Going in, moral, circles: A data-driven exploration of moral circle predictors and prediction models

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Abstract

Moral circles help define the boundaries of one's moral consideration. One's moral circle may provide insight into how one perceives or treats other entities. A data-driven model exploration was conducted to explore predictors and prediction models. Candidate predictors were built upon past research using moral foundations and political orientation. Moreover, we also employed additional moral psychological indicators, i.e., moral reasoning, moral identity, and empathy, based on prior research in moral development and education. We used model exploration methods, i.e., Bayesian model exploration, Bayesian model averaging, and elastic-net regression. The study successfully replicated past research supporting the relationship between moral foundations, political orientation, and the moral circle. Additional moral psychological constructs, such as post-conventional moral reasoning and moral identity, significantly predicted the moral circle width. The identified components of the moral circle were conceptually related to *phronesis*, i.e., practical wisdom. We discussed the educational implications of the findings, particularly those related to moral education focusing on *phronesis* cultivation, multiculturalism and global citizenship, and climate justice.

Keywords: Moral circle; Moral reasoning; Moral Identity; Empathy; Data-driven analysis

Introduction

A moral circle defines the expansiveness of one's conceptual circle including various entities, such as humans, animals, plants, and non-living beings, that are considered to be

worth moral treatment and regard from one's perspective (Laham, 2009). For instance, if one's moral circle only includes ingroup human beings within its boundary, then the person might feel ethical responsibility for close others, such as people in the same family, community, or ethnic group, and care about their well-being exclusively (Passini, 2016). That person might not consider outgroup human beings and non-human beings as entities worth moral consideration and concern. Hence, they might be less empathic towards them than ingroup human beings (Graham et al., 2017). Alternatively, a person with a wide moral circle embracing non-human beings constituting the Earth might be more concerned about such beings' welfare.

Previous research has reported that the width of one's moral circle is significantly associated with how one perceives and treats various entities (Crimston et al., 2016; Laham, 2009; Waytz et al., 2019). We may consider discrimination and hate crimes against immigrants as examples of why the expansiveness of one's moral circle could be a significant topic in moral education (Bucholc, 2013). Let us imagine a case where one has a narrow moral circle so that one feels a strong responsibility for close others, such as those with the same ethnicity and nationality. In such a case, one may not assume that immigrants, who are out of their ethnic group and nation, possess the same degree of moral rights as the ingroup members. Such might result in dehumanization and negative perceptions toward the outgroup. Contrarily, one with a wide moral circle embracing outgroup people might be more emphatic toward them and motivated to implement actions to help them. Such a point about the moral circle can be expanded to issues related to non-human beings (Bratanova et al., 2012; Crimston et al., 2016). For instance, matters related to the climate crisis and justice are inseparable from moral circle discussions

(Bratanova et al., 2012). People with wider moral circles might more seriously consider non-human beings, including animals, plants, and even non-living entities, worth moral concern and treatment than those with narrower circles. Hence, they would engage in activities to preserve the environment and promote climate justice at the motivational and behavioral levels.

Moral Psychological Constructs and Expansiveness of Moral Circle

Research has examined various social and psychological factors predicting the expansiveness of the moral circle. For instance, Waytz et al.'s (2017) large-scale psychological study reported that socially and politically liberal participants demonstrated significantly wider moral circles than conservative participants. Furthermore, Crimston et al. (2016) investigated the relationship between moral psychological constructs and moral circle. When the expansiveness of one's moral circle was analyzed, they reported that individualizing foundations (care/harm) and universal personal values positively predicted the expansiveness while binding foundations (ingroup/loyalty, authority/subversion, purity/degradation) showed a negative association. They also tested which factors, including moral foundations, moral identity, and empathy, significantly predicted participants' behavioral intent to help various entities across the moral circle. Such findings are consistent with previous moral foundations theory (MFT) research on moral foundations and empathy towards outgroup human beings, such as immigrants and refugees, reporting their differentiated associations with individualizing and binding foundations (Graham et al., 2009, 2013; Süssenbach et al., 2019). The studies addressing the moral circle would expand the scope of the moral concern to be analyzed beyond the

boundary of human beings, which were previously examined by the MFT research, by employing the concept of the moral circle.

In addition to moral foundations, we assume that other moral psychological constructs predicting moral motivation and behavior are also fundamental in examining the moral circle. We are particularly interested in several indicators, such as moral reasoning, identity, and empathy, as candidate constructs given recent research in moral functioning (Darnell et al., 2019; Han, 2024d). According to a recently proposed theoretical framework of moral functioning, the *phronesis* (practical wisdom) model, optimal moral functioning to render the best (behavioral) decisions requires integrative coordination among various psychological components (Kristjánsson & Fowers, 2022). The multifaceted psychological processes include moral reasoning, identity, and emotion to promote motivation and behavior (Darnell et al., 2019, 2022). Based on this theoretical model, recent empirical studies demonstrated that ethical reasoning, moral identity, and empathy (an affective process in moral domains) are fundamental in prosocial engagement and positive youth development (Han, 2024e, 2024d). Thus, moral reasoning, identity, and empathy will also contribute to predicting moral circle expansiveness with moral foundations.

First, we will overview moral identity as a predictor for the moral circle. Passini (2016) reported that moral identity measured in terms of internalization and symbolization positively predicted the moral circle expansiveness. In this study's context, according to Aquino and Reed (2002), moral internalization is the extent to which moral values are central to one's self-identity while moral symbolization is related to whether symbolizing moral values via activities and expressions are important to themselves.

Researchers have reported the positive predictive value of moral identity in the inclusive mindset and behavior toward outgroup members. Reed and Aquino (2003) demonstrated that moral identity was positively associated with one's intent to contribute to helping refugees. Winterich et al. (2009) reported that a strong moral identity positively moderated the relationship between identity prime and intent to donate to outgroup organizations. These studies consistently suggest that moral identity, the centrality of moral values to one's self-identity, is fundamental in expanding one's moral circle towards outgroup members and entities. As a possible explanation, they proposed that moral identity regulates one's cognitive processes involving defining psychological boundaries between "us" and "them," so it positively contributes to widening the moral circle (Reed & Aquino, 2003).

Empathy is another construct worth consideration. Although empathy has various definitions, following Decety and Cowell (2014), we focus on perspective-taking and empathic concern as subcomponents of empathy directly relevant to moral functioning. Decety and Cowell (2014) argued that other components of empathy, such as personal distress and fantasy, are irrelevant to moral functioning, and even worse, they, particularly personal distress, may hinder appropriate moral action while dealing with ethical problems. Han et al.'s (2020) empirical investigation supported the exclusive association between empathic concern, perspective-taking, and moral functioning. Ladak et al. (2023) proposed that encouraging perspective-taking can help people consider the perspectives of entities outside of their routine moral considerations. Empathic concern, being compassionate to and concerned about others' welfare, is another factor in empathy predicting the inclusiveness of moral concern. Their empirical investigation demonstrated

that encouraging perspective-taking and strong empathic concern significantly promoted moral concern for animals and non-human artificial intelligence agents. Such a positive association between empathic concern, perspective-taking, and moral circle expansiveness was also found when outgroup human beings were considered potential objects of moral concern (Miron et al., 2020).

On top of the examined moral psychological factors, moral reasoning might also contribute to predicting one's moral circle. Although the previous studies examined moral identity and empathy as predictors, the authors did not consider another fundamental moral psychological factor, moral reasoning, which constitutes a part of the integrative moral functioning model (Darnell et al., 2019, 2022; Han, 2024d), while investigating moral circle expansiveness. Despite lacking relevant empirical research, we may refer to Graham et al.'s (2017) conceptual paper for a hint. They referred to the theoretical frameworks addressing moral judgment development, such as the Piagetian and Kohlbergian models (Kohlberg, 1981; Piaget, 1948), within the context of discussions on the moral circle. They mentioned that Piaget and Kohlberg proposed the developmental model of moral judgment and reasoning favoring educational approaches promoting centrifugal, not centripetal, forces in the moral circle framework. They also introduced the recent trend in moral education underscoring global citizenship as an attempt to expand the moral circle. Finally, the authors compared the Piagetian and Kohlbergian frameworks with traditional approaches pursuing centripetal by focusing on binding values. These recent works on the moral circle demonstrate moral psychologists' interest in examining the moral psychological mechanism of the moral circle and its practical implications, such as how discussions on the topic can contribute to socio-cultural issues and educational practice.

Current Study

We will explore the best prediction models and predictors predicting participants' moral circle expansiveness via data-driven model exploration. Previous studies attempted to examine how several socio-psychological indicators, such as moral foundations and political orientation, could predict the width of the moral circle (e.g., Crimston et al., 2016; Wyntz et al., 2017). However, they did not comprehensively consider moral psychological indicators, particularly those closely related to moral development and education proposed by the integrative moral functioning model (Darnell et al., 2022; Han, 2024d), predicting moral motivation and action closely associated with moral development and education. Although some attempted to address the topic, most did not employ several fundamental aspects of moral development, especially moral judgment and reasoning development. Graham et al. (2017) briefly discussed the implications of moral reasoning and education within discussions on moral circles. However, they did not empirically examine the factors and constructs related to moral development and education in their work.

Moreover, previous studies performed hypothesis-driven correlation and regression analysis instead of conducting data-driven analysis to identify potential predictors and prediction models. For instance, Crimston et al. (2016) included potential predictors in their regression models based on preassumptions and hypotheses instead of searching for the best candidate predictors based on data. Such a hypothesis-driven approach in testing candidate predictors and models may result in inflated false positives or biases while interpreting results. Also, that approach might be suboptimal for exploration from the epistemological perspective. Thus, additional research employing data-driven analysis might be warranted for comprehensively understanding moral psychological factors

associated with the moral circle. Such examination will also shed light on moral educators' efforts to address the expansiveness of students' moral circle by additionally considering psychological factors related to moral development and education.

To address the limitations of the previous studies mentioned above, we will employ psychological indicators associated with moral functioning based on literature in moral psychology. Following prior studies examining moral psychological constructs closely correlated with moral motivation and action (Han, 2024e), we will include moral reasoning (Y.-J. Choi et al., 2019; Han, Dawson, Thoma, et al., 2020), moral identity (Aquino & Reed, 2002), and empathy (Davis, 1983) in the candidate predictors. Moreover, we will also examine moral foundations related to whether one emphasizes individualizing or social binding in the present study (Graham et al., 2011). As previous research on the moral circle reported that one's political orientation (liberalism vs. conservativism) also significantly predicted the circle's width on top of moral psychological indicators, we will survey participants' political orientation as a control variable (Waytz et al., 2019).

Instead of employing conventional analysis methods focusing on hypothesis testing, including frequentist correlation and regression analysis, we will use data-driven tools to explore the best prediction model (Jack et al., 2018). First, we will seek the best candidate prediction models via Bayesian model exploration (Han, 2024a). Once the top prediction models are identified, we will perform Bayesian regression to gather additional information (Bürkner, 2017). Second, we will conduct Bayesian Model Averaging and elastic-net regression to explore the best averaged and regularized regression models (Han, 2024b; Han & Dawson, 2021; Hoeting et al., 1999). Although these methods do not suggest one specific candidate model like conventional regression analysis, they can

propose models less susceptible to model uncertainty and overfitting (Han, 2024b; McNeish, 2015). Third, we will discuss how candidate moral psychological predictors could accurately predict the width of the moral circle by examining models suggested by the three methods mentioned above. Instead of relying on one specific method, we will attempt multiverse model exploration for a more accurate interpretation of analysis results. Finally, we will consider the implications of the findings for moral education. Based on the identified moral psychological indicators as best predictors for the moral circle, we will discuss the roles of moral educators in promoting the expansion of the circle to address recent socio-moral issues, such as treating outgroup members and non-human beings ethically and addressing climate justice issues (Cripps, 2024; Olson & Wessels, 2020).

Methods

All data and source code files used in the present study are available via the Open Science Framework at https://osf.io/smuw3/?view_only=8ff9982fc5af4ff19cbfb7e767216b0c.

Participants

We recruited 501 participants (13.77% men, 85.43% women, .80% other; Age mean = 21.21 years, *SD* = 5.41 years) from a public university in the Southern United States. They signed up for the research subject pool and received a course credit as compensation for participation. We administered the study via an online survey platform, Qualtrics. We excluded participants with the study completion time in the top (632.36 minutes) and bottom 10% (11.78 minutes) to avoid any outliers due to uncareful responses or extremely long delays (Huang, 2014). The filtered data included responses from 426 participants

(15.02% men, 84.51% women, .46% other; Age mean = 21.39 years, *SD* = 5.75 years). We used the filtered data for further data-driven exploration.

Measures

Moral Circle Measure

We employed a measure for the moral circle expansiveness consisting of one item employed by Waytz et al. (2017). We asked participants to report the extent of their moral circle by choosing one of sixteen options (1: all of your immediate family [narrowest]–16: all things in existence [widest][1]) corresponding to the outer limit of the circle (see Waytz et al. [2017] for further details).

Behavioral Defining Issues Test (bDIT)

We used the bDIT to assess participants' moral reasoning development (Choi et al., 2019; Han et al., 2020). The bDIT was developed based on the Defining Issues Test, an ethical judgment measure invented by neo-Kohlbergians. It presented three moral dilemmas and eight questions per dilemma to examine the extent to which participants utilized the post-conventional schema (versus the personal interests and maintaining norms schemas) to render ethical decisions (see Choi et al. [2019] and Han et al. [2020] for the additional information about the test). Participants were requested to choose one of

[1] Extended family (2); closest friends (3); all friends (including distant ones) (4); acquintances (5); people one has ever met (6); people in one's country (7); people in one's continent (8); people in all continents (9); all mammals (10); all amphibians, reptiles, mammals, fish, and birds (11); all animals on earth including paramecia and amoebae (12); all animals in the universe, including alien lifeforms (13); all living things in the universe including plants and trees (14); all natural things in the universe including inert entities such as rocks (15).

three options representing the three schemas mentioned above that was most important in decision-making for each question. Their P-score representing the likelihood of employing the post-conventional schema was then calculated for how many questions they selected the post-conventional schema option out of all 24 questions. The internal consistency in terms of Cronbach α was .76.

Moral Identity Scale (MIS)

We used the MIS to measure one's moral identity in two dimensions, i.e., moral internalization and symbolization (see Aquino & Reed [2002] for the full scale). At the beginning of the scale, participants were presented with adjectives presenting moral values, i.e., caring, compassionate, fair, friendly, generous, hardworking, helpful, honest, and kind. Then, they were asked to answer eleven items and mark their responses on a five-point scale (1: Strongly disagree – 5: Strongly agree). The internalization subscale was measured by five items (e.g., "It would make me feel good to be a person who has these characteristics"), and the symbolization was measured by six items (e.g., "I often buy products that communicate the fact that I have these characteristics."). We used the composite score of each subscale for further analysis. The internal consistency of the internalization subscale was α = .84 and that of the symbolization subscale was α = .86.

Interpersonal Reactivity Index (IRI)

We employed the IRI to assess participants' empathy (see Davis [1983] for the full scale). The IRI has four subscales: personal distress, empathic concern, perspective-taking, and fantasy. We used two subscales, i.e., empathic concern and perspective-taking, as previous research has proposed that only these subscales significantly predict moral motivation and behavior (Decety & Cowell, 2014). Each subscale was measured with seven

items (e.g., “I often have tender, concerned feelings for people less fortunate than me” for empathic concern and “I try to look at everybody's side of a disagreement before I make a decision” for perspective-taking). The scale asked participants the extent to which each item describes themselves well. Each response was anchored to a five-point scale (1: Does not describe me well – 5: Describes me very well). We used the composite score of each subscale in this study. The internal consistency of the empathic concern subscale was $\alpha = .78$ and that of the perspective-taking subscale was $\alpha = .77$.

Moral Foundations Questionanire (MFQ)

We used the MFQ to measure the extent to which participants considered five different moral foundations proposed by the MFT, i.e., care/harm, fairness/cheating (individualizing foundations), ingroup/loyalty, authority/subversion, purity/degradation (binding foundations), importantly while making moral judgments. The questionnaire consisted of two parts (see Graham et al. [2011] for the full questionnaire). In the first part, participants were asked to what extent each foundation was relevant to their thinking while making moral judgments (e.g., care/harm: “Whether or not someone suffered emotionally”; fairness/cheating: “Whether or not some people were treated differently than others”; ingroup/loyalty: “Whether or not someone’s action showed love for his or her country”; authority/subversion: “Whether or not someone showed a lack of respect for authority”; purity/degradation: “Whether or not someone violated standards of purity and decency”). Their responses in the first part were anchored to a six-point scale (0: Not at all relevant – 5: Extremely relevant).

The second part asked whether participants agreed on each sentence representing different foundations (e.g., care/harm: “Compassion for those who are suffering is the most

crucial virtue"; fairness/cheating: "Justice is the most important requirement for a society"; ingroup/loyalty: "I am proud of my country's history"; authority/subversion: "Respect for authority is something all children need to learn"; purity/degradation: "Chastity is an important and valuable virtue"). The responses were quantified with a six-point scale (0: Strongly disagree – 5: Strongly agree). We used the composite score of each foundation acquired with six items per foundation. The internal consistency of each subscale was as follows: care/harm $\alpha = .70$, fairness/cheating $\alpha = .59$, ingroup/loyalty $\alpha = .63$, authority/subversion $\alpha = .66$, purity/degradation $\alpha = .76$.

Political Orientation Item

We surveyed participants' political orientation as a control variable. We used a single item in Pavlović et al. (2022) for this purpose: "Overall, what would be the best description of your political views?" Participants' responses were on an 11-point scale (0: Very left-leaning – 10: Very right-leaning).

Procedures for Data-driven Moral Exploration

We employed data-driven model exploration methods to identify the best predictors and models predicting the width of the moral circle. We used three exploration methods, i.e., Bayesian model exploration (Han, 2024a), Bayesian model averaging (BMA) (Hoeting et al., 1999), and elastic-net regression (*glmnet*) (Friedman et al., 2021; Han & Dawson, 2021). These three methods were chosen as they have been widely utilized in data-driven research projects in psychology and education (Han, 2024b). Then, we examined whether there was a good agreement between the models suggested by the methods. In all cases, we used these variables as candidate predictors: post-conventional moral reasoning, moral internalization, moral symbolization, empathic concern, perspective-taking, five moral

foundations (i.e., care/harm, fairness/cheating, ingroup/loyalty, authority/subversion, purity/degradation), and political orientation. Before performing model exploration, we tested the potential multicollinearity among the candidate predictors with a variable inflation factor (VIF). We concluded that significant multicollinearity existed when a VIF exceeded 3.0 (Thompson et al., 2017). We standardized predictors for better convergence during Bayesian regression analysis and additional information on effect sizes (Han, 2024e).

First, Bayesian model exploration was employed to identify the five best models predicting the moral circle while minimizing potential overfitting. We used an *R* routine, *explore.models* (Han, 2024a), comparing candidate regression models by generating all possible combinations of candidate predictors with the Bayesian Information Criterion (BIC). It suggests models with the lowest BIC values as best candidate models. We used the Poisson distribution since the moral circle was quantified into an ordinal variable. BICs are an approximation for actual Bayes Factors (BFs) indicating the extent to which one model is superior to the other given evidence (Kass & Raftery, 1995). Thus, following guidelines by Han (2024a), we additionally performed Bayesian regression analysis with the *brms* package for the five top models identified by *explore.models* and examined their model BFs, R^2 values, and cross-validation performance (via leave-one-out cross-validation). The default Cauchy prior was used for BF estimation following Rouder and Morey's (2012) guidelines. For additional information about whether the suggested models performed well and were robust against overfitting, we also performed the same procedures with the full model including all candidate predictors and the null model only with an intercept. Model BFs were calculated by comparing each candidate model and the null model to examine to

what extent the candidate model outperformed the null model. For interpretation, we employed $2\log(BF) \geq 2.00$ as a threshold representing the presence of positive evidence supporting one model versus the null model (Kass & Raftery, 1995).

Second, we performed BMA to estimate the averaged model across best candidate models to address the model uncertainty issue and overfitting. BMA first identifies the most probable models based on data (Hoeting et al., 1999). The process estimated the likelihood of the inclusion of each candidate predictor and the probability of candidate regression models following the mechanism of Bayesian statistics. Then, it averages the models and predictor coefficients to estimate the average model. According to prior research, the averaged model is robust against model uncertainty, which could be an issue when only one specific model is employed, and overfitting (Han, 2024b; Hoeting et al., 1999). On top of the averaged model, BMA additionally provides useful information to evaluate the relative importance of models and predictors, i.e., the posterior probabilities of the models and predictors (Han, 2024b). We used the *BMA* package to perform with the Poisson distribution (Raftery et al., 2005).

Third, we conducted elastic-net regression to estimate a regression model while penalizing unnecessary coefficients to improve cross-validation performance. Elastic-net regression is a regularized regression that estimates a robust regression model against overfitting (Friedman et al., 2021; Han & Dawson, 2021). During the model estimation process utilizing the maximum likelihood estimation, elastic-net regression penalizes unnecessary coefficients by minimizing the sum of the squared and absolute values of estimated coefficients, which are included in the likelihood function (see glmnet for the mathematical further details). We explored the model parameters that minimized the

cross-validation error during the five-fold cross-validation. Then, we examined the estimated predictor coefficients in the identified model. Elastic-net regression was conducted with the *glmnet* package (Friedman et al., 2021). Like the previous analyses, we employed the Poisson distribution. We employed the parameters for model tuning that Han and Dawson (2021) chose, an empirical study that used elastic-net regression in moral and civic education.

Finally, we compared the results from the three methods to examine whether they could make a good agreement. We focused on which predictors survived the exploration procedures and were included in the identified best models. Moreover, we also examined the candidate predictors' posterior probabilities to acquire additional information on their relative importance in predicting the moral circle width.

Results

Bayesian Model Exploration

First, when we checked the potential multicollinearity, we found that the highest VIF value from the model was 2.47, which did not exceed the 3.00 threshold. Hence, we concluded that multicollinearity would not be a significant issue during model exploration.

Table 1

Results from Bayesian Model Exploration with explore.model

Order	Model	BIC	AIC	*Log LR*	2log(BF) vs. null	Cross-validation error	R^2
1	Symbolization + Internalization + Care/harm - Authority/subversion	2623.00	2602.92	-1296.46	25.28	-1.30	9.74%
2	Moral reasoning + Symbolization + Internalization + Care/harm - Authority/subversion	2623.22	2599.12	-1293.56	23.00	.00	10.37%
3	Symbolization + Internalization - Political orientation + Care/harm - Authority/subversion	2625.40	2601.31	-1294.65	21.95	-1.10	10.10%

4	Moral reasoning + Symbolization + Internalization + Care/harm - Ingroup/loyalty	2626.19	2602.09	-1295.05	21.46	-1.50	10.05%
5	Perspective-taking + Symbolization + Internatlization + Care/harm - Authority/subversion	2626.38	2602.29	-1295.14	21.43	-1.80	10.02%
Full model	All predictors	2648.81	2600.61	-1288.31	-1.65	-4.60	11.89%
Null model	Intercept only	2691.63	2687.61	-1342.81		-41.30	.00%

Note. BIC: Bayesian Information Criterion. AIC: Akaike Information Criterion. *Log LR*: Log-likelihood ratio. 2log(BF) vs. null: model 2log(BF) value when compared with the null model. Cross-validation error: Cross-validation error estimated via leave-one-out cross-validation with the *loo* package. .00 indicates the best cross-validity while the smaller values indicate the inferior outcomes.

Table 1 reports Bayesian Model Exploration outcomes and follow-up Bayesian regression results with the top five suggested models (see Table S1 for the full information about Bayesian regression results). In all best models, both moral identity subscales, i.e., internalization, symbolization, and care/harm foundation were suggested as predictors to be included; all associations were positive. We found that several other candidate predictors were partially included in the top five models, i.e., moral reasoning, perspective-taking (positive associations), authority/subversion foundation, and political orientation (negative associations).

The resultant model 2log(BF)s exceeding the 2.00 threshold present that the identified five best models were significantly better supported by data than the full and null models. Cross-validation accuracy or error values suggest that the suggested five models demonstrated better cross-validity than the full and null models, so they are more robust against overfitting. Although the suggested models contained fewer predictors than the full model with all predictors, their R^2 values were comparable with the R^2 of the full model.

Thus, they are deemed to predict the moral circle expansiveness well while being less susceptible to the overfitting issue.

Bayesian Model Averaging

Table 2 reports the results from BMA. Consistent with the results from Bayesian model exploration, internalization, symbolization, and care/harm foundation are included in all candidate models identified by BMA as shown by their 100% inclusion probability. The authority/subversion foundation's inclusion probability is also higher than 90%. Other variables reported inclusion probability values in the following order (higher to lower): post-conventional moral reasoning, political orientation (being conservative), ingroup/loyalty foundation, perspective-taking, fairness/cheating foundation, empathic concern, purity/degradation foundation.

Table 2

Results from Bayesian Model Averaging

Predictors	Inclusion probability	*E* (Coef.)	*SD*	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	100.00%	2.20	.02	2.20	2.20	2.20	2.20	2.20
Moral reasoning	48.00%	.02	.03		.04		.05	
Symbolization	100.00%	.06	.02	.07	.07	.06	.07	.06
Internalization	100.00%	.08	.02	.08	.08	.08	.06	.08
Perspective-taking	9.10%	.00	.01					.03
Empathic concern	4.20%	.00	.01					
Care/harm	100.00%	.08	.02	.09	.08	.08	.07	.08

Fairness/cheating	8.40%	.00	.01					
Ingroup/loyalty	14.40%	-.01	.02				-.06	
Authority/subversion	90.30%	-.07	.03	-.08	-.07	-.07		-.08
Purity/degradation	1.50%	.00	.00					
Political orientation	19.30%	-.01	.02			-.03		
Model probability				25.80%	23.10%	7.80%	5.20%	4.80%

Note. *E* (Coef.): The expected value of each coefficient calculated by averaging the coefficient across models.

According to the averaged coefficient values, post-conventional moral reasoning, moral identity, empathy, and individualizing foundations positively predict the moral circle expansiveness. On the other hand, binding foundations and being politically conservative are negatively associated with the dependent variable.

Elastic-net Regression

Table 3 presents predictor coefficients estimated by elastic-net regression minimizing the cross-validation error. Among the candidate predictors, fairness/cheating and purity/degradation foundations did not survive the regularization process, so their coefficients became zero in the final model. In line with what we found from Bayesian model exploration and BMA, post-conventional moral reasoning, moral identity (i.e., symbolization and internalization), empathy (i.e., perspective-taking and empathic concern), and care/harm foundation positively predict the moral circle expansiveness.

Furthermore, ingroup/loyalty, authority/subversion foundations, and being politically conservative show negative associations with the dependent variable in the regularized model.

Table 3

Result from Elastic-net Regression

Predictor	Coefficient	Predictor	Coefficient
Intercept	2.20	Care/harm	.06
Moral reasoning	.03	Fairness/cheating	-
Symbolization	.05	Ingroup/loyalty	-.02
Internalization	.05	Authority/subversion	-.02
Perspective-taking	.02	Purity/degradation	-
Empathic concern	.00	Political orientation	-.02

Discussion

We explored the models predicting the expansiveness of one's moral circle with data-driven exploration methods, i.e., Bayesian model exploration implemented by *explore.models,* BMA, and elastic-net regression. We examined moral psychological constructs suggested as significant predictors for moral motivation and behavior by prior research, i.e., ethical reasoning, moral identity, and empathy. We also included moral foundations and political orientation suggested as predictors for the moral circle by previous moral circle studies in the list of candidate predictors. Although there are minor differences across the prediction models reported by the different methods, we found a consistent pattern in the directions of the associations between predictors and the

dependent variable. Sophisticated post-conventional moral reasoning, moral identity, empathy, and individualizing foundations predicted the wide moral circle. Binding foundations and being politically conservative were negatively associated with the dependent variable. Despite the consistent pattern, the strength of the association varies across predictors. Moral identity subscales, care/harm, and authority/subversion foundations demonstrated the strongest association. Post-conventional moral reasoning, ingroup/loyalty foundation, and political orientation showed a considerable but relatively weaker relationship. Empathy subscales, fairness/cheating, and purity/degradation foundations reported the weakest association as some occasionally did not survive the variable selection procedures.

Generally, findings from our study successfully replicated those in previous studies examining the relationship between moral foundations, political orientation, and the moral circle (e.g., Crimston et al., 2016; Passini, 2016; Waytz et al., 2019). First, individualizing foundations, particularly the care/harm foundation, positively predicted the moral circle expansiveness while binding foundations demonstrated a negative association as reported by Crimston et al. (2016). Second, consistent with Waytz et al. (2019), political conservativism among participants was associated with a narrower moral circle. The representative individualizing foundation, i.e., the care/harm foundation, primarily concerns others' welfare regardless of who the objects are; in some cases, items ask the potential harm to non-human beings (e.g. "One of the worst things a person could do is hurt a defenseless animal.") (Graham et al., 2011). Hence, it is plausible to expect that the foundation is associated with the wider moral circle, which may embrace non-human beings as potential objects of moral concern. Contrarily, binding foundations are mainly

about ethical matters regarding one's close other, community, and society (Graham et al., 2011). For instance, authority/subversion and ingroup/loyalty foundations are closely related to treating one's ingroup members with respect and loyalty. Thus, strong binding foundations might predict a narrow moral circle concentrating upon social institutions, which may not include outgroup members and non-human beings (Smith et al., 2014).

One novel finding regarding moral foundations and political orientation was that moral foundations significantly predicted the moral circle even after considering one's political orientation. Generally, individualizing foundations demonstrate a positive association with liberalism while binding foundations are closely tied to conservativism (Graham et al., 2009). Moreover, political conservativism is supposed to be closely associated with strong care about family, community, nation, and other social institutions. Meanwhile, liberalism is tied to pursuing diversity and inclusion (Ben-Ner et al., 2009). Therefore, it is convincing to expect that conservativism negatively predicts the moral circle expansiveness as reported by Waytz et al. However, previous research on predictors for the moral circle (e.g., Crimston et al., 2016; Waytz et al., 2019) did not simultaneously consider both factors as candidate predictors. Hence, the findings from our data-driven explorations demonstrating the unique contributions of moral foundations and political orientation to predicting the moral circle shed light on future moral psychological research addressing the relationship between those two factors.

We also found a positive relationship between post-conventional moral reasoning and the width of the moral circle. Given the nature of the post-conventional schema, such a positive association sounds plausible. According to the Neo-Kohlbergian model of moral judgment development, two other schemas, personal-interest and maintaining norms

schemas, are mainly concerned about pursuing one's interest or relationship with close others (personal-interest) or maintaining social conventions and institutions (maintaining norms) (Rest et al., 1999). Thus, if one tends to employ these two schemas while addressing moral issues, one is likely to focus on values within the boundary of one's society rather than expanding their horizon of judgment and reasoning. On the other hand, a person who primarily utilizes post-conventional reasoning may critically reconsider existing social norms and take diverse ethical perspectives to render solutions. Such is likely to result in the expansion of the moral circle and moral concern. Although there has not been sufficient prior research directly relevant to this topic, Endicott et al. (2003) reported that post-conventional moral reasoning was positively correlated with multicultural experiences and perspectives. This study primarily addresses multiculturalism, which is limited to concerns about outgroup human beings. However, at the least, the finding may suggest that post-conventional reasoning (versus reasoning based on personal interest or social norms) is associated with the tendency to expand the boundary of moral concern beyond ingroup members.

Moral identity, including internalization and symbolization, demonstrated a strong positive connection with the moral circle. Internalization is the extent to which ethical values are central to one's self-identity as overviewed in the introduction. Symbolization is the importance of engaging in actions to symbolize one's moral identity. Previous research has shown that having a strong moral identity predicts the expansion of the in-group boundary (Reed & Aquino, 2003). As a result, moral identity positively predicts prosocial and charitable behavior toward out-group members, positive attitudes toward out-group brands (W. J. Choi & Winterich, 2013), and decreased out-group prejudice. Crimston et al.

(2016) and Passini (2016) additionally examined the fact that moral identity predicts moral circle width more directly. Our study successfully replicated the previous studies and provided evidence supporting the positive relationship between moral identity and moral circle expansiveness.

One interesting point in our finding is that symbolization also showed the positive association mentioned above like internalization. Previous studies have consistently reported that only internalization was a significant predictor (Crimston et al., 2016; Passini, 2016). Our data-driven approach might make such a difference despite it being a speculative interpretation. Prior works included all candidate predictors in their regression model, so the strength of the association between symbolization and the dependent variable might diminish due to the correlation between symbolization and other included predictors. Including unnecessary predictors yields less precise models and inferences (Pituch & Stevens, 2016) so it may result in erroneously estimated coefficients as we assumed. This is concerning in our study since Dawson and Han (2023) and Han et al. (2020) examining the correlation among various moral psychological constructs reported that symbolization was significantly associated with moral reasoning, empathy, and moral foundations. Because our data-driven methods suggested stringent models excluding unnecessary predictors (Han, 2024b), the resultant models might demonstrate the actual predictive importance of symbolization.

Another interesting result was that empathy showed positive but weaker associations with the moral circle width compared with other moral psychological indicators mentioned above, i.e., moral reasoning and identity. It is opposite to expectation as previous research has consistently proposed the positive relationship between empathy

and the moral circle. One possibility is that empathy, especially towards outgroup members, might be predicted by the width of the moral circle instead of vice versa. Many previous works addressing this topic, including Graham et al. (2017) and Waytz et al. (2017), considered the moral circle may predict one's empathic motive and behavior to be concerned about outgroup members' and beings' welfare. Perhaps other moral psychological indicators previously examined, e.g., moral foundations and identity, might predict the moral circle. Then, the moral circle expansiveness might predict the strength of outgroup empathy. Thus, empathy in our prediction models might not be prevalent and considered important compared with other candidate predictors. However, this interpretation is speculative because our study was cross-sectional, so it is impossible to examine any causal relationship appropriately. It may warrant further investigations involving multi-time point data collection and analysis.

These findings suggest several implications for moral education. As we overviewed in the introduction, expanding one's moral circle is closely related to addressing significant modern ethical issues, such as how to treat outgroup members and non-human beings (Graham et al., 2017). Problems related to multiculturalism and climate justice are inseparable from the moral circle expansion (Bratanova et al., 2012; Bucholc, 2013). Given our findings illuminating the importance of moral development, especially the development of moral reasoning and identity, in predicting the moral circle, we suggest that moral educators consider and employ the theory and practice of moral education based on *phronesis*, i.e., practical wisdom. According to philosophical and psychological works on *phronesis* and its cultivation, it consists of multiple psychological components, such as affective processes, moral blueprint and identity, and ethical adjudication (Darnell

et al., 2019; Kristjánsson & Fowers, 2022). Optimal moral functioning can occur based on the holistic cultivation and development of the components and appropriate coordination and networking among them (Han, 2024d, 2024c).

We found that the expansive moral circle is predicted by sophisticated moral reasoning, strong moral identity, and empathy to some degree. These functional components have been deemed connected to the constituents of *phronesis* (Darnell et al., 2019; Han, 2024d). In other words, although our study per se cannot present any evidence supporting causality, the findings may suggest that the development of the multifaceted *phronesis* would be closely tied to and eventually constitute the developmental basis for the moral circle expansion. Hence, moral educators interested in the moral circle as a target of education may consider employing the methods to cultivate *phronesis*. Additionally, cultivating *phronesis* may address a dilemma regarding the moral circle. Graham et al. (2017) proposed that balancing the centrifugal (expansion) and centripetal forces (caring for close others, such as family) in the moral circle can be a significant challenge for moral development and moral education. Given *phronesis* as practical wisdom enables one to avoid extreme ends, which are vices, and figure out the virtuous golden mean to behave in different situations optimally (Kristjánsson, 2023), we assume that it can also significantly contribute to resolving the problem of balancing the two forces in the moral circle (Graham et al., 2017).

Furthermore, methodology-wise, our study can provide moral development and education researchers with novel insights about appropriately exploring prediction models with collected data. Unlike previous studies addressing a similar topic utilizing conventional hypothesis-driven methods, we employed data-driven model exploration

methods robust against inflated false positives and overfitting (Han, 2024b, 2024a; McNeish, 2015). Utilizing data-driven methods will allow researchers to explore models and gather ideas about how to formulate hypotheses for follow-up confirmatory and experimental studies.

Although our study has methodological merits and significantly contributes to research on the moral circle, several limitations warrant further studies. First, as mentioned previously, our study was cross-sectional, so additional longitudinal data collection and analysis is warranted to generate any valid conclusion about causality. Future studies may examine the causal relationship between the moral circle and empathy, and how moral education would influence its developmental change. Second, we examined limited aspects of moral functioning, i.e., ethical reasoning, moral identity, empathy, and moral foundations, so it might only partially reveal the moral circle and its psychological mechanism. For instance, although we mentioned *phronesis* while discussing educational implications, we did not use a real measure for *phronesis*. It was partially inevitable due to the computational complexity involving model exploration. Hence, additional scales may need to be adopted along with additional computational resources in future studies.

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