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Journal of Environmental Psychology 27 (2007) 14–25

Journal of ENVIRONMENTAL PSYCHOLOGY

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Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour

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Available online 29 December 2006

Abstract

The goal of the present paper is a replication as well as an extension of the Hines et al. [(1986/87). Analysis and synthesis of research on responsible environmental behaviour: A meta-analysis. *Journal of Environmental Education*, *18*, 1–8] meta-analysis on psycho-social determinants of pro-environmental behaviour. Based on information from a total of 57 samples the present meta-analysis finds mean correlations between psycho-social variables and pro-environmental behaviour similar to those reported by Hines et al. In a second step, the matrix of pooled correlations is used for a structural equation modelling (SEM) test of theoretically postulated structural relations between eight determinants of pro-environmental behaviour (so-called Meta-analytic SEM (MASEM)). MASEM results confirm that pro-environmental behavioural intention mediate the impact of all other psycho-social variables on pro-environmental behaviour (27% explained variance). Results also confirm that besides attitude and behavioural control personal moral norm is a third predictor of pro-environmental behavioural intention (52% explained variance). The MASEM also indicates that problem awareness is an important but indirect determinant of pro-environmental intention. Its impact seems to be mediated by moral and social norms, guilt and attribution processes.

Keywords: Meta-analysis; Meta-analytic SEM (MASEM); Pro-environmental behaviour; TPB; Norm-activation model

1. Introduction

It is now 20 years ago that Hines, Hungerford, and Tomera (1986/87) published their meta-analysis of research on responsible environmental behaviour. The goal of this analysis was not only to identify variables reliably associated with pro-environmental behaviour, but also to determine quantitatively the strengths of these relationships. This was the reason why Hines et al. use the quantitative meta-analysis approach for research synthesis. The literature search conducted by Hines et al. resulted in a list of 128 primary studies which assessed variables in association with pro-environmental behaviour and reported the information needed for including them in a meta-analysis. A great share of these 128 studies concentrates on the relation between pro-environmental behaviour and socio-structural variables. However, a small number of these studies (Hines et al. do not report the exact number) analyse the association between the four psycho-social variables attitude, locus of control/self-efficacy, moral responsibility, behavioural intention and pro-environmental behaviour.

The meta-analytical results of Hines et al. concerning the average bivariate association of these four psycho-social variables with pro-environmental behaviour provide the starting point of the present research: Based on 9 studies Hines et al. found a mean correlation between pro-environmental attitudes and pro-environmental behaviour of $r = .38$, between locus of control/self-efficacy and pro-environmental behaviour of $r = .37$ (15 studies); between the felt moral obligation to behave in a pro-environmental way and pro-environmental behaviour of $r = .33$ (6 studies), and between pro-environmental behavioural intention and pro-environmental behaviour of $r = .49$ (6 studies).

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doi:10.1016/j.jenvp.2006.12.002

Against the background of their meta-analytical results, Hines et al. (1986/87) proposed a model of environmental behaviour which views the intention to act and objective situational factor as direct determinants of pro-environmental behaviour. Intention itself is viewed as summarising the interplay of cognitive (action skills, knowledge of action strategies and issues) as well as personality variables (attitudes, locus of control, and personal responsibility).

In the following decade, the meta-analysis conducted by Hines et al. exerted a strong impact on the further research on psycho-social determinants of pro-environmental behaviour. Using modern statistical methods for synthesising results of a body of primary studies it provided convincing empirical evidence for the utility of psycho-social variables as predictors of pro-environmental behaviour. This finding encouraged many researchers to continue their research on psycho-social determinants of pro-environmental behaviours.

2. The present research

It is astonishing that despite the impact of this first meta-analysis to the best of our knowledge no further meta-analyses of research on pro-environmental behaviour have been published since 1986. Lack of new research cannot be the reason for this gap. Since the work of Hines et al. a steady stream of primary studies analysing determinants of pro-environmental behaviour has been published. A meta-analysis of these more recent studies is urgently needed, not only because of the long time that has passed since the appearance of the Hines et al. meta-analysis but also because the results of this meta-analysis are based on a relatively small number of primary studies.

Thus, the first goal of the present paper is to assemble a body of more recent studies for a independent replication of the Hines et al. meta-analytical results. The second goal of the present meta-analysis directly ties up where the Hines et al. paper ends: We want to perform a meta-analytical test of a theoretical model integrating eight psycho-social determinants of pro-environmental behaviour. Such a theory-driven meta-analysis more adequately reflects one main trend of environmental psychological research during the last decade: The use of psychological action theories for analysing the interplay of knowledge, behavioural constraints/opportunities as well as personal values and motives in influencing the decision to behave in a pro-environmental way (e.g., Bamberg & Schmidt, 2003; Taylor & Todd, 1995).

The greater emphasis on modelling and testing construct relationships corresponds with a similar development in meta-analytical methodology: Apart from the traditional univariate effect sizes, researchers have started to emphasise synthesising multivariate effect sizes, especially correlation matrices, because of the increasing complexity of the research questions (e.g., Cheung, 2000; Hedges & Olkin, 1985). Just inspecting a matrix of synthesised correlations, however, may not be very informative in understanding the underlying relationships among the variables. As a result, researchers have become interested in testing theoretical models with structural equation modelling (SEM) based on the meta-analytically pooled correlation matrix (Becker, 2000; Viswesvaran & Ones, 1995). In the present paper we want to use this methodological integration of meta-analysis and SEM, which is called meta-analytic SEM (MASEM), to test our integrative theoretical model.

After presenting the model used as theoretical framework for our meta-analysis, the second section of the paper describes a two-stage procedure for conducting the MASEM. The third section describes the search strategy as well as inclusion criteria used for assembling the body of studies included in the present meta-analysis. The main section reports the results of the MASEM analysis. The last section summarises and evaluates these results from a theoretical as well as methodological point of view.

3. The theoretical model

Pro-environmental behaviour is probably best viewed as a mixture of self-interest (e.g., to pursue a strategy that minimises one's own health risk) and of concern for other people, the next generation, other species, or whole ecosystems (e.g., preventing air pollution that may cause risks for others' health and/or the global climate). This mixture of self-interest and pro-social motives is also reflected by the theoretical models most frequently applied for explaining pro-environmental behaviour: Researchers who view environmental behaviour primarily as pro-socially motivated often use the norm-activation model (NAM, Schwartz, 1977) as theoretical framework, whereas researchers who view self-interest as the more important motive often rely on rational choice models like the theory of planned behaviour (Ajzen, 1991).

The basic premise of the NAM is that moral or personal norms are direct determinants of pro-social behaviour. Schwartz (1977) conceived moral norms as feelings of strong moral obligations that people experienced for themselves to engage in pro-social behaviour. In line with this model several primary studies provide evidence that moral norms contribute to an explanation of pro-environmental behaviours like energy conservation (Black, Stern, & Elworth, 1985), recycling (Guagnano, Stern, & Dietz, 1995), travel mode choice (Hunecke, Blöhbaum, Matthies, & Höger, 2001), and pro-environmental buying (Thøgersen, 1999). As reported above, Hines et al. (1986/87) found a mean correlation of $r = .33$ between a feeling of moral obligation to preserve the environment and pro-environmental behaviour.

The formation as well as activation of a moral norm is probably based on the interplay of cognitive, emotional, and social factors (e.g., Bierhoff, 2002): In the field of pro-environmental behaviour the awareness of and knowledge about environmental problems are probably important cognitive preconditions for developing moral norms. Causal attribution seems to be a second important

cognitive process contributing to the development of moral norms. The internal attribution of a harmful behaviour often triggers emotional reactions, namely guilt feelings (e.g., Weiner, 2000). Guilt is defined as a "painful feeling of regret that is aroused when the actor actually causes, anticipates causing, or is associated with an aversive event." (Ferguson & Stegge, 1998, p. 20). Guilt is an important pro-social emotion because it results in a felt obligation (moral norm) to compensate for the caused damage (Baumeister, 1998). Feelings of guilt are also closely related with social norms. A perceived mismatch between one's own behaviour and social norms leads to feelings of guilt (Baumeister, 1998). Besides their impact on feelings of guilt, social norms also directly contribute to the development of moral norms. They deliver the standards what behaviour a social reference group view as appropriate in a specific context—that is what the group views as right or wrong. If an individual internalises these standards they provide the content of her/his personal moral norms.

The second theoretical framework, Ajzen's TPB, is based on a more hedonistic model of human beings. It assumes that people are motivated to avoid punishments and to seek rewards. According to this model, decision making is guided by a rational evaluation of behavioural consequences. The sum of perceived positive and negative consequences determines the global attitude toward a behavioural option. Attitude does not directly determine behaviour but only indirectly via behavioural intention. The TPB also stresses the importance of situational constraints. When forming their behavioural intention, people do not only take into account their attitudes toward this behaviour but also estimate their ability to perform this behaviour that is their perceived behavioural control (PBC) over it. Social norms are viewed as a third factor influencing decision making. In the TPB framework a social norm is primarily conceptualised as perceived social pressure that is the expectations of significant reference persons to perform or not perform a behaviour. Fear of social exclusion is viewed as a primary motive why people tend to fulfil social norms. Like attitude and PBC, social norm is thought to determine behaviour not directly but only indirectly via its impact on intention. The TPB further assumes that when PBC is a reliable predictor of objective behavioural control it also predicts behaviour directly.

In line with the introductory statement that pro-environmental behaviour is best viewed as a mixture of self-interest and pro-social motives, it is suggested to combine both theoretical frameworks. Thus, various researchers have proposed introducing moral norm as additional independent predictor of intention besides attitude, social norm and PBC (e.g., Manstead, 2000). In their analysis of the determinants of five specific pro-environmental intentions, Harland, Staats, and Wilke (1999) found that the inclusion of moral norm raised the proportion of explained variance of intention by 1–10%.

Fig. 1 presents our proposed integrative model graphically. As can be seen for a more balanced representation of self-interest and pro-social motives moral norm instead of social norm is conceptualised as a third independent determinant of intention. This change is empirically supported by reviews of TPB applications (e.g., Ajzen, 1991; Armitage & Conner, 2001) which indicate that social norm often exerts no direct effect on intention after checking for the effects of attitude and PBC. Our integrative model ascribes a more indirect role to social

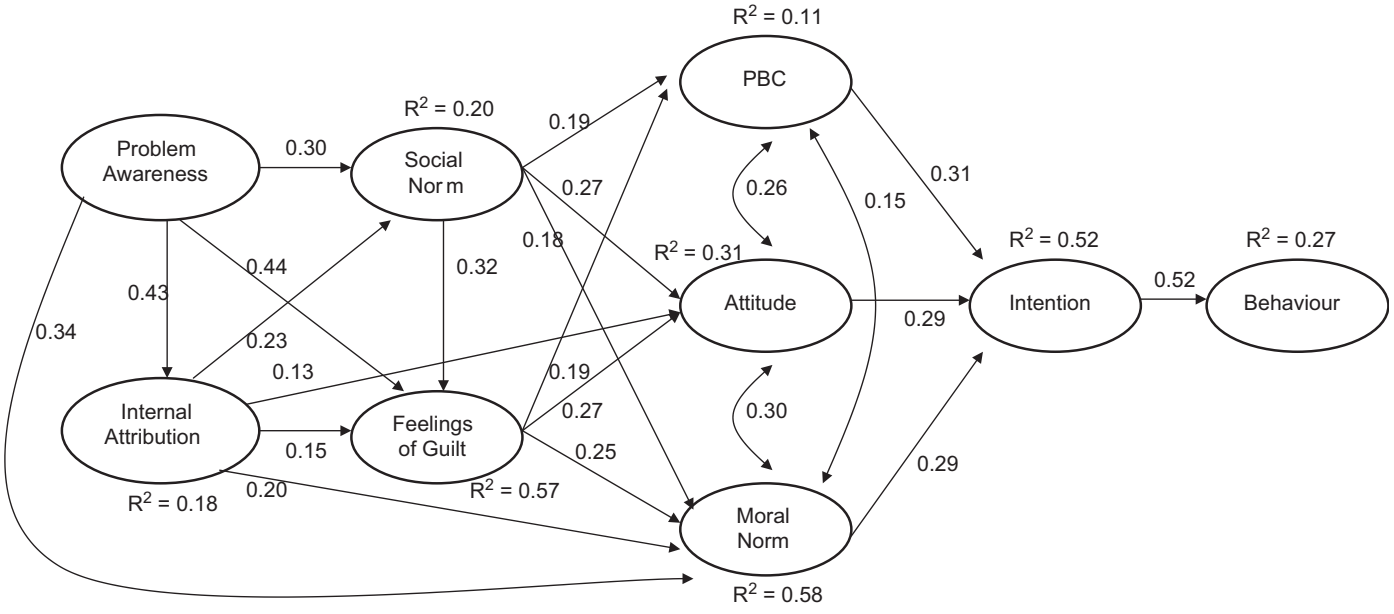

Fig. 1. Results of the MASEM based on pooled random-effects correlations, PBC = perceived behavioural control, single-headed arrows = standardised path-coefficients; double-headed arrows = correlations, R^2 = explained variance.

norms. In line with Sherif's (1936) classical study on the informational influence of social norms it is assumed that frequently people follow social norms not because they fear social pressure, but because they use social norms as information about what behaviour is appropriate. Thus, social norms may not only provide information whether a specific behavioural option is morally right or wrong but also whether it is beneficial or easy to perform.

4. Method

4.1. Data collection

As it was our goal to conduct a meta-analytical test of the above-described integrative theoretical model, we primarily searched for studies applying the NAM, TPB or similar models to pro-environmental behaviour and that were published in peer-reviewed journals. Because the TPB as well as the NAM provides clear definitions and operationalisations of the theoretical constructs we are interested in, researchers applying these frameworks should use similar items for measuring the respective psycho-social constructs. Passing a review process is used as an additional criterion that the correlations reported in these studies indeed reflect associations between the same theoretical constructs. Furthermore, we focused our search on papers published since 1995. The rationale for this restriction was the results of preliminary literature searches indicating that the systematic application of the NAM and TPB in environmental psychology started at that time.

One strategy for identifying the studies relevant for our meta-analysis consisted in using the internet search machine Google Scholar and the databases PsycInfo, Web of Science, and Scopus. Search keywords were the following terms: recycling; waste reduction; energy saving; energy conservation; travel mode choice; travel behaviour; car-use; bus-use; public transportation; cycling; walking; travel demand measures; pro-environmental mobility behaviour; water conservation; organic food, green consumerism; green purchases; meat consumption; ethical consumer; environment-friendly buying behaviour; environmental consumer behaviour; ecological consumer behaviour; sustainable consumption; green consumer behaviour; ecological behaviour; pro-environmental behaviour, conservationism; environment-friendly behaviour; environment protection behaviour; ecological behaviour and moral norm; ecological behaviour & personal norm; ecological behaviour & morality; pro-environmental attitudes; pro-environmental behaviour & constraints; ecological behaviour & social norms; ecological behaviour & norm activation model; pro-environmental behaviour & theory of planned behaviour.

The second search strategy consisted in inspecting the content tables since 1995 of those 36 journals where the studies found with the electronic search strategy have been published (the list can be requested from the authors).

4.2. Inclusion criteria

Our literature search resulted in a list of 163 empirical papers matching our keywords. In the next step, we carefully read the abstracts and the measurement section of the papers. Papers which did not analyse at least two of the constructs included in our theoretical model or where the construct definitions and/or measures did not fit our understanding were excluded at this stage ($n = 86$). For the remaining papers we checked whether a matrix of bivariate Pearson correlations and sample size was reported. This information was needed to conduct the meta-analysis. During this step we lost a substantive number ($n = 31$) of interesting studies (e.g., Chu & Chiu, 2003; Oom do Valle, Rebello, Reis, & Menezes, 2005; Thøgersen, 2006) because they only report multivariate results obtained from regression or SEM analyses without documenting the respective bivariate correlations. Forty-six studies reporting results for 57 independent samples fulfil all the selection criteria. These 57 correlation matrices provide the input for calculating the pooled average correlations needed for the MASEM analysis. In the reference section the 46 studies included in our meta-analysis are marked by an asterisk.

4.3. Conducting an MASEM

Researchers typically conduct MASEM by means of the following two-stage procedure (Viswesvaran & Ones, 1995). In the first stage, the correlation coefficients of two constructs obtained from the primary studies are meta-analytically pooled and tested for homogeneity. In the literature two statistical approaches for calculating the pooled correlations are found: the Hedges and Olkin (1985) and Hunter and Schmidt (1990) method. In the present paper the Hedges and Olkin method is used. In this method the correlations from each primary study are first converted into a standard normal metric by using Fisher's r-to-Z transformation. The transformed primary correlations are then used to calculate an initial pooled mean correlation, in which each primary correlation is weighted by the inverse of its within-study variance (so-called 'fixed effects' model, see Hedges & Olkin, 1985, p. 231). Then the Q-test statistic of homogeneity (see Hedges & Olkin, 1985, p. 231) is calculated for each pooled correlation. Because the Q-test was developed for univariate-z values, Cheung (2000) recommends using a Bonferroni-adjusted at-least-one approach for testing the homogeneity of correlation matrices. This means that the hypotheses of homogeneity will be rejected if at least one of the elements of a pooled correlation matrix is heterogeneous across studies.

When the heterogeneity tests are insignificant, the fixed-effects model is appropriate for calculating the pooled correlation matrix. However, when these tests indicate heterogeneity, the application of a fixed-effects model is not appropriate (e.g., Hunter & Schmidt, 2000). In this case the random-effects model has to be used for pooling the

correlations. Random effects model means that for calculating the pooled correlations the inverse of a variance term incorporating within-study as well as between-studies variance is used for weighting the single primary studies. There are different methods for estimating the between-studies variance component (e.g., Hedges & Vevea, 1998). In the present paper a non-iterative method based on the results of the Q-statistic (Hedges & Vevea, 1998, Eq. (10)) is applied. The pooled random-effects correlation matrix is recalculated with these new weights and converted back to the r metric.

One problem in synthesising correlation matrices is that studies often involve different numbers of variables, depending on the research interest of a specific researcher. There are two ways to handle this issue (Viswesvaran & Ones, 1995). The first way consists in including only studies that contain all model variables—that is to use listwise deletion. The second way, in most applied contexts probably the only viable one, consists in estimating the elements of the pooled correlation matrix based on different numbers of studies—that is to use pairwise deletion.

In the second stage, the produced pooled correlation matrix is used as input for an SEM path analysis. However, when pairwise deletion is used for producing pooled correlation matrix, the elements of this correlation matrix are based on different sample sizes. Because for fitting the SEM information about the total sample size is needed, in the pairwise deletion case one is confronted with the difficult question what the appropriate total sample size is. In the literature one can find different ad hoc proposals how to determine the appropriate sample size in this case. Some researchers propose the arithmetic mean for this purpose, others the harmonic mean, or the median.

Table 1
Total sample size (upper row) and number of independent correlation matrices (lower row) obtained for each construct

Construct	1	2	3	4	5	6	7	8	9
1. Problem	11,740								
	(23)								
2. Attribution	2471	3565							
	(7)	(9)							
3. Social norm	3358	175	12,255						
	(6)	(1)	(33)						
4. Guilt	2760	443	4154	4597					
	(4)	(1)	(6)	(7)					
5. PBC	3789	175	10,467	4154	13,378				
	(8)	(1)	(25)	(6)	(34)				
6. Attitude	1727	175	9053	2627	9588	12,345			
	(4)	(1)	(26)	(4)	(24)	(33)			
7. Moral norm	8957	1540	8126	4154	8836	6646	14,022		
	(15)	(4)	(16)	(6)	(18)	(14)	(26)		
8. Intention	6571	3068	7900	3070	8356	8551	8907	14,365	
	(13)	(7)	(22)	(5)	(24)	(23)	(19)	(36)	
9. Behaviour	8276	1866	7325	3203	8029	6751	6840	5654	14,394
	(18)	(6)	(18)	(5)	(18)	(17)	(11)	(15)	(36)

5. Results

Table 1 presents the information (number of available independent primary bivariate correlation coefficients and the pooled total sample size on which these coefficients are based) extracted from the 57 samples included in our meta-analysis. Table 1 impressively demonstrates the above mentioned missing values problem one is often confronted with when conducting an MASEM analysis. Because our proposed integrated theoretical model contains 9 variables, 36 pooled mean correlations are necessary for conducting the MASEM test of this model. As can be seen from Table 1, the information available from the 57 samples included in our meta-analysis varies considerably over these 36 cells: Whereas 24–26 independent primary correlations are available for calculating the pooled average bivariate correlations of social norm, attitude, and PBC, the calculation of pooled mean correlations for the construct attribution with social norm, guilt, PBC, and attitude is impossible, because only one correlation coefficient is available for these four associations. The great differences in the information available are also reflected in the total sample sizes on which the reported correlation coefficients are based: The pooled total sample sizes vary from $n = 10{,}467$ for the correlation of social norm and PBC to $n = 175$ for the correlation of attribution and social norm.

Thus, Table 1 indicates a first future research task: Until now there has obviously been very little systematic research on the association between internal attribution processes, feelings of guilt, pro-environmental social norms and attitudes. Simultaneously, the high rate of missing values renders the listwise deletion strategy impossible for producing the pooled correlation matrix necessary for conducting the planned MASEM test of the integrated theoretical model: In the total pool of 46 studies there is not one study assessing all nine model variables simultaneously. Thus we have to use the pairwise deletion strategy to estimate the elements of the pooled correlation matrix.

However, before calculating the pooled correlation matrix we have to check the representativeness of our database. One potential thread of representativeness is reporting bias (the so-called file drawer problem; Rosenthal, 1979), which arises when studies with non-significant results are not published. One way to assess the presence of reporting bias is to use formal rank-correlation-based statistical tests (e.g., Armitage & Berry, 1987). However, because they use ordinal information in the case of a low and medium-sized sample these tests have low statistical power (e.g., Begg, 1994). Thus, most authors (e.g., Light, Singer, & Willett, 1994) recommend to use funnel plots for a graphical 'eyeball' test of biases. As the name says a funnel plot graphically presents the bivariate distribution of sample size versus effect size. If no bias is present this plot should be shaped like a funnel, with the spout pointing up that is, with a broad spread of points for

the highly variable small studies at the bottom and decreasing spread as the sample size increases. However, the mean effect size should be the same regardless of sample size. That is, one should be able to draw a vertical line through the mean effect size, and the points should be distributed on either side for all sample sizes. In other words, the funnel should not be skewed.

Because presenting funnel plots for all the 32 associations would need to much space, Figs. 2a–d presents only the respective funnel plots for the correlation of attitude, PBC and moral norm with intention and intention with behaviour. The *x*-axis of the figures represents correlation size and the *y*-axis sample size. The vertical line goes through the estimated random effects pooled correlation (see below). For the association of attitude, social norm and PBC with intention the plot of the retrieved correlations shows a picture quite consistent with the requested funnel pattern. However, for the sample of retrieved intention–behaviour correlations the plot shows a 'hole' in the low left part of the distribution. From the 15 retrieved intention–behaviour correlations only two are below .20. This finding provides some evidence that the sample of intention–behaviour correlations retrieved from the literature may be biased by not reporting low insignificant intention–behaviour correlations.

The upper triangular matrix presented in Table 2 reports the respective pooled correlation coefficients resulting from the pairwise deletion strategy under the fix-effects assumption. In the cases where only one primary correlation was available these primary correlations were directly inserted into the matrix. In order to test the homogeneity of the pooled correlation matrix we calculated the *Q*-test statistic of homogeneity for each matrix element. Only for two (problem awareness and attitude; guilt and moral norm) of the 32 pooled correlations the *Q*-statistic was insignificant. For most of the remaining 30 correlations the value of the *Q*-statistic was below the critical value of $p = .0016$ which, according to the Bonferroni-adjusted at-least-one approach (Cheung, 2000) indicates strong heterogeneity of the pooled correlation matrix.

As a consequence we recalculated the 32 pooled correlations under the obviously more appropriate random-effects assumption. The lower part of Table 2 presents the pooled correlation matrix calculated under the random-effects assumption. Table 3 reports the 95% confidence intervals of these estimates.

The information given in Tables 2 and 3 provides an answer to our first research question: How similar are the pooled mean correlations found in our meta-analysis to those reported by Hines et al. (1986/87)? Based on 17

Table 2
Fisher's Z-back-transformed pooled 'true' correlation matrix under the fix-effects (upper triangular matrix) and random-effects assumption (lower triangular matrix)

Construct	1	2	3	4	5	6	7	8	9
1. Problem	—	.43	.42	.61	.10	.30	.61	.38	.22
2. Attribution	.43	—	.36*	.45*	.18*	.36*	.53	.33	.25
3. Social norm	.40	.36*	—	.57	.31	.49	.61	.46	.31
4. Guilt	.63	.45*	.55	—	.31	.52	.66	.55	.31
5. PBC	.11	.18*	.29	.29	—	.49	.41	.61	.30
6. Attitude	.27	.36*	.47	.48	.44	—	.81	.66	.54
7. Moral norm	.63	.53	.53	.66	.35	.67	—	.63	.58
8. Intention	.40	.33	.42	.50	.54	.62	.59	—	.52
9. Behaviour	.19	.24	.31	.30	.30	.42	.39	.52	—

*No pooled correlation.

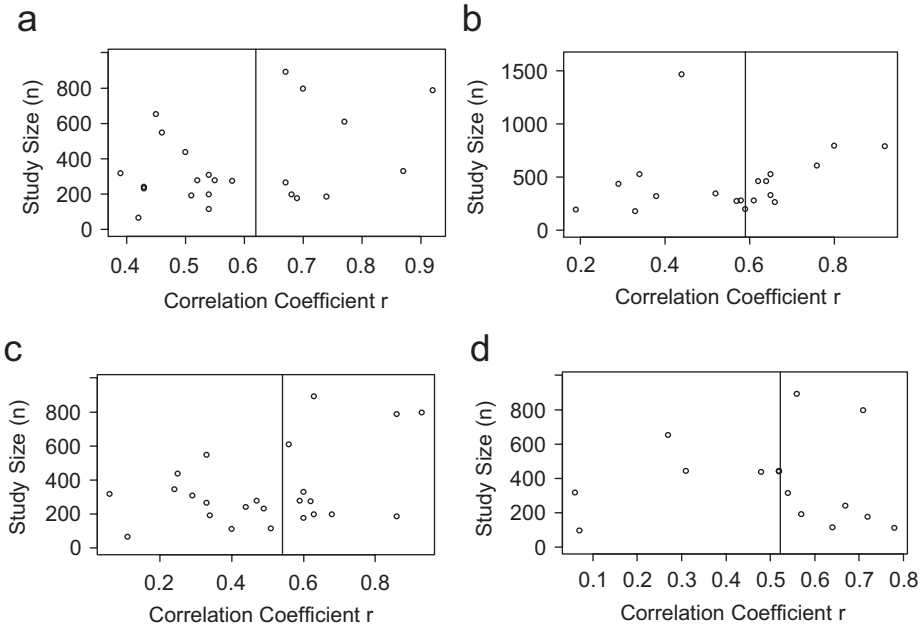

Fig. 2. (a) Funnel-plot of the 23 attitude-intention correlations, (b) funnel-plot of the 19 moral norm–intention correlations, (c) funnel-plot of the 24 PBC-intention correlations, (d) funnel-plot of the 15 intention.

Table 3
A 95%-confidence interval of the correlations calculated under random-effects assumption

	Construct	1	2	3	4	5	6	7	8	9
1. Problem		—								
2. Attribution	LCI 95%	.22	—							
	UCI 95%	.60								
3. Social norm	LCI 95%	.21	—*	—						
	UCI 95%	.57								
4. Guilt	LCI 95%	.49	—*	.47	—					
	UCI 95%	.73		.63						
5. PBC	LCI 95%	−.04	—*	.22	.00	—				
	UCI 95%	.26		.36	.54					
6. Attitude	LCI 95%	.08	—*	.41	.18	.35	—			
	UCI 95%	.43		.53	.70	.53				
7. moral norm	LCI 95%	.43	.12	.44	.60	.20	.43	—		
	UCI 95%	.77	.79	.62	.72	.49	.82			
8. Intention	LCI 95%	.29	.21	.34	.20	.40	.52	.47	—	
	UCI 95%	.49	.44	.49	.71	.66	.70	.69		
9. Behaviour	LCI 95%	.11	.13	.21	.21	.18	.26	.12	.42	—
	UCI 95%	.27	.34	41	.38	.40	.56	.61	.61	

*No pooled correlation.

studies we found a random-effects mean correlation of $r = .42$ between attitude and pro-environmental behaviour. For this association Hines et al. reported a mean correlation of $r = .37$ (9 studies). The 95% confidence interval calculated for our estimate includes the Hines et al. result. Thus, the difference between the two estimates can be attributed to random fluctuation. For the association of PBC and pro-environmental behaviour we found a mean correlation of $r = .30$ (18 studies). Hines et al. reported a mean correlation of $r = .37$ (15 studies) for self-efficacy/locus of control and pro-environmental behaviour. Again this result is included by our 95%-confidence interval. We found a mean correlation of moral norm and pro-environmental behaviour of $r = .39$ (11 studies), Hines et al. reported a mean correlation of moral obligation and pro-environmental behaviour of $r = .33$ (6 studies), which is included by our 95% confidence interval. In our meta-analysis, the mean correlation of intention and pro-environmental behaviour is $r = .52$ (15 studies); Hines et al. report a mean correlation of $r = .49$ (6 studies) for this association, which is again included by our 95% confidence interval. Thus, for the association between these four psycho-social variables and pro-environmental behaviour our meta-analysis results in pooled mean correlations very similar to those reported by the Hines et al. meta-analysis 20 years ago.

In stage 2 of our analysis we used the pooled random-effects correlation matrix as input for the MASEM test of the structural relation of the nine variables postulated by our integrated theoretical model. The MASEM analysis was conducted with the programme LISREL 8.30 (Jöreskog & Sörbom, 1996). For parameter estimation the maximum-likelihood procedure was used. As discussed above in the context of MASEM a severe disadvantage of the decision to use pairwise deletion for producing the pooled correlation consists in the problem of deciding on the appropriate sample size. In our MASEM we decided to use the harmonic mean of $n = 1341$ as sample size estimation. For assessing data-model fit the criteria recommended by Hu and Bentler (1999) were used. Their criteria include a comparative fit index (*CFI*) greater or equal to .96 with a standardised root-mean-square residual (*SRMR*) less than or equal to .10. An alternative criterion involved a root-mean-square error of approximation (*RMSEA*) less than .06 with an *SRMR* less than or equal to .10.

Fig. 1 presents the results of the estimated MASEM (standardised structural coefficients and explained variances). As can be seen from Fig. 1, our MASEM results confirm empirically the hypothesis derived from the integrated model that behavioural intention mediates the association of all other psycho-social variables with pro-environmental behaviour. We also tested the direct association between PBC and behaviour proposed by the TPB. After checking for the effect of intention the respective path coefficient is not statistically significant and was deleted from the model. On average intention explains 27% of the variance of pro-environmental behaviour.

The hypothesis that PBC, attitude, and moral norm are independent predictors of intention is also confirmed. The intercorrelation of these three constructs are relatively low (.15–.30) which confirms the empirical independence of the three predictors. Together PBC, attitude, and moral norm explain on average 52% of variance of the intention construct.

As expected, feelings of guilt, social norm, internal attribution, and problem awareness are all significant predictors of the moral norm construct. Together these four variables explain on average 58% of the variance of the moral norm. The assumption is also confirmed that besides its direct as well as indirect (via guilt) association with moral norm, social norm is directly associated with PBC and attitude. There is also a direct association between feelings of guilt and attitude. As assumed internal attribution is a significant predictor of social norm, moral norm, feelings of guilt, and attitude. However, one has to be very cautious in interpreting these associations because they are based not on pooled correlations but correlations obtained from one single study. The MASEM results also support the assumed indirect, however important, role of problem awareness. This variable is directly associated with internal attribution, guilt, social norm, and moral norm.

According to the criteria recommended by Hu and Bentler (1999) for assessing data-model fit, the correspondence between model implied and the actual pooled correlation matrix can be judged as acceptable ($\chi^2 = 148.54$; df = 14, $p < .001$; $RMSEA = .089$; $CFI = .98$; $SRMR = .039$). The LISREL-input file for the MASEM analysis is documented in Appendix A.

6. Discussion and conclusion

The goal of the present paper is a replication as well as an extension of the meta-analysis on psycho-social determinants of pro-environmental behaviours published 20 years ago by Hines et al. Extension means that the aim was not only to report a matrix of pooled bivariate correlations but to use these correlations for an MASEM test of the postulated integrated model of psycho-social determinants of pro-environmental behaviour. Such a theory-driven multivariate meta-analytical approach reflects more adequately the main trend of environmental psychology research during the last decade. From an applied perspective, using MASEM is interesting because it provides the possibility to estimate average path-coefficients across a body of studies. These path coefficients reflect the average predictive power of a specific explanatory variable across different studies when simultaneously checking for the independent impact of the other predictors included in the model.

Our literature search focusing on the period from 1995 to 2006 resulted in a total sample of 57 effect sizes from 46 independent studies. Compared with the relatively few studies Hines et al. found in the mid eighties, in the last decade there thus has been a significant increase of studies analysing the association between psycho-social variables and pro-environmental behaviour within the framework of psychological action models. A first inspection of the pooled information shows great differences in the degree of research directed in the last decade towards the nine psycho-social constructs included in our integrative model: Whereas a considerable number of studies have analysed the role of problem awareness/knowledge, attitude, PBC, social norm, moral norm, and intention as behavioural predictors, the number of studies including 'moral' feelings like guilt or shame as predictors are considerably lower and quasi no research addresses the role of internal attribution processes. Because theoretical arguments as well as the few data yet available underline the potential importance of these constructs especially for understanding the formation as well as activation of pro-environmental moral norms, further research is urgently needed.

The result that statistical tests indicate a strong heterogeneity of the pooled primary correlations is a second important finding. Obviously, the associations of the model constructs vary considerably across the type of pro-environmental behaviour or the kind of sample analysed in the primary studies. Thus additional meta-analyses have to be conducted focussing on factors causing this heterogeneity. However, at the moment the possibility for conducting such moderator analyses may be severely restricted by the low total number of available studies.

Because of the heterogeneity of the primary correlations the random-effects model is a methodologically appropriate way for estimating the pooled mean correlations. Comparing the pooled mean correlations estimated in our meta-analysis with those reported by Hines et al. shows very similar results. Because the two analyses are based on not overlapping studies sets separated by at least 10 years, this finding indicates a high temporal stability of the association between psycho-social variables and pro-environmental behaviour. Obviously the grave political, social, and economic changes during the time period 1986–2006 have little influence on how psycho-social variables are associated with pro-environmental behaviour.

The results of the MASEM analysis are quite supportive for our postulated integrative theoretical model. The assumed mediating role of behavioural intention is confirmed. After checking for the effect of intention none of the other variables has a significant additional effect on pro-environmental behaviour. On average, intention explains 27% variance of self-reported pro-environmental behaviour. Despite the fact that this result is very similar to that obtained by Armitage and Conner (2001) in their huge meta-analysis of 180 empirical TPB applications across different behavioural domains, one has to mention that this result may be based on a biased sample. Reporting bias may have resulted in an overestimation of the intention–behaviour correlation.

Our meta-analytical results also confirm the view of pro-environmental behaviour as a mixture of self-interest and pro-social motives. After checking for the effect of PBC, attitude as well as moral norm are significant independent predictors of intention. The average impact of the three predictors PBC ($\beta = .31$), attitude ($\beta = .29$), and moral norm ($\beta = .29$) is quite similar. This indicates that on average, the intention to perform a pro-environmental behavioural option can be described as a weighted balance of information concerning the three questions 'How many positive/negative personal consequences would result from choosing this pro-environmental option compared to other options?', 'How difficult would be the performance of the pro-environmental option compared to other options?', and 'Are there reasons indicating a moral obligation for performing the pro-environmental option?'. On average PBC, attitude, and moral norm can explain 52% variance of the intention construct, which also is in line with the finding of Armitage and Conner (2001).

The MASEM results support our assumption that in the field of pro-environmental behaviour the formation as well as activation of a moral norm itself is determined by the interplay of cognitive, emotional, and social factors. Problem awareness, internal attribution, feelings of guilt, and social norms all significantly contribute to the prediction of moral norm. Together these four predictors explain 58% variance of moral norm. An interesting result is the association of feelings of guilt with attitude and PBC. Obviously, people who anticipate stronger feelings of guilt when not behaving in a pro-environmental way also tend to view the performance of the pro-environmental option as easier and associate more positive personal consequences with choosing the pro-environmental option. The result that feelings of guilt is a significant predictor of moral norm as well as attitude and PBC underlines the

significance of analysing the impact of 'moral' emotions on pro-environmental intentions in future studies.

The MASEM results also provide support for our view of social norm as more indirect determinant of intention. Besides its direct association with moral norm, social norm is also indirectly associated with moral norm via its association with feelings of guilt. Furthermore, social norm is not only directly associated with moral norm but also with the perceived degree of behavioural control as well as attitude. As discussed above, people may use social norms for judging how easy and beneficial the performance of a specific behavioural option would be. Our results underline the role of awareness of and knowledge about environmental problems as a second important indirect determinant of pro-environmental behaviour. Awareness/knowledge is not only associated with the internal attribution of responsibility, social norms, and feelings of guilt, but also directly influences the degree of PBC over as well as the attitude toward choosing a pro-environmental behaviour.

Our analysis also confirms the expected association between internal attribution, social norm, and feelings of guilt. However, these results should be interpreted very cautiously because they are not based on pooled but only on one primary correlation coefficient.

To prevent the misconception that the constructs problem awareness, internal attribution, social norm, and feelings of guilt specified in the integrative model as more indirect determinants of pro-environmental behaviour are unimportant, Table 4 presents the total effects of these constructs on the more proximal behavioural determinants.

The total effects represent the sum of the direct and mediated indirect effects through which a predictor influences a dependant variable. As can be seen from Table 4 the total effect of problem awareness on behaviour as well as intention is higher than the total effect of the more proximal determinants moral norm, attitude and PBC. Table 4 indicates that the strong total effect of problem awareness on behaviour and intention results mainly from its strong association with feelings of guilt and moral norm. Obviously, knowledge is a necessary, however not sufficient precondition for developing pro-environmental moral norms and attitudes. We want to stress that when interpreting the total effects one has to take into account that these total effects depend on the validity of the underlying model. Changing the relations postulated by the model, changes the total effects. Furthermore, the total effects reflect not causality but only correlations.

Table 4
Standardised total effects

Construct	1	2	3	4	5	6	7	8	9
1. Behaviour	—	.52	.15	.15	.16	.11	.13	.10	.18
2. Intention		—	.29	.29	.31	.21	.26	.18	.35
3. Moral norm			—	—	—	.25	.26	.29	.65
4. Attitude				—	—	.27	.36	.25	.34
5. PBC					—	.19	.25	.08	.19
6. Guilt						—	.32	.22	.63
7. Social norm							—	.23	.40
8. Attribution								—	.43
9. Problem									—

For an adequate evaluation of the presented MASEM results the methodological problems with which this method is still struggling also have to be mentioned. At the moment these problems potentially threaten the statistical validity of some results. The major statistical problem associated with the MASEM method concerns the determination of the appropriate sample size for fitting the SEM. All the procedures momentarily used for this purpose like the arithmetic or harmonic mean are ad hoc solutions, not based on statistical theory. Because the Type I error of the χ^2 test statistics, the goodness-of-fit indices, the statistical power and the standard errors of parameter estimates all depend on sample size, using different methods for estimating the sample size can result in different statistical inferences.

A second difficulty is that an MASEM based on pooled correlations produced via the univariate-z method ignores the sampling variation across studies. After pooling the correlation matrices, researchers use the pooled correlation matrix as the observed correlation matrix without considering the sampling variation across studies (e.g., Cheung & Chan, 2005). Thus, this potential variance source of the standard errors of the parameter estimation is not taken into account when fitting SEM under the univariate approach. Moreover, the potential covariation among the elements of the meta-analytically pooled correlation matrix is totally ignored in the univariate approach despite the fact that these correlations are often correlated to a certain degree (Olkin & Siotani, 1976).

The third difficulty consists in the fact that MASEM uses a correlation matrix instead of a covariance matrix as input. Many researchers have warned about the problems of analysing the correlation matrix instead of the covariance matrix in primary research applications of SEM. Specifically, the χ^2-statistics and the standard errors of parameter estimation may be incorrect.

Ignoring these methodological problems, what substantive conclusions can be drawn from our MASEM analysis? The positive conclusion is that in the last decade environmental psychology has made considerable progress in identifying central psycho-social determinants of people's intention to choose the pro-environmental behavioural option. Our meta-analytical results support the conception of pro-environmental behaviour as a mixture of self-interest and pro-social motives. Thus, an adequate understanding of pro-environmental behaviour has to take both motives, self-interest as well as morality, into account. There is also progress in the understanding of factors/processes contributing to the development as well as activation of pro-environmental moral norms. However, our analysis underlines that more research is needed for a better understanding of the role of 'moral' emotions like empathic distress, guilt

and shame in the formation as well as activation of pro-environmental moral norms. Another important question concerns the potential influence of cultural differences on the construct associations specified in our integrative model. Are there cultural differences in the impact of self-interest and pro-social motives on pro-environmental behavioural intentions? Are there cultural differences in the relevance of social versus moral norms or the role of specific emotions in the activation of moral norms?

As in other behavioural domains, the presently used theoretical models are less successful in explaining pro-environmental behaviour itself. The result that in the meta-analysed studies intention on average predicts only 27% variance of behaviour indicates that the processes contributing to the actual enactment of pro-environmental behavioural intention are not fully understood. At the moment the concepts of implementation intention (e.g., Gollwitzer, 1999) and habit (Verplanken & Wood, 2006) are discussed as additional independent behavioural predictors.

Our meta-analysis summarises the results of correlational test of theoretical frameworks used in the last decade for the prediction of pro-environmental intentions and behaviours. As mentioned above such correlational tests do not allow causal inferences. Thus, from our point of view the next decade of research on pro-environmental behaviour should concentrate more on the direct experimental test of the causal processes postulated by the theoretical frameworks. For this purpose more laboratory as well as field experiments are needed that systematically manipulate the variables viewed as causally determining the motivation as well as actual performance of pro-environmental behaviours.

Appendix A. The SEM Input (LISREL)

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Title 'Random-effects MASEM Bamberg & Moeser 2006, 57 Effect Sizes'
Da NI = 9 NO = 1341 MA = cm
LA
prob attri snorm guilt pbc att mnorm intent behav
CM
*
1.00
0.43 1.00
0.40 0.36 1.00
0.63 0.45 0.55 1.00
0.11 0.18 0.29 0.29 1.00
0.27 0.36 0.47 0.48 0.44 1.00
0.63 0.53 0.53 0.66 0.35 0.67 1.00
0.40 0.33 0.42 0.50 0.54 0.62 0.59 1.00
0.19 0.24 0.31 0.30 0.30 0.42 0.39 0.52 1.00
se
9 8 7 6 5 4 3 2 1/
mo ny = 9 ne = 9 ps = sy,fi te = sy,fi be = fu,fi
Le
Behaviour Intentio Moral Attitude Control Guilt SocNor Attribut ProbAwa
st 1.0 ly(1,1) ly(2,2) ly(3,3) ly(4,4) ly(5,5) ly(6,6) ly(7,7) ly(8,8) ly(9,9)
fr ps(1,1) ps(2,2) ps(3,3) ps(4,4) ps(5,5) ps(6,6) ps(7,7) ps(8,8) ps(9,9) ps(3,4) ps(3,5) ps(4,5)
fr be(1,2) be(2,3) be(2,4) be(2,5) be(3,6) be(4,6) be(5,6) be(6,7) be(5,7) be(4,7) be(3,7)
fr be(7,8) be(6,8) be(3,8) be(4,8) be(3,9) be(6,9) be(7,9) be(8,9)
ou tv se sc ef mi it = 70 ad > 50 ad = off
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