they are differentially aligned with sustainability across cultures. For example, personal concerns and beliefs are more potent drivers of sustainable behavior in individualistic cultures as compared to more collectivistic ones (Eom et al., 2016; Krettenauer et al., 2020). By contrast, in more collectivistic cultures, sustainable behavior is more strongly dictated by social norms (Eom et al., 2016; Krettenauer et al., 2020). Although the individualism-collectivism dimension is only one of many ways in which cultural differences can manifest, such findings open the possibility that adolescents from different cultures construe motive-alignment differently. In the present research, we explore this possibility.

The present research

The aim of our research was to develop and validate a comprehensive but concise self-report scale—the SMAS—to assess individual differences in the extent to which adolescents construe sustainability as aligning with their core motives: as autonomy-assertive and status-enhancing. Participants were early and middle adolescents (ages 12–17). At this age, the autonomy and status motives become especially pronounced; the behaviors driven by these motives may still be relatively malleable; and young people possess the self-reflective skills to be aware of, and report on, their core motives (Crone & Dahl, 2012; Yeager et al., 2018). To test the cross-national validity of the scale, we recruited participants from four countries, two relatively individualistic (U.S., the Netherlands) and two relatively collectivistic (China, Colombia; Hofstede Insights, 2021). We conducted one non-registered (Study 1) and three pre-registered studies (Studies 2, 3, and 4). In Study 1, we developed the SMAS and examined its psychometric properties in a U.S. sample. In Study 2, we adapted the SMAS for use in different languages (Dutch, Chinese, and Spanish), and established its factor structure in a cross-national sample of Dutch, Chinese, and Colombian adolescents. In Studies 3 and 4, we mapped the nomological

network of the SMAS by examining associations with established correlates (Study 3) and objective indicators (Study 4) of sustainable engagement and behavior in Dutch samples. Finally, we pooled together the samples from all studies to investigate the measurement invariance of the SMAS across ages, genders, and countries. Studies 2–4 were preregistered on the Open Science Framework at https://osf.io/3e4tj/?view_only=153711585d7c4799bd07763cde4b347a. Instruments, data, and analysis code for all four studies are available on the Open Science Framework at https://osf.io/wd9jy/?view_only=8dbcc6408baf4e43a94393e8d980297a. All studies were approved by the Ethics committee of the Faculty of Social and Behavioral Sciences of Utrecht University, The Netherlands, protocol number 2010-03.

Study 1: Scale development

The aim of Study 1 was to select items for the final version of the SMAS from a larger pool of items. The study also explored the factor structure and internal consistency of the final Sustainability Motive-Alignment Scale.

Method

Participants and procedure

Participants were 500 adolescents from the United States (47% girls, 53% boys; 48% White, 17% Black, 11% Hispanic, 17% other, 7% not indicated) aged 16 (38%) to 17 (62%). They were recruited *via* survey platform Pollfish.

Initial item pool

The initial item pool contained 20 items. We wrote the items to assess adolescents' construal of sustainable behavior as autonomy-enhancing, addressing environmental justice concerns, and having social status appeal. Inspired by literature suggesting the overlap and synergy between the autonomy and status motives in adolescence (e.g. Bryan, 2020; Galla et al., 2021; Thomaes et al., 2023; Yeager et al., 2018) this item pool was broad in content coverage and parsimonious enough to capture these motives and their joint manifestations without the aim of creating a multidimensional scale that separates them. Items were scored on a 5-point Likert-type response scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Results and discussion

Item selection

We selected items from the initial item pool to construct a brief measure that comprehensively taps differential manifestations of sustainability motive-alignment. As a first step, we selected items on empirical grounds, based on two selection criteria. We retained items with high ($r_s > .50$) corrected item-total correlations (to strengthen internal consistency among items), and moderate ($r_s < .50$) inter-item correlations with other selected items (to avoid empirical redundancy among items). After this first step, we retained 11 items. As a second step, we selected items on conceptual grounds. Each author individually flagged items for removal if they were conceptually redundant with one (or more) of the other selected items, or, in retrospect, if they appeared to tap the content domain that we intend to assess less well. We excluded 3 items flagged for removal by at least two authors and retained 8 items. As a third step, we inspected the retained items to verify their comprehensiveness, and concluded that items tapping sustainability as autonomous expression in the form of assertiveness were underrepresented. We unanimously selected one of two such previously deleted items that were close to our empirical threshold of item-total correlation to include in the final scale. The nine items of the final scale sufficiently covered all aspects of sustainability

motive-alignment. Indeed, the unit-weighted sum of the nine items of the final SMAS correlated almost perfectly with the unit-weighted sum of the 20 items in the initial item pool, $r(498) = .96, p < .001$.

Scale dimensionality

We empirically explored the dimensionality of the SMAS through parallel factor analysis (FA) with 300 iterations, using both resampled and simulated data (Zwick & Velicer, 1986). In parallel analyses, factors are retained when the eigenvalue of each factor in the original data is greater than the eigenvalue of the corresponding component or factor in the resampled or simulated data (O'Connor, 2000). Results are presented in Table 1. The parallel FA suggested that a dual-factor solution might fit the data, though the eigenvalues of the first factor were considerably greater than those of the second.

Guided by the results of the parallel FA, we conducted an exploratory FA with maximum likelihood estimation and oblimin rotation, which resulted in good model fit, $\chi^2(19, N=500) = 18.22, p = .536$, CFI = 1.00, TLI = 1.00, RMSEA = 0.00, 95%CI RMSEA [0.000, 0.037], P-Close = .995, SRMR = .020 (Table 1). The two extracted factors were highly correlated ($r = .64$). Because we were unable to make a meaningful conceptual distinction between the two

Table 1. Results of parallel factor analysis (FA) and exploratory factor analyses (EFA) with 2-factor and 1-factor solutions in Study 1.

Factor	Parallel FA		
	Data Eigenvalues	Simulated Data Eigenvalues	Resampled Data Eigenvalues
1	3.02	0.60	0.61
2	0.32	0.16	0.16
3	0.07	0.10	0.11
4	0.04	0.06	0.06
5	-0.00	0.02	0.02
6	-0.07	-0.02	-0.02
7	-0.07	-0.06	-0.06
8	-0.11	-0.10	-0.10
9	-0.17	-0.16	-0.16

Items	2-Factor EFA		1-Factor EFA
	Factor 1 Loadings	Factor 2 Loadings	Factor Loadings
(item #3) By doing good things for the natural environment, I can express what I value as a person.	0.56	0.05	.50
(item #5) My generation should show that we can treat the earth better than older generations.	-0.11	0.69	.55
(item #9) When I do things that are sustainable, I feel like I am living my life in the way I want.	0.73	-0.03	.55
(item#10) People who buy or use sustainable products are cool (for example, people who eat sustainable food or buy sustainable clothes).	0.44	0.21	.56
(item #13) When it comes to taking care of the natural environment, older generations have a lot to learn from my generation.	-0.03	0.60	.55
(item#15) I would like it if others saw me as someone who cares about preventing climate change.	0.22	0.41	.58
(item#18) By doing good things for the natural environment, young people can stand up against people in positions of power who fail to protect the climate.	0.15	0.57	.68
(item#19) Young people, including myself, are fed up with governments and big companies doing very little to protect the climate.	0.02	0.67	.65
(item#20) Most young people respect individuals who are committed to conserving the earth.	0.18	0.44	.57

Note. We considered loadings above .40 as acceptable.

factors, we tested whether the SMAS maintains good psychometric properties as a single-factor scale. Results corroborated that it does, $\chi^2(27, N=500) = 76.93, p < .001, CFI = 0.952, TLI = 0.936, RMSEA = 0.06, 95\%CI RMSEA [0.045, 0.077], P-Close = .123, SRMR = .047$ (Table 1). All item loadings were satisfactory ($\geq .50$). The internal consistency of the single-factor scale was good ($\omega = .82, \alpha = .82$). Mean scale scores were overall relatively high ($M = 3.89, SD = 0.61$) and moderately left-skewed (skewness = $-0.52, kurtosis = .49$).

Discussion

To conclude, the Study 1 results show that the SMAS has good internal consistency and strong item loadings as a parsimonious, single-factor scale. These results also call for further scrutiny of the structure and psychometric properties of the SMAS. To this end, we conducted a new study with a larger sample, and we targeted adolescents in a different age range, living in three different countries.

Study 2: Cross-national adaptation

The aim of Study 2 was to adapt the SMAS for use in different languages, and to establish its factor structure in a cross-national sample. Although we preregistered measurement invariance analyses in this study, we conducted these analyses at a later stage, pooling the samples from all 4 studies. We conducted the study in the Netherlands, China, and Colombia.

Method

Scale translation

We translated the scale into Dutch ourselves (three of the authors are native Dutch speakers). To translate the scale into Chinese and Spanish, we hired professional native translators, experienced with translations for psychological research. First, a translator translated and adapted the scale using language appropriate for the cultural context and the adolescent age group. Then, another translator back-translated the scale into English. Finally, in collaboration with the first translator, we resolved discrepancies between the original and the back-translated scale. The scale is available in all four languages in the Appendix.

Participants and procedure

Participants were 5,244 (46.9% girls, 53.0% boys, 0.1% other) adolescents, ages 12–14 ($M = 13.07, SD = 0.79$).

We recruited participants in the Netherlands, China, and Colombia *via* the online survey panels of research company Kantar (Table 2 presents sample descriptives per country). Data was collected in the framework of a larger, ongoing, cross-national longitudinal study.

Results

Psychometric properties

We explored the dimensionality of the SMAS in the full sample through parallel FA with 300 iterations, using both resampled and simulated data (Zwick & Velicer, 1986). The preliminary results suggested the existence of four factors (Table 3). We extracted the four factors in an exploratory FA with maximum likelihood estimation and oblimin rotation, which resulted in good model fit, $\chi^2(6, N = 5,244) = 8.44, p = .208, CFI = 1.00, TLI = 0.999, RMSEA = 0.009, 95\%CI RMSEA [0.000, 0.021], P-Close = 1.00, SRMR = .004$ (Table 3). We extracted one 5-item factor, two 1-item factors, and one 2-item factor. Considering the limited usefulness of this factor solution, as well as the SMAS structure found in Study 1, we explored whether the SMAS would maintain good psychometric properties as a single-factor scale. It did, $\chi^2(27, N = 5,244) = 516.23, p < .001, CFI = 0.964, TLI = 0.953, RMSEA = 0.059, 95\%CI RMSEA [0.054, 0.063], P-Close = .001, SRMR = .035$ (Table 3). All item loadings were satisfactory ($\geq .45$). The internal consistency of the single-factor scale was good ($\omega = .84, \alpha = .84$). Mean scale scores were relatively high ($M = 4.04, SD = 0.62$) and left-skewed (skewness = $-1.04, kurtosis = 1.67$), not so much in the Netherlands ($M = 3.46, SD = 0.57$), but especially so in China ($M = 4.21, SD = 0.46$) and Colombia ($M = 4.24, SD = 0.57$).

Discussion

The results of Study 2 suggest that the SMAS has good internal consistency and item loadings as a unidimensional scale across countries. SMAS scores were overall quite high, especially in China and Colombia.

Table 2. Demographic information per country for participants of Study 2.

	The Netherlands	China	Colombia
N Participants	1,256	2,126	1,862
Age M (SD)	13.03 (0.81)	13.09 (0.79)	13.06 (0.78)
Gender			
Boys	649 (51.67%)	1202 (56.54%)	926 (49.73%)
Girls	601 (47.85%)	924 (43.46%)	936 (50.27%)
Other	6 (0.48%)	0 (0%)	0 (0%)

Table 3. Results of parallel factor analysis (FA) and exploratory factor analyses (EFA) with 4-factor and 1-factor solutions in Study 2.

Factor	Parallel FA		
	Data Eigenvalues	Simulated Data Eigenvalues	Resampled Data Eigenvalues
1	3.43	0.35	0.33
2	0.18	0.05	0.05
3	0.12	0.03	0.03
4	0.06	0.02	0.02
5	-0.01	0.01	0.01
6	-0.03	-0.01	-0.01
7	-0.04	-0.02	-0.02
8	-0.13	-0.03	-0.03
9	-0.14	-0.05	-0.05

Item	4-Factor EFA				1-Factor EFA
	Factor 1 Loadings	Factor 2 Loadings	Factor 3 Loadings	Factor 4 Loadings	Factor Loadings
1. By doing good things for the natural environment, I can express what I value as a person.	0.59	0.11	-0.02	-0.06	.56
2. My generation should show that we can treat the earth better than older generations.	0.61	-0.01	0.06	0.13	.64
3. When I do things that are sustainable, I feel like I am living my life in the way I want.	-0.05	0.74	-0.02	0.11	.74
4. People who buy or use sustainable products are cool (for example, people who eat sustainable food or buy sustainable clothes).	0.13	0.65	0.02	-0.06	.70
5. When it comes to taking care of the natural environment, older generations have a lot to learn from my generation.	0.00	0.00	1.01	0.00	.46
6. I would like it if others saw me as someone who cares about preventing climate change.	0.17	0.56	0.01	0.06	.74
7. By doing good things for the natural environment, young people can stand up against people in positions of power who fail to protect the climate.	0.02	0.44	0.05	0.22	.61
8. Young people, including myself, are fed up with governments and big companies doing very little to protect the climate.	0.04	0.05	0.02	0.75	.57
9. Most young people respect individuals who are committed to conserving the earth.	-0.04	0.55	0.10	-0.15	.45

Note. We considered loadings above .40 as acceptable.

One possible explanation is that social desirability concerns color participants' responses. Accordingly, in Study 3, we tested the possible effects of social desirability in examining the psychological and social correlates of motive-alignment.

Study 3: Psychological and social correlates

The aim of Study 3 was to confirm the factor structure and internal consistency of the SMAS, to explore its test-retest reliability, and to investigate its association with sustainable behavior and well-established correlates thereof: sustainable attitudes, which reflect the degree of favorable views about the natural environment; sustainable moral norms, which reflect the degree of obligation to behave sustainably; sustainable injunctive norms, which reflect the degree of perceived social expectations by close others to behave sustainably; sustainable descriptive norms, which reflect the degree of perceiving close others as behaving sustainably; and sustainable self-efficacy, which reflects the degree of belief that sustainable behaviors

are effective. We also examined whether sustainability motive-alignment would show incremental validity in predicting sustainable behavior above and beyond these correlates of sustainable behavior.

Method

Participants and procedure

Participants were 259 Dutch secondary school students (54.8% girls, 44.8% boys, 0.4% other; 78% Dutch, 19.7% mixed Dutch, 2.3% other ethnic identity), ages 12–17 ($M = 13.85$, $SD = 1.45$). The study took place during the SARS-COV-19 pandemic. We collected data (4.8% of which were missing completely at random for main variables, $p = .069$) during school hours, either at schools (84.2%) or remotely—depending on public health measures at the time. We also examined the test-retest reliability of the SMAS across approximately seven weeks ($M = 49.17$, $SD = 32.12$ days). The retest sample consisted of 104 (40.2% retention) adolescents (37.5% girls, 61.5% boys, 1% other), ages 12–17 ($M = 14.09$, $SD = 1.66$).

Adolescents who participated in the retest did not systematically differ in gender distribution from those who did not, $\chi^2(1) = 3.03, p = .082$. Adolescents who participated in the retest were significantly older than those who did not ($M = 13.68, SD = 1.26$ years), $t(180.22) = -2.099, p = .038, d = 0.28$.

Measures

Means, standard deviations, and reliability coefficients of the measures are presented in Table 4.

Primary variables

Sustainability motive-alignment

We measured sustainability motive-alignment with the 9-item SMAS.

Sustainable attitudes

We measured sustainable attitudes with the Revised New Ecological Paradigm Scale for Children (Manoli et al., 2007), a 10-item Likert response format (1 = *strongly disagree* to 5 = *strongly agree*) scale. After reverse-scoring three items, we averaged responses for the total scale score.

Sustainable behavior

We measured sustainable behavior with the Behavior-Based Environmental Attitude Scale (Kaiser et al., 2007), a 40-item scale with 33 Likert response format items (1 = *never*, to 5 = *very often*) and 7 binary response format items (1 = *no*, 2 = *yes*). After reverse-scoring items, we first binary coded Likert-type responses according to recommendations by Kaiser et al. (2007) (1, 2, 3 recoded as 0 = nonengagement in sustainable behavior, and 4, 5 recoded as 1 = engagement in sustainable behavior) and then averaged responses across all 40 binary coded items for the total scale score.

Sustainable norms

We measured sustainable moral norms with a 4-item Likert response format (1 = *definitely not*, to 6 = *yes, definitely*) scale (de Leeuw et al., 2015). We averaged responses for the total scale score.

We measured sustainable injunctive social norms with a 3-item Likert response format (1 = *definitely not*, to 6 = *yes, definitely*) scale (de Leeuw et al., 2015). We averaged responses for the total scale score.

We measured sustainable descriptive social norms with a 3-item Likert response format (1 = *definitely not*, to 6 = *yes, definitely*) scale (de Leeuw et al., 2015). We averaged responses for the total scale score.

Table 4. Means, standard deviations, reliability coefficients, and correlations with confidence intervals for main variables of Study 3.

Variable	M	SD	ω/α	1	2	3	4	5	6	7	8	9	10	11
1. Motive-Alignment	3.39	0.46	.79/.78											
2. Motive-Alignment Retest	3.37	0.46	.81/.79	.68**										
3. Attitudes	3.55	0.47	.64/.64	.42**	.39**									
4. Moral Norms	4.36	0.72	.75/.75	.31, .52	.41**	.33**								
5. Injunctive Norms	3.32	0.94	.81/.81	.44, .62	.52**	.29**	.48**							
6. Descriptive Norms	3.67	0.96	.87/.86	.43, .61	.45**	.21**	.51**	.74**						
7. Self-Efficacy	3.80	0.57	.72/.73	.46**	.45**	.09, .33	.41, .60	.68, .79	.38**					
8. Behavior	.44	.14	.77/.77	.54**	.33**	.30**	.51**	.46**	.30**	.40**				
9. Social Desirability	.33	.26	.78/.77	.45, .63	.44**	.38**	.46**	.50**	.49**	.28**	.17**			
10. Age	13.85	1.45	-	.41, .59	.27, .59	-.07	.16, .39	.04, .29	.07, .32	-.03, .22	.05, .29	-.09		
11. Gender Female	1.55	0.50	-	.06, .29	.14	-.19, .06	-.09	-.02	-.01	-.04	-.02	-.02	-.09	
12. Socioeconomic Status	7.21	1.45	-	-.03	-.01	-.04	.07	.03, .28	-.07, .18	-.08, .17	-.05, .20	-.05	-.09	-.08
				[-.16, .11]	[-.26, .24]	[-.18, .10]	[-.07, .20]	[-.07, .21]	[-.02, .26]	[-.07, .20]	[.01, .28]	[-.08, .20]	[-.23, .05]	[-.21, .06]

Note. Values in square brackets indicate the 95% confidence interval for each correlation. * indicates $p < .05$. ** indicates $p < .01$.

Sustainable self-efficacy

We measured sustainable self-efficacy with a 4-item Likert response format (1 = *strongly disagree* to 5 = *strongly agree*) scale (Ojala, 2012). We averaged responses for the total scale score.

Control variables

Socioeconomic status

We measured subjective socioeconomic status with the MacArthur Scale of Subjective Social Status—Youth Version (Goodman et al., 2001), a 1-item pictorial measure showing a ladder with 10 steps. Participants were first asked to imagine that the ladder represents the status of the Dutch population and then asked to place themselves on the ladder, with higher placement indicating higher subjective status.

We measured objective economic status with 5 items selected from the Home Possessions Scale (Organization for Economic Cooperation and Development (OECD), 2017). Participants indicated the number of cars, rooms with bath or shower, computers, and televisions (4 options per possession: 0, 1, 2, 3 or more), and whether they have their own room at home (0 = *no*, 1 = *yes*). Following prior work (OECD, 2017), we first recoded responses in the Likert scale from “0” and “1” to “1”, then summed responses across all 5 items for the total scale score ($M = 7.09$, $SD = 4.05$, $\alpha = .43$). Because the measure showed inadequate reliability, we did not use it in analyses.

Social desirability

We measured social desirability with the Revised Children’s Manifest Anxiety Scale-Lie subscale (Reynolds & Richmond, 1978), a 9-item binary response format (0 = *no*, 1 = *yes*) scale. After reverse-scoring three items, we averaged responses for the total scale score.

Attention check

We included two attention check items, asking participants to respond with a specific response option. We placed one of the items between items 16 and 17 of the sustainable behavior scale (“please respond “often” to this question”; 83% correct responses, 4.2% missing), and the second between items 2 and 3 of the environmental self-efficacy scale (“please respond “strongly disagree” to this question”; 79.5% correct responses, 5.7% missing). We coded as attentive respondents those that responded correctly to both attention checks (72.6% of participants).

Results

Psychometric properties of SMAS

A confirmatory factor analysis suggested that the 9-item SMAS performed well as a single-factor scale (Figure 1). All standardized item loadings significantly predicted the latent factor, $ps < .001$, yet they differed from each other in doing so (i.e. they were not tau-equivalent), as indicated by substantial decrease in model fit when assuming equal item loadings, $\chi^2(35) = 67.95$, $p < .001$, CFI = .93, TLI = .92, RMSEA = .06, 95%CI RMSEA [0.038, 0.082], P-Close < 0.201, SRMR = .109. Although the standardized loading of item 9 ($\lambda = .23$, $p < .001$) was below our preregistered threshold of $|.40|$, we retained it based on the findings in Study 2, which were derived from a much larger and more diverse sample. The scale showed adequate internal consistency ($\omega = .79$, $\alpha = .78$). Given the absence of tau-equivalence, we relied on factor scores instead of mean scores for analyses, though these two forms of scale scores were almost perfectly correlated—both in the main test, $r(257) = .99$, $p < .001$, and in the retest, $r(102) = .98$, $p < .001$. SMAS factor scores were slightly above the midpoint of the scale ($M = 3.39$, $SD = 0.46$) and normally distributed (skewness = -0.55 , kurtosis = 0.82). The correlation between the test and retest, $r(102) = .68$, $p < .001$, suggested adequate test-retest reliability according to our preregistered cutoff of $r = .60$.

Correlates of SMAS

Results are presented in Table 4.

Demographics

Sustainability motive-alignment levels did not differ as a function of participants’ age, $p = .733$ (though older adolescents reported higher levels in the re-test, $p = .039$). Sustainability motive-alignment levels also did not differ as a function of subjective socioeconomic status, $p = .712$. Sustainability motive-alignment levels did differ between genders, $t(217.82) = -2.82$, $p = .005$, $d = 0.36$, with girls ($M = 3.46$, $SD = 0.4$) scoring higher than boys ($M = 3.30$, $SD = 0.50$).

Sustainability correlates

Sustainability motive-alignment positively related to all established correlates of sustainable behavior that we measured, as well as sustainable behavior itself. Correlations were moderate ($r_{\text{range}} = .42$ – $.54$, $ps < .001$).

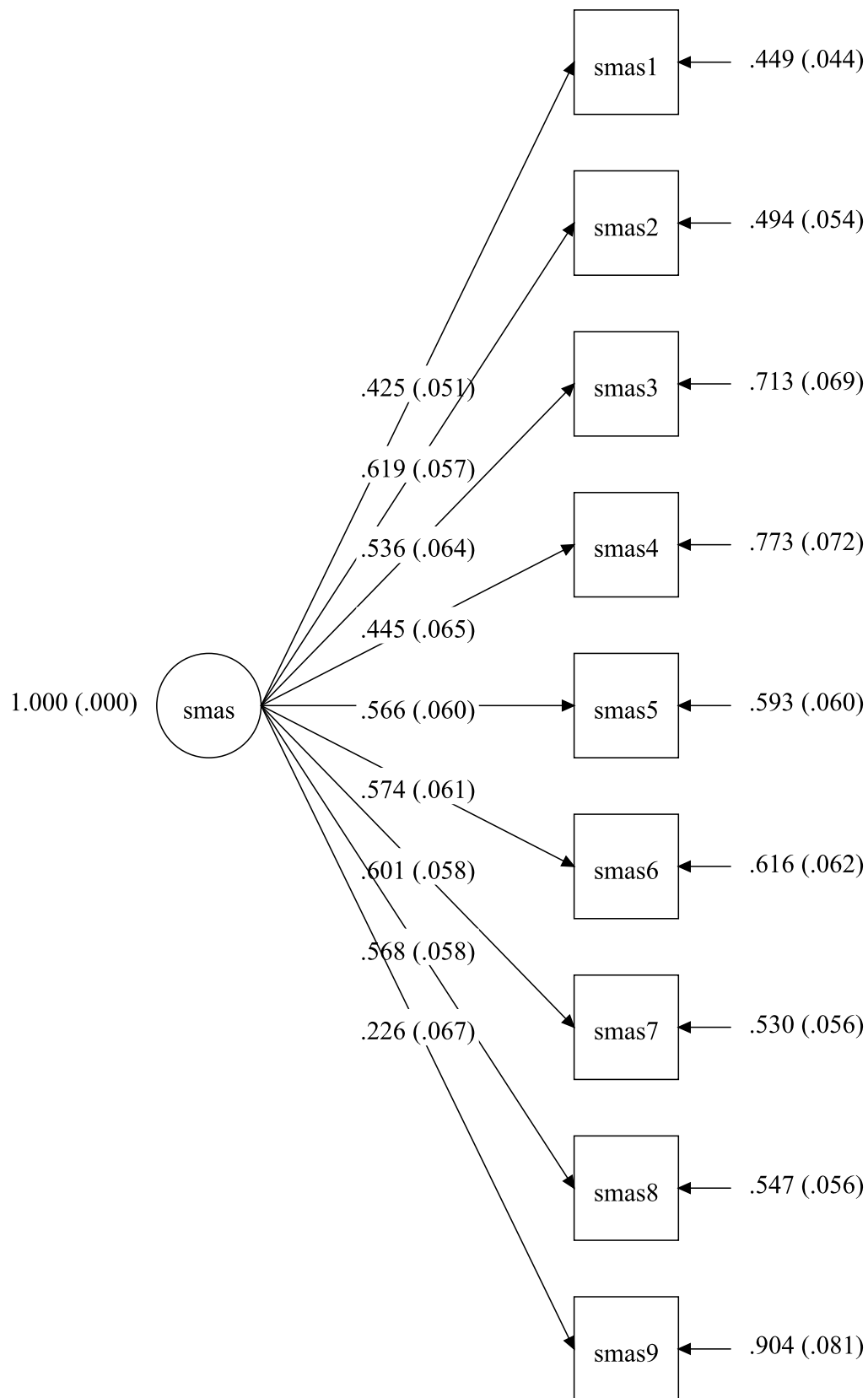


Figure 1. Results of confirmatory factor analysis of the SMAS scale in Study 3.

Note. Model fit indices: $\chi^2(27) = 33.85$, $p = .171$; CFI = .99; TLI = .98; RMSEA = .03, 95%CI [0.000, 0.061], P-Close = 0.830; SRMR = .03. Fit was considered adequate for CFI and TLI values $>.90$ (good fit if $>.95$), for RMSEA and SRMR $<.08$ (good fit if $<.05$) (Byrne, 2001; Hu & Bentler, 1999).

Incremental predictive validity

Importantly, hierarchical regression analyses in which we first controlled for one established correlate of sustainable behavior and then entered sustainability motive-alignment as a predictor of sustainable behavior showed that, in all cases, sustainability motive-alignment significantly predicted sustainable behavior above and beyond these correlates (step 2: SMAS $\beta_{\text{range}} = .33\text{--}.42$, $ps < .001$; control correlates $\beta_{\text{range}} = .17\text{--}.33$, $ps < .010$; $R^2\text{-change}_{\text{range}} = .08\text{--}.14$; $F\text{-change } ps < .001$; Table S1).

Robustness

We tested the robustness of this pattern of associations in multiple ways. First, we repeated analyses separately controlling for gender and age, including their two-way interactions with sustainability motive-alignment. We also repeated analyses controlling separately for socioeconomic status, or social desirability (which positively related to many of our sustainability variables; Table 4). Second, we repeated analyses including only participants who passed both attention checks ($n = 188$, 72.6% of sample). Third, we repeated analyses controlling for participants' completion location (i.e. at school or remotely). Across all robustness tests, results on the relations of SMAS with its correlates did not change in direction or statistical significance, neither did they greatly change in size (robustness vs. SMAS-only models $\beta\text{-change}_{\text{range}} = -.06\text{--}.05$, $\beta\text{-change}_{\text{mean}} < .01$, $\beta\text{-change}_{\text{median}} = .00$; Table S2)¹. Thus, relations of sustainability motive-alignment with sustainable behavior and its relevant correlates were robust.

Discussion

The results of Study 3 suggest that the SMAS has good internal consistency and is adequately test-retest reliable. However, its 9th item did not predict the latent factor as strongly as other items did, and item loadings were significantly different from each other. Sustainability-motive alignment was positively related to sustainable behavior, and it descriptively predicted such behavior above and beyond well-established correlates, similarly (in the case of injunctive and descriptive norms) or more strongly than (in the case of attitudes, moral norms, and self-efficacy). As we suspected, sustainability motive-alignment is also modestly linked to

social desirability, and it is slightly higher in girls—at least in the Netherlands. Robustness analyses showed that relations of sustainability-motive alignment with its sustainability-relevant correlates were robust above and beyond these relations. Taken together, Study 3 results suggest that sustainability motive-alignment robustly belongs in a network of sustainability-relevant constructs and is a distinct, moderately strong, and non-redundant correlate of sustainable behavior. In Study 4, we sought to expand the nomological network of the SMAS to two more circumscribed indices of sustainability: climate change knowledge and sustainable clothing choices.

Study 4: Climate change knowledge & sustainable clothing choices

The aim of Study 4 was to confirm the factor structure and internal consistency of the SMAS and investigate its association with climate change knowledge and sustainable clothing choices in adolescents' daily life.

Method

Participants & procedure

Participants were 300 Dutch adolescents (38% girls, 61% boys, 1% missing; 82% born in the Netherlands, 11% born elsewhere, 7% missing), ages 16 (48%) or 17 (52%). We recruited participants *via* the online survey panels of research company Ipsos.

Measures

Means, standard deviations, and reliability coefficients for the measures are presented in Table 5. A detailed description of study measures is provided in the Supplement. We measured sustainability motive-alignment with the SMAS. We measured participants' physical, causal, and impact knowledge of climate change with a well-established instrument (Tobler et al., 2012), previously adapted for adolescents (Stevenson et al., 2014). We measured participants' sustainable clothing choices *via* three self-report indices created for this study. We asked participants to report, for four of their 4 most frequently worn garments (garment 1: hoodie/pullover/blouse; garment 2: t-shirt/shirt; garment 3: trousers/skirt/dress; garment 4: jacket), the garment brand, materials, and whether it is first- or secondhand. Per garment, we coded the sustainability of brand and materials according to conventional ratings (1 = *very low sustainability* to 5 = *very high sustainability*, averaging across garment codings for a total score), and we binary-coded the

¹We additionally found a significant two-way interaction of sustainability motive-alignment with age when predicting injunctive norms, with higher levels of sustainability motive-alignment predicting injunctive norms more strongly for older adolescents, $b = .16$, $SE = .06$, $p = .011$ (Supplement).

Table 5. Means, standard deviations, reliability coefficients, and correlations with confidence intervals for main variables of Study 4.

Variable	M	SD	ω/α	1	2	3	4	5	6	7	8
1. Motive-Alignment	3.42	0.52	.78/.77								
2. Climate Change Knowledge	12.47	3.26	.66/.67	.20**							
3. Garment Brand	2.56	0.45	.36/.35	[.09, .31] -.10	-.17**						
4. Garment Materials (Binary)	0.64	0.48	.78 † / .65†	[-.23, .02] .02	[-.29, -.04] -.07	-.04					
5. Garment First-Hand (Binary)	0.71	0.45	.55 † / .56†	[-.11, .15] -.09	[-.19, .06] .05	[-.17, .09] .02	-.01				
6. Age	16.52	0.50	-	[-.20, .02] -.07	[-.06, .16] .09	[-.11, .14] .02	[-.14, .12] -.07	-.02			
7. Gender Female	1.38	0.49	-	[-.18, .05] .14*	[-.03, .20] .08	[-.11, .14] -.28**	[-.20, .06] -.05	[-.13, .09] -.15*	.07		
8. Socioeconomic Status	6.35	1.68	-	[.03, .25] .11	[-.03, .19] .09	[-.40, -.16] -.06	[-.17, .09] -.02	[-.26, -.03] .18**	[-.04, .18] .01	-.12*	
9. Social Class	3.39	0.77	-	[-.01, .23] .02	[-.03, .21] .21**	[-.19, .07] -.08	[-.16, .11] .08	[.07, .29] .09	[-.11, .13] .08	[-.24, -0.00] -.00	.35**
				[-.10, .13]	[.09, .32]	[-.21, .05]	[-.06, .21]	[-.03, .21]	[-.04, .20]	[-.12, .12]	[.24, .45]

Note. Values in square brackets indicate the 95% confidence interval for each correlation.

†Reliability computed before binarizing the total scale score.

*indicates $p < .05$. **indicates $p < .01$.

ownership (0 = *first-hand*, 1 = *secondhand*, summing across garment codings for a total score (details in Supplement and Table S3). To be able to explore the robustness of our results, we additionally measured subjective socioeconomic status with the same measure we used in Study 3 (Goodman et al., 2001), and social class (created for this study, as a substitute of the index we used in Study 3).

Data preparation for garment choice indices

Data quality

Approximately one third of responses on garment brand (36.48%) and materials (36.30%) were invalid (e.g. brands not indexed for their sustainability or nonsensible responses). Per index, we treated these responses as missing and imputed them with the mean of the index.

Processing garment brand responses

The reliability of the scale was low ($\alpha = .35$) and could not be improved by removing responses on any of the garments. For this reason, we kept all responses across garments, and averaged across responses to create a total score.

Processing garment material responses

Garment 4 reduced the reliability of the index below acceptable standards (from $\alpha = .64$ to $\alpha = .55$), so we ignored it. Because there was little variability in scores (74% of the garments received a score of 1 or 2 on the sustainability rating for garment materials) and

48% of participants had a total score (i.e. average responses across garments) of 2 or greater, we binarized the total scale (0 = scores below 2 in the original scale, representing non-sustainable materials; 1 = scores 2 or greater in the original scale, representing sustainable materials).

Recoding garment ownership responses

Responses on garment ownership were right-skewed, with 71% of participants indicating no secondhand ownership. For this reason, we binarized the total scale (0 = ownership of at least 1 s-hand garment, 1 = ownership of first-hand garments only). The reliability of the scale was low ($\alpha = .56$) and could not be improved by removing responses on any of the garments.

Results

Psychometric properties of SMAS

A confirmatory factor analysis showed again that the SMAS performed well as a single-factor scale, $\chi^2(27) = 44.11$, $p = .020$, CFI = .97, TLI = .95, RMSEA = .05, 95%CI RMSEA [0.018, 0.070], P-Close = 0.575, SRMR = .04. All standardized item loadings significantly predicted the latent factor, $ps < .001$, yet they differed from each other in doing so (i.e. they were not tau-equivalent), as indicated by substantial decrease in model fit when assuming equal item loadings, $\chi^2(35) = 78.68$, $p < .001$, CFI = .88, TLI = .88, RMSEA = .07, 95%CI RMSEA [0.045, 0.084], P-Close = 0.100, SRMR = .097 (Table S4). Although the

standardized loadings of items 4 ($\lambda = .33, p < .001$) and 9 ($\lambda = .24, p < .001$) were lower than our preregistered threshold of $|\lambda| \geq .40$, we retained them based on the findings in Study 2, which were derived from a much larger and more diverse sample. The scale showed adequate internal consistency ($\omega = .78, \alpha = .77$). Given the absence of tau-equivalence, we relied on factor scores instead of mean scores for analyses, though these two forms of scale scores were almost perfectly correlated, $r(296) = .97, p < .001$. SMAS factor scores were slightly above the midpoint of the scale ($M = 3.42, SD = 0.52$) and normally distributed (skewness = -0.63 , kurtosis = 0.71).

Correlates of SMAS

Results are presented in Table 5.

Demographics

Sustainability motive-alignment levels did not differ as a function of participants' age, socioeconomic status, or social class, $ps \geq .065$. They did, however, differ between genders, $t(225.70) = -2.40, p = .017, d = 0.29$, with girls ($M = 3.51, SD = 0.72$) scoring higher than boys ($M = 3.36, SD = 0.50$).

Sustainability correlates

Sustainability motive-alignment modestly positively related to climate change knowledge ($p = .001$). It was, however, unrelated to sustainable clothing choices, as indexed by reports of garment brand, material, or first-hand ownership ($ps \geq .104$).

Robustness

We tested the robustness of this pattern of associations in two ways. First, we tested associations in a series of regression analyses that controlled for gender and age, and explored the gender \times sustainability motive-alignment interaction (but not the analogous interaction with age, due to the small age range in the Study 4 sample). Second, we tested associations *via* regression analyses that controlled separately for socioeconomic status and social class.

Results are presented in Table S5. The associations between sustainability motive-alignment and climate change knowledge did not change in direction or statistical significance across robustness tests (except for when we added the gender \times sustainability motive-alignment interaction in predicting knowledge, where neither the main effects nor the interaction term were significant, $ps \geq .082$). The associations between sustainability motive-alignment and garment material and brand were largely robust. Specifically, the

associations between sustainability motive-alignment and garment first-hand ownership were robust when controlling for age, gender, and socioeconomic status, but changed when controlling for social class. Sustainability motive-alignment was not related to first-hand garment ownership in the main analyses, but predicted decreased likelihood to own only first-hand garments when controlling for social class, $\beta = -0.06, SE = 0.03, p = .025$, suggesting higher levels of sustainability. Across all robustness tests, correlations with the SMAS did not greatly change in size (robustness vs. SMAS-only models β -change_{range} = -0.11 – $.09$, β -change_{mean} = $.02$, β -change_{median} = $.01$; Table S5). Thus, associations between sustainability motive-alignment and the sustainability indices we assessed were overall robust, and in one case, appeared suppressed by the effect of social class.

Discussion

The results of Study 4 confirm the adequate reliability of the SMAS as a single-factor scale. They also show that sustainability motive-alignment is robustly associated with environmental knowledge. We found little evidence to suggest that sustainability motive-alignment manifests in adolescents' sustainable clothing choices, though the corresponding measure underperformed psychometrically, which limited its informativeness.

Measurement invariance of the SMAS

We pooled together the data from all studies (total $N = 6,303$) to examine the measurement invariance of the single-factor SMAS. Measurement invariance examines whether a measure is psychometrically equivalent across groups or measurement occasions. Establishing measurement invariance demonstrates that the scale used to assess the construct is interpreted in the same way across groups or timepoints, and it is thus a prerequisite for such comparisons. Measurement invariance usually involves three steps of increasingly restrictive CFA models: 1) establishing configural invariance (i.e. good model fit, without constraining item loadings and intercepts to be equal across groups or timepoints), 2) establishing metric invariance (i.e. similarly good model fit, while constraining item loadings but not intercepts across groups/timepoints), 3) establishing scalar invariance (i.e. similarly good model fit, while constraining item loadings and intercepts across groups or timepoints). Upon establishing scalar invariance, scale scores can be safely compared across groups or timepoints. We

examined measurement invariance across adolescents from different age-groups (early adolescence: ages 12-14; middle adolescence: ages 15-17), genders, and countries.

Measurement invariance between early and Middle adolescence

We examined the measurement invariance of the SMAS between early ($n = 5,420$; 86% of sample) and middle adolescence ($n = 883$; 14% of sample). We established a good fit for configural, full metric, and full scalar invariance (Table 6). A comparison of standardized latent means based on the scalar model showed that early adolescents (reference group, $M = .00$, $SE = .00$) scored higher than mid-adolescents ($M = -0.58$, $SE = 0.04$), $p < .001$.

Measurement invariance across genders

We examined the measurement invariance of the SMAS between boys ($n = 3,340$; 53.0% of sample) and girls ($n = 2,953$; 46.9% of sample). The 10 participants (0.1% of the sample) who identified as gender “other” were too few to include in these analyses. We established a good fit for configural, full metric, and full scalar invariance (Table 6). A comparison of standardized latent

means based on the scalar model showed that boys (reference group, $M = .00$, $SE = .00$) scored slightly lower than girls ($M = 0.08$, $SE = 0.03$), $p = .005$.

Measurement invariance across countries

We examined the measurement invariance of the SMAS across the Netherlands ($n = 1,815$; 28.8% of sample), China ($n = 2,126$; 33.7% of sample), Colombia ($n = 1,862$; 29.5% of sample), and the United States ($n = 500$; 7.9% of sample). We established a good fit for configural, partial metric (after freeing the loading of item 9), and partial scalar invariance (after freeing the intercepts of six items: 1, 2, 4, 5, 8, and 9; Table 6). Given that only three items (i.e. 3, 6, and 7; 33.3% of items) were scalar invariant across countries, the latent means of the partial scalar model could be substantially biased (Ciecuch et al., 2019; De Beuckelaer & Swinnen, 2018; Putnick & Bornstein, 2016). As such, we did not examine latent mean differences across countries based on the partial scalar model.

Approximate measurement invariance

We examined whether it is possible to test for approximate measurement invariance, and to compute

Table 6. Results of measurement invariance analyses across age groups, genders, and countries in the pooled sample of all studies.

Measurement invariance between age groups													
Model	χ^2	Df	χ^2	$\Delta\chi^2$	CFI	Δ CFI	TLI	RMSEA	95% CI RMSEA	P-Close	Δ RMSEA	SRMR	Decision
Configural	552.18	54			0.969		0.959	0.054	[0.050, 0.058]	.000		0.027	Good Fit
Metric	669.605	62	117.425***		0.963	-0.006	0.957	0.056	[0.052, 0.060]	.000	0.002	0.046	Accept
Scalar	735.911	70	66.306***		0.959	-0.004	0.958	0.055	[0.051, 0.059]	.011	0.001	0.045	Accept
Measurement invariance between genders													
Model	χ^2	Df	χ^2	$\Delta\chi^2$	CFI	Δ CFI	TLI	RMSEA	95% CI RMSEA	P-Close	Δ RMSEA	SRMR	Decision
Configural	459.049	54			0.975		0.967	0.049	[0.045, 0.053]	.671		0.024	Good Fit
Metric	467.092	62	8.043***		0.975	0.000	0.971	0.046	[0.042, 0.049]	.969	-0.003	0.026	Accept
Scalar	500.782	70	33.690***		0.974	-0.001	0.973	0.044	[0.041, 0.048]	.995	-0.005	0.029	Accept
Measurement invariance across countries													
Model	χ^2	Df	χ^2	$\Delta\chi^2$	CFI	Δ CFI	TLI	RMSEA	95% CI RMSEA	P-Close	Δ RMSEA	SRMR	Decision
Configural	638.341	108			0.954		0.939	0.056	[0.052, 0.060]	.011		0.032	Good Fit
Metric	802.975	132	164.634***		0.942	-0.012	0.937	0.057	[0.053, 0.061]	.001	0.001	0.058	Reject
Metric - free loading 9	741.542	129	103.201***		0.947	-0.007	0.941	0.055	[0.051, 0.059]	.017	-0.001	0.051	Accept
Scalar - free loading 9, free intercept 9	2263.719	150	1522.177***		0.818	-0.129	0.825	0.095	[0.091, 0.098]	.000	0.040	0.029	Reject
Scalar - free loading 9, free intercepts 9, 4	1977.586	147	1236.044***		0.842	-0.105	0.846	0.089	[0.085, 0.092]	.000	0.034	0.093	Reject
Scalar - free loading 9, free intercepts 9, 4, 8	1213.156	144	471.614***		0.908	-0.039	0.908	0.069	[0.065, 0.072]	.000	0.014	0.068	Reject
Scalar - free loading 9, free intercepts 9, 4, 8, 5	1049.814	141	308.272***		0.922	-0.025	0.92	0.064	[0.060, 0.068]	.000	0.009	0.065	Reject
Scalar - free loading 9, free intercepts 9, 4, 8, 5, 2	962.226	138	220.684***		0.929	-0.018	0.926	0.062	[0.058, 0.065]	.000	0.007	0.065	Reject
Scalar - free loading 9, free intercepts 9, 4, 8, 5, 2, 1	854.326	135	112.784***		0.938	-0.009	0.926	0.058	[0.054, 0.062]	.000	0.003	0.065	Accept

Note. Fit was considered adequate for CFI and TLI values $> .90$ (good fit if $> .95$), for RMSEA and SRMR $< .08$ (good fit if $< .05$) (Byrne, 2001; Hu & Bentler, 1999). To compare measurement models, we conducted difference tests (denoted by Δ) in the χ^2 , in the Comparative Fit Index (CFI), and in the Root Means Square Error of Approximation (RMSEA) between models. We accepted more restricted models over simpler models when two of the following criteria were met: $\Delta\chi^2 p > .05$, $|\Delta$ CFI| $< .01$, and $|\Delta$ RMSEA| $< .015$ (Chen, 2007).

and compare latent means *via* a different method: the multiple-group factor analysis alignment (Asparouhov & Muthén, 2014). This approach (hereafter: alignment optimization; Cieciuch et al., 2019) is recommended when full scalar invariance is not achieved, and has been used to estimate approximate measurement invariance, latent means, and latent mean differences across countries in prior research (e.g. Cieciuch et al., 2019). Alignment optimization is based on the configural model but takes into account the noninvariance of loadings and intercepts. As such, it generates the fit indices of the configural model and detects, without constraining loadings and intercepts to be equal across groups or timepoints, the best approximation of invariance in the data, computing means that take into account the noninvariance patterns that the method detects. The latent means produced by alignment optimization are the most accurate given the noninvariance in the data, and are safer to compare when up to 25% of the parameters are noninvariant (Asparouhov & Muthén, 2014).

Using fixed alignment optimization (a recommended practice when there is little noninvariance in loadings and a small number of groups), the SMAS relatively underperformed in terms of approximate scalar invariance, with an average invariance index of .67 (scores range from 0 to 1, with 1 representing full scalar invariance). Slightly more than half of the parameters (especially item intercepts) were noninvariant in at least one country, with invariance patterns close to 25% in China,

Colombia, and the Netherlands, but lower in the United States (Table 7). Latent means of the SMAS significantly differed across countries, $ps < .001$: They were highest in Colombia ($M = 1.40$, $SE = 0.08$), followed by China ($M = 1.26$, $SE = 0.08$), then the United States ($M = 0.86$, $SE = 0.07$), and the Netherlands ($M = 0.00$, $SE = 0.00$; reference group). These means should be interpreted with great caution though, given the noninvariance of the scale. That said, considering these means, it appears that countries that are more culturally similar in terms of individualism versus collectivism showed comparatively smaller latent mean differences in the SMAS.

For this reason, we followed up by examining how such cultural differences may contribute to the measurement noninvariance of the scale *via* Multilevel CFA, nesting participants within countries. This approach is recommended when measurement invariance is not established, and has been used in past research to detect why noninvariance may occur across countries (Cieciuch et al., 2019; Davidov et al., 2018). The model was not identified because it had more parameters (i.e. intercepts and loadings) at the within and between level than level 2 clusters (countries), so we refrained from reporting or interpreting it.

Discussion

Results of measurement invariance analyses showed that the SMAS is invariant between early and mid-

Table 7. Results of approximate measurement invariance (alignment optimization) across countries in the pooled sample of all studies.

Item Number	Loadings Invariance			
	Country			
	Netherlands	China	Colombia	United States
1	✓	–	–	✓
2	✓	✓	✓	✓
3	✓	✓	✓	✓
4	✓	✓	✓	✓
5	✓	✓	✓	✓
6	✓	✓	✓	✓
7	✓	✓	✓	✓
8	✓	–	–	✓
9	–	✓	✓	✓
Loadings Noninvariance %	11.10%	22.20%	22.20%	0%
Item Number	Intercepts Invariance			
	Country			
	Netherlands	China	Colombia	United States
1	✓	–	–	✓
2	✓	✓	✓	✓
3	–	✓	✓	✓
4	✓	–	✓	–
5	✓	✓	–	✓
6	–	✓	✓	✓
7	✓	✓	✓	✓
8	–	✓	–	✓
9	✓	–	✓	✓
Intercepts Noninvariance %	33.30%	33.30%	33.30%	11.10%
Total Noninvariance%	22.20%	27.80%	27.80%	5.60%

adolescence, with early adolescents reporting higher levels. The SMAS is also invariant between genders, with girls reporting somewhat higher levels. Finally, the SMAS is cross-nationally noninvariant. One item (9) loads less consistently across countries, and only three items (3, 6, and 7) appear fully measurement invariant. Thus, adolescents from different countries construe sustainability motive-alignment differently. Based on findings of alignment optimization analyses, noninvariance patterns may be related to cultural differences in individualism-collectivism. In light of these findings, and in the presence of violations to measurement invariance in future work, cross-national comparisons of scale scores should be interpreted with due caution.

General discussion

Our aim was to develop and validate the SMAS, a brief self-report scale that captures individual differences in adolescents' perceptions of sustainability as behavior that promotes autonomy and peer status. In four studies across four culturally diverse countries, the SMAS showed good reliability and validity as a single-factor scale. Our results show the merit of using the SMAS to measure individual differences in sustainability motive-alignment, a construct that captures adolescents' construal of sustainable behavior as more or less relevant to their developmentally salient goals. As such, the SMAS can spark developmentally informed research on the psychological underpinnings of adolescent sustainability.

Scale properties

Our studies show that sustainability motive-alignment can be measured reliably and validly as a trait-like individual difference variable. Corroborating the idea that adolescents' core motives for autonomy and status may jointly drive adolescents' sustainable beliefs and behaviors (Thomaes et al., 2023), the SMAS showed good reliability and fit as a single-factor scale across all studies (Studies 1-4).

Measurement invariance analyses showed that the way adolescents construe sustainability motive-alignment does not change over time. This makes the scale suitable for use in longitudinal and, more broadly, developmentally oriented studies, as it allows the examination of developmental trends and age differences in sustainability motive-alignment. Measurement invariance analyses also showed that girls and boys construe sustainability motive alignment similarly. This not only allows gender comparisons in sustainability motive-alignment, but it also allows researchers to trust that their research

findings when using the SMAS truly reflect sustainability motive-alignment, regardless of the gender distribution in their studies.

At the same time, researchers should be aware of a few limitations of the scale, which are worth further scrutiny in future studies. First, the scale's 9th item did not perform optimally, especially in the Netherlands. This item appeared highly culturally variant and loaded less strongly on the scale's latent factor compared to other items in Studies 3 and 4. Yet, the item does not damage the scale's reliability and validity, and adds conceptual coverage to the scale.

Second, and partly relatedly, item loadings were not tau-equivalent (i.e. did not all predict equally strongly the latent factor), which suggests that researchers should compute factor total scale scores, as they are more representative of sustainability motive-alignment levels than mean total scale scores. Still, factor and mean scores were almost perfectly correlated in studies 3 and 4, so total scale scores based on raw responses are still informative.

Third, measurement invariance analyses showed that adolescents from different cultures construed sustainability motive-alignment differently. Each of the three scalar invariant items tapped a different aspect of motive alignment. Thus, despite the subtle cultural differences we found, we believe it would be premature to conclude that certain aspects of motive alignment are inherently differentially construed across countries. However, the findings suggest that, primarily the level (indicated by significant cross-national differences in item means), and secondarily, the centrality (as indicated by significant cross-national differences in item loadings) of many pro-environmental behaviors with regard to motive-alignment is culturally diverse. During our attempt to establish approximate measurement invariance, we found that latent scores were more similar in countries that are also more culturally similar in terms of individualism-collectivism. Specifically, we found higher latent scores in the more collectivistic countries of Colombia and China, and lower latent scores in the more individualistic countries of United States and the Netherlands. These latent scores are likely biased and should be interpreted with great caution given the cultural noninvariance of the scale. Regardless, these findings are consistent with cross-national research suggesting that sustainability levels tend to be higher in cultures that promote collective welfare over personal advancement (Higuera-Castillo et al., 2019; Schultz et al., 2005). These results could tentatively suggest that the motive-alignment hypothesis

is cross-culturally applicable, but that the scope for increase in motive-alignment (e.g. targeted with intervention) may be larger in more individualistic countries. More importantly, however, these results also suggest that youth from different countries and especially from cultures that differ in their degree of individualism-collectivism may interpret the SMAS items differently. Future cross-cultural research should help better understand the reasons behind the scale's patterns of cross-national (and likely cross-cultural) noninvariance, before proceeding to cross-national comparisons.

Together, our studies show that the SMAS offers researchers on adolescent sustainability a brief, reliable, and valid scale that can be included across diverse research designs without taxing adolescent participants' attention or time.

Relations with sustainability-related variables

Importantly, we found that sustainability motive-alignment is a conceptually distinct, non-redundant correlate of adolescent sustainability and its self-reported correlates: attitudes, norms, and self-efficacy (Study 3). Illustrating its relevance for sustainable behavior, sustainability motive-alignment predicted such behavior above and beyond other correlates, demonstrating incremental predictive value. Sustainability motive-alignment predicted sustainable behavior equally as well as injunctive and descriptive norms, and more strongly than environmental attitudes, moral norms, and self-efficacy. Sustainability motive-alignment also related to a more objective indicator of sustainability: environmental knowledge (Study 4). Although we did not find evidence that it relates to the sustainability of adolescents' garment choices (Study 4), we note that the garments measure was psychometrically subpar and suffered from substantial missingness. As a result, these findings call for replication with stronger and more nuanced garment choice measures (e.g. explicitly asking whether and which materials are recycled). Together, these findings show that sustainability motive-alignment captures a key psychological dimension underlying adolescents' tendencies toward sustainability. Future research can generate novel insights into adolescent sustainability by assessing motive-alignment—insights that cannot be obtained by assessing related but distinct constructs, such as sustainable attitudes, norms, or self-efficacy.

Demographics and social desirability

Our studies also show how sustainability motive-alignment relates to demographics and social desirability.

Gender differences were small (Studies 3, 4, and measurement invariance analyses), and showed that girls have higher levels of sustainability motive-alignment. These gender differences are consistent with prior research suggesting that females generally endorse more sustainable attitudes than males (Dietz et al., 2002).

Age differences were not present in Studies 3 and 4, yet they emerged in the measurement invariance analyses, for which we had a larger sample. Theory suggests that SMAS scores should peak in adolescence and decline gradually in adulthood, when other motives, such as romantic and kin care ones, become more salient (Salmela-Aro et al., 2007; Thomaes et al., 2023). Our findings, however, showed that sustainability motive-alignment levels decrease from early to mid-adolescence—consistent with a documented decrease in sustainable attitudes and concern in mid-adolescence (Olsson & Gericke, 2016). This finding has two potential implications. First, it raises the possibility that sustainability motive-alignment peaks in late adolescence (i.e. ages 18-25). Second, practices to raise sustainability motive-alignment levels may be more necessary during mid-adolescence.

Furthermore, we found no relation between sustainability motive-alignment and subjective social status and class (Studies 3 and 4), which suggests that sustainability motive-alignment is independent of the perceived social standing of adolescents' family of origin. Consistent with the idea that sustainability motive-alignment captures adolescents' social image concerns, it was modestly related to social desirability (Study 3). Thus, sustainability motive-alignment appears to primarily capture adolescents' personal status concerns, rather than the perceived status of their family.

Importantly, relations with all these variables did not alter the relations of sustainability motive-alignment with well-established sustainability-relevant constructs except for the unreliable measure of garment choices (Studies 3 and 4), which tentatively suggests that controlling for them when examining the correlates of sustainability motive-alignment may not be a priority.

Implications for broader motive-alignment research

The SMAS can help expand research beyond the domain of sustainability. Contemporary psychological theory (Bryan, 2020; Yeager et al., 2018) and research (Bryan et al., 2016; Galla et al., 2021) has recognized the importance of mobilizing adolescents' widely held values, desires, and concerns to instigate behavior change. The sustainability motive-alignment hypothesis applies this motive-alignment (or: values-

alignment; Bryan, 2020) principle to the domain of adolescent sustainability. The SMAS is the first comprehensive scale to our knowledge that captures individual differences in motive-aligned adolescent behavior. As the SMAS is created on the basis of a theoretical premise that goes beyond sustainable behavior, it should in principle be possible to adapt its items to capture motive-alignment in other behavioral domains, such as eating preferences or social media use—where experimental work has already made first steps (Bryan et al., 2016; Galla et al., 2021). Thus, modifying the SMAS to measure the motive-alignment of other adolescent behaviors can help standardize findings across diverse domains of motive-alignment research.

Limitations and future research

The present studies are not without limitations. First, our scale did not separate the two motives we measured. Our research was inspired by literature suggesting the overlap and synergy between these two motives in adolescence (e.g. Bryan, 2020; Galla et al., 2021; Thomaes et al., 2023; Yeager et al., 2018). As such, the process that we followed to construct the scale was not aimed at distinguishing between the motives. Rather, our aim was to create a scale broad in content coverage and parsimonious enough to capture these motives and their joint manifestations. Although our efforts were successful, an empirical question for future work is to measure and examine the distinct manifestations and consequences of each of the two motives.

Another limitation is that our studies mainly relied on self-reports, which limits our understanding of how sustainability motive-alignment relates to sustainable behavior. Future research that examines how the SMAS relates to observed or objectively measured sustainable behavior can elucidate the centrality of sustainability motive-alignment to adolescent sustainability, as compared to other psychological determinants and barriers. Research that does so should also address the methodological challenges that arise when systematically measuring diverse indicators of sustainable behavior in daily life (e.g. garment choices).

Attesting to the idea that sustainability motive-alignment is a relatively stable individual difference construct, the SMAS showed adequate test-retest reliability across seven weeks. Future longitudinal research should test the long-term stability and developmental trajectories of sustainability motive-alignment. Such research can address crucial questions

about the origins, salience, and consequences of sustainability motive-alignment across development. A relevant open question for future developmental research is whether a modified version of the SMAS that taps into motives most salient during adulthood can explain sustainable engagement in adulthood in a similar way that the current version of the SMAS does in adolescence.

Our studies also did not address whether motive-alignment comprises state components that may fluctuate from moment to moment, or from one context to another. This may be possible in the formative period of adolescence, when identity exploration, attitudes, values and peer norms undergo rapid changes (Daniel & Benish-Weisman, 2019; Erikson, 1968; Vollebergh et al., 2001). Future intensive longitudinal and experimental research that examines possible changes in states of sustainability motive-alignment can shed light on this issue. Such research can directly test how life experiences and interventions influence the levels of sustainability motive-alignment and its possible downstream impact on adolescents' sustainable behavior.

Furthermore, future studies could expand the nomological network of the SMAS beyond sustainability-relevant correlates. An important step in this direction would be to examine relations of sustainability motive-alignment with individual differences in the strength of the motives for, and in the attainment of, autonomy and peer status. Such research can uncover differences in the motivational profiles of adolescents with higher versus lower levels of sustainability motive-alignment, as well as the actual relational consequences of sustainability motive-alignment in adolescents' daily lives.

Conclusion

Research on the psychological drivers of adolescent sustainability is still in its early days. Addressing this issue from a developmental angle, the SMAS reliably and validly measures how adolescents construe sustainable behavior as aligned with their core motives for autonomy and status. Encompassing these developmentally salient motives as central determinants of adolescent sustainability, this brief and comprehensive scale can help provide novel fundamental and practically applicable insights into the development and consequences of adolescent sustainability.

Disclosure statement

No potential conflict of interest was reported by the authors.

Competing interests

The authors report there are no competing interests to declare.

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Appendix

Sustainability Motive-Alignment Scale (SMAS), English Version

How much do you agree or disagree with these statements?

	1 - Strongly disagree	2 - Disagree somewhat	3 - Neither agree nor disagree	4 - Agree somewhat	5 - Strongly agree
By doing good things for the natural environment, I can express what I value as a person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My generation should show that we can treat the earth better than older generations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People who buy or use sustainable products are cool (for example, people who eat sustainable food or buy sustainable clothes).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When it comes to taking care of the natural environment, older generations have a lot to learn from my generation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like it if others saw me as someone who cares about preventing climate change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
By doing good things for the natural environment, young people can stand up against people in positions of power who fail to protect the climate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Young people, including myself, are fed up with governments and big companies doing very little to protect the climate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I do things that are sustainable, I feel like I am living my life in the way I want.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most young people respect individuals who are committed to conserving the earth.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sustainability Motive-Alignment Scale (SMAS), Dutch Version

In hoeverre ben je het eens of oneens met deze uitspraken?

	1 - Helemaal oneens	2 - Oneens	3 - Niet eens, niet oneens	4 - Eens	5 - Helemaal eens
Door goede dingen te doen voor de natuur of het milieu, kan ik laten zien waar ik voor sta.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn generatie zou moeten laten zien dat we beter kunnen omgaan met de aarde dan volwassenen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Als ik duurzame dingen doe, heb ik het gevoel dat ik leef zoals ik dat zelf wil.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mensen die duurzame producten kopen of gebruiken zijn cool (bijvoorbeeld, mensen die duurzame voeding eten of duurzame kleding kopen).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Als het gaat om zorgen voor de natuur of het milieu, is er veel dat volwassenen kunnen leren van mijn generatie.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik zou het fijn vinden als anderen mij zien als iemand die het belangrijk vindt om klimaatverandering tegen te gaan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Door goede dingen te doen voor de natuur of het milieu, kunnen jongeren zich afzetten tegen machthebbers die niets doen om het klimaat te beschermen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jongeren zoals ik zijn het zat dat overheden en grote bedrijven heel weinig doen om het klimaat te beschermen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
De meeste jongeren hebben respect voor mensen die proberen zuinig om te gaan met de aarde.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sustainability Motive-Alignment Scale (SMAS), Simplified Chinese Version

对这些陈述，您有多同意或不同意？

	1 - 极不同意	2 - 有点不同意	3 - 既不同意也不反对	4 - 有点同意	5 - 非常同意
通过做有利于自然环境的事情，我可以表达出我个人的价值观。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
我这一代人应该表示出，我们可以比老一辈更好地对待地球。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
购买或使用可持续发展的产品的年轻人很酷(例如，吃可持续发展的食品或购买可持续发展的服装的人)。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
在照顾自然环境方面，老一辈可以向我们这一代学习很多东西。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
如果其他人认为我是一个关心防止气候变化的人，我会很高兴。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
通过做有利于自然环境的事情，年轻人可以与那些未能保护气候的当权者抗争。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
包括我自己在内的年轻人已经无法再忍受政府和公司不怎么做努力保护气候。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
当我做一些可持续发展的事情时，我觉得自己过着自己想要的生活方式。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
大多数年轻人尊重致力于保护地球的人。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sustainability Motive-Alignment Scale (SMAS), Spanish Version

¿Qué tan de acuerdo o en desacuerdo estás con estas afirmaciones?

	1 - Muy en desacuerdo	2 - Algo en desacuerdo	3 - No estoy de acuerdo ni en desacuerdo	4 - Algo de acuerdo	5 - Muy de acuerdo
Al hacer cosas por el entorno natural, puedo expresar lo que valoro como persona.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mi generación debería demostrar que podemos tratar a la Tierra de mejor manera que las generaciones anteriores.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Las personas que compran o utilizan productos sostenibles son bacanas (por ejemplo, personas que comen comida sustentable o compran ropa sustentable).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuando se trata de cuidar el entorno natural, las generaciones anteriores tienen mucho que aprender de mi generación.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quisiera que los demás me vieran como alguien al que le preocupa prevenir el cambio climático.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Al hacer cosas por el entorno natural, los jóvenes pueden enfrentarse a personas en posiciones de poder que fracasan en la protección del clima.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Los jóvenes, incluyéndome a mí mismo/a, están cansados de que los gobiernos y las grandes compañías hagan tan poco para proteger el clima.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuando hago cosas sostenibles, siento que estoy viviendo mi vida de la manera que quiero.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
La mayoría de los jóvenes respetan a las personas que están comprometidas con la conservación de la Tierra.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>