Supplement to Nosek and Smyth (2005): Evidence for the generalizability of distinct implicit and explicit attitude constructs via a latent variable renanalysis of Nosek (2005)

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When accounting for the structure of data collected by IAT and self-report, the superiority of a correlated two-factor model (conceptualized as implicit and explicit attitudes) to a single attitude model has been demonstrated for a few attitudinal domains, including racial attitudes, ethnocentrism, and self-esteem (Cunningham et al. 2001; Cunningham, Nezlek, & Banaji, 2004; Greenwald & Farnham, 2000). Here we test the generalizability of this finding by applying a latent variable modeling approach to data previously analyzed by Nosek (2005) for each of 57 web-based studies.

Like the earlier research, the specification here of implicit and explicit attitude constructs is confounded with measurement method. As a consequence, a two-factor solution is an indeterminant function of both attitude and method variance. Cunningham et al. (2004) footnoted this limitation, but argued, since a control IAT, birds vs. trees, did not load with five ingroup-outgroup IATs on an "implicit ethnocentrism" factor, that IAT method variance was not a strong driver of the two-factor solution. They further suggested that if "systematic measurement error alone" was responsible for the implicit ethnocentrism factor, then the substantial correlation between implicit and explicit ethnocentrism (r = .47) would be unlikely. We do not disagree, and test this supposition systematically here across a wide range of attitude domains.

Method

The materials and procedures were described in detail by Nosek (2005). An additional six weeks of data collection beyond that reported by Nosek (2005) added 1,017 participants and 2,685 completed tasks. Study participants were randomly assigned to receive sets of tasks for one of 57 attitude domains, each set comprised of an IAT and self-reports. The study was administered online via *Project Implicit* (2002) between January 10 and October 20, 2003.

Participants

7,853 volunteers completed a total of 15,248 sets of implicit and explicit measures for one of 57 attitude object pairs. Following data cleaning (see Nosek, 2005), a total of 13,165 usable completed tasks remained (average n of 231 per attitude pair).

Materials

Implicit Association Test (IAT). IATs for 57 attitude object pairs were selected to represent a wide range of topics (see Table 1, a duplicate of Table 1 in Nosek & Smyth, 2005). The IAT measures association strengths between category (e.g., Democrats-Republicans) and attribute (e.g., Good-Bad) concepts. IAT effects are expressed with the *D* measure described by Greenwald et al. (2003). For all tasks, positive *D* scores indicate implicit preference for the attitude object that was preferred on average. Two *D* scores (one based on 'practice' trials, and the other based on 'critical' trials) served as the indicators of implicit attitudes (see Greenwald et al., 2003). Across the 57 domains, median internal consistency for these IAT split-halves was r=.63.

Self-report measures. Two self-reported attitude items from the questionnaire reported by Nosek (2005) were of direct relevance for this study. Feelings of warmth were indicated on a 9-point scale for each attitude object of a pair (e.g., toward Democrats and toward Republicans). Participants also used a 9-point scale to rate their preference for the attitude objects compared to the perceived norm (the second explicit measure appeared in the questionnaire for a subset (70%) of the total completed tests). A difference score was calculated between ratings of each object of a pair so as to be conceptually parallel to the relative assessment property of the IAT (e.g., the warmth rating of Republicans subtracted from that for Democrats). Positive values indicate greater liking for the object that was implicitly preferred on average (-8 to +8). Median internal consistency between items was r=.74.

Procedure

Participants first registered an identity and completed a demographics questionnaire (http://implicit.harvard.edu/implicit/research/). Once registered, participants could log-in at

the front page of the research web site and be randomly assigned to one of many possible studies in the Project Implicit study pool. Participants who logged in multiple times were never assigned to the same study more than once. The 57 attitude object pairs described here were treated as 57 independent studies. Implicit and explicit measures for each domain were presented in a randomized order.

Analyses

Our primary hypothesis was that the two measurement approaches, self-reports and IATs, assess related but unique constructs. Thus, we expected that two common factors, one indicated by the explicitly measured attitudes and one by those implicitly measured, for each target attitude pair would provide the best fit to the data, even if the factors were highly correlated.

The sequence of models fit to the data for each of the 57 object pairs is depicted in Figure 1: first a 1-factor model represents the common variance of all four indicators, collapsing across measurement method; then a 2-factor model, with distinct factors specified by measurement method. Our assessment of model fit is based primarily on the *root-mean-square error of approximation* index, (*RMSEA* or ε_a; Browne & Cudeck, 1993; Steiger & Lind, 1980). This index considers both absolute fit and model complexity, such that improvement in fit, which occurs whenever parameters are added to a model, is evaluated as a function of the "cost" of the additional complexity (Steiger, 2000). Guidelines proposed by MacCallum, Browne, and Sugawara (1996) suggest that models fitting with ε_a<.05 should be considered "close" fits, those with values .05 to .08 as "fair" fits, .08 to .10 as "mediocre," and above .10 as "poor." All models were estimated with *Mplus* statistical software, Muthén & Muthén, 1998–2004.

Results and Discussion

Results of 1-factor and correlated 2-factor models for each of the 57 attitude object pairs appear in Table 1. In all but one case, the dual attitude specification is statistically superior to the single attitude specification (the 2-factor model for Males-Females failed to converge,

leaving the hypothesis untested for this domain). Specifically, with just one factor specified, none of the 90% confidence intervals (CIs) around the estimate of *RMSEA* (ε_a) include the .05 level indicative of a close fit to the data. But when two correlated factors are specified, based on implicit and explicit measurement, the fit of each model includes .05 in the ε_a confidence interval. To insure that this good fit was not simply the result of a nearly saturated model, we fit in each domain an alternative two-factor model with the same number of parameters in which each factor was indicated by one of the self-report measures and one of the IATs. Without exception, these models fit poorly, i.e., no lower bound for the 90% CI around ε_a was below 0.1.

Thus, even when implicit and explicit attitude factors were highly correlated (e.g., $\underline{r} \geq .60$ for nine attitude objects), fitting the data with a single factor was inferior to the "related but distinct" 2-factor representation. The consistency of this finding suggests that the dual-attitude conceptualization of implicit and explicit attitudes is general across attitude domains. Nosek and Smyth (2005) test whether this dual attitude specification holds after common method variance has been partitioned.

Another important feature of this demonstration is the fact that the correlation between implicit and explicit attitude factors was virtually always significantly positive (the *r* was not statistically different from zero for just three domains) and varied widely across the attitude contrasts, ranging from non-significant correlations for the Asians-Whites, future-past, and approach-avoid contrasts, to a high of $\underline{r} = .79$ for the pro choice-pro life contrast. This variability across domains suggests that there are features of these topics that moderate implicit-explicit correspondence. Nosek (2005) examined this question in detail and found the implicit-explicit relationship to be multiply-determined by attitude features including: (1) self-presentation: motivation to avoid negativity toward a domain for social or personal purposes – stronger self-presentation concerns related to weaker implicit-explicit correspondence (see also Fazio & Towles-Schwen, 1999; Hofmann et al., in press); (2) attitude strength: the importance, certainty, or amount of elaboration for a particular attitude domain – stronger attitudes corresponded

with stronger implicit-explicit correspondence (Hofmann et al., in press); (3) attitude dimensionality: the degree to which positivity toward one domain implied negativity toward the complementary domain – greater bipolarity of an attitude was associated with stronger implicit-explicit correspondence; and (4) attitude distinctiveness: the degree to which one believe his or her attitude to be different than the social norm – non-normative attitudes elicited stronger implicit-explicit correspondence than normative attitudes. Importantly, all four moderators were unique predictors of the magnitude of implicit-explicit correspondence across attitudinal domains suggesting that no one factor could be accounted for by the others (Nosek, 2005). So, the variation in implicit-explicit correspondence is not due to a single factor, such as self-presentation concern. In conclusion, these data suggest that implicit and explicit attitudes are related, but distinct factors, and that the magnitude of their relationship appears to be multiply-determined.

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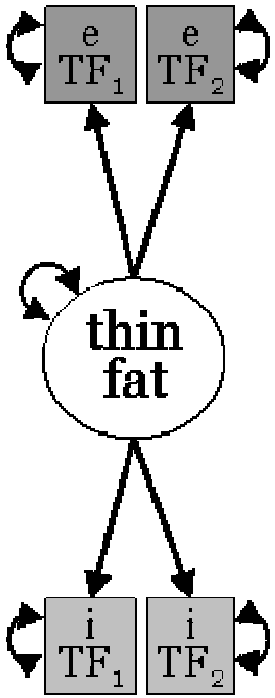
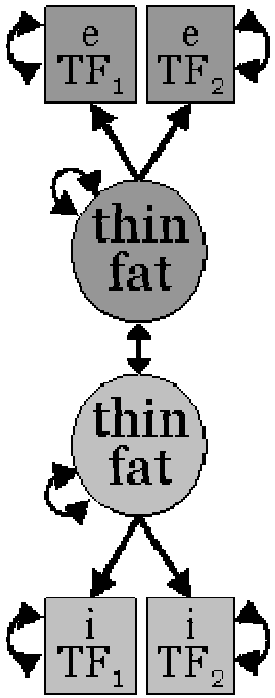
Table 1. Results of 1- and 2-factor attitude models fit to measures of 57 attitude object pairs

		1-factor model			2-factor model			
Attitude object	*N*	χ^2	ε_a	90% CI ε_a	χ^2	ε_a	90% CI ε_a	Factors *r* (*t*)
asianswhites	279	44	.28	.21-.35	1.4	.04	.00-.17	.01 (0.1)
hotcold	211	262	.79	.71-.87	0.5	.00	.00-.16	**.13** (2.1)
pantsskirts	255	73	.37	.30-.45	0.1	.00	.00-.10	**.15** (3.1)
futurepast	235	76	.40	.32-.48	3	.10	.00-.23	.26 (1.9)
thinpeoplefatpeople	275	50	.30	.23-.37	0.4	.00	.00-.14	**.27** (2.0)
approachavoid	180	28	.27	.19-.36	0.3	.00	.00-.16	.29 (1.3)
simpledifficult	210	56	.36	.28-.44	0.0	.00	.00-.01	**.29** (3.4)
publicprivate	196	40	.31	.23-.40	0.0	.00	.00-.05	**.30** (3.7)
freedomsecurity	220	67	.38	.31-.47	1	.00	.00-.16	**.31** (2.5)
tallpeopleshortpeople	226	53	.34	.26-.42	3	.09	.00-.22	**.31** (2.9)
familycareer	238	42	.29	.22-.37	0.1	.00	.00-.12	**.33** (2.7)
marriedsingle	261	169	.57	.50-.64	0.5	.00	.00-.14	**.33** (3.4)
richpeoplepoorpeople	222	89	.44	.37-.52	1	.00	.00-.17	**.34** (3.2)
defenseeducation	214	50	.33	.26-.42	2	.07	.00-.21	**.36** (3.7)
lettersnumbers	228	75	.40	.33-.48	0.1	.00	.00-.12	**.37** (3.4)
jocksnerds	239	80	.40	.33-.48	0.0	.00	.00-.00	**.38** (4.0)
oldpeopleyoungpeople	250	42	.28	.21-.36	0.0	.00	.00-.00	**.40** (3.1)
capitalpunishimprison	260	66	.35	.28-.43	0.2	.00	.00-.13	**.41** (3.7)
yankeesdiamondbacks	200	42	.32	.24-.40	1	.04	.00-.20	**.41** (4.5)
flexiblestable	201	35	.29	.21-.37	0.0	.00	.00-.10	**.42** (4.4)
juliarobertsmegryan	255	41	.28	.21-.35	1	.03	.00-.17	**.43** (4.7)
reasonemotions	175	84	.49	.40-.58	0.0	.00	.00-.09	**.44** (3.9)
rebelliousconforming	208	132	.56	.48-.64	0.4	.00	.00-.16	**.44** (4.2)
summerwinter	260	133	.50	.43-.58	0.4	.00	.00-.14	**.44** (5.5)
leadershelpers	265	60	.33	.26-.41	2	.07	.00-.19	**.45** (5.4)
tomcruisedenzelwashington	242	52	.32	.25-.40	0.3	.00	.00-.14	**.46** (4.8)
labormanagement	194	47	.34	.26-.43	0.1	.00	.00-.14	**.47** (3.9)
exercisingrelaxing	258	185	.60	.53-.67	0.3	.00	.00-.14	**.48** (5.8)
jaylenodavidletterman	196	49	.35	.27-.43	0.0	.00	.00-.04	**.48** (4.5)
foreignplacesamericanplaces	205	44	.32	.24-.40	0.0	.00	.00-.11	**.49** (5.3)
microsoftapple	205	77	.43	.35-.51	3	.09	.00-.23	**.49** (4.1)
newyorkcalifornia	253	66	.36	.29-.43	2	.05	.00-.18	**.49** (4.3)
coffeetea	250	90	.42	.35-.50	0.0	.00	.00-.00	**.50** (5.6)
drinkingabstaining	249	100	.44	.37-.52	0.2	.00	.00-.13	**.50** (5.9)
jewchristian	253	77	.39	.31-.46	0.0	.00	.00-.00	**.50** (5.2)
classicalhiphop	243	106	.47	.39-.54	1	.00	.00-.16	**.51** (6.0)
northernerssoutherners	207	62	.39	.30-.47	1	.00	.00-.17	**.51** (5.8)
jewsmuslims	243	52	.32	.25-.40	2	.07	.00-.20	**.52** (5.5)
bookstelevision	233	77	.40	.33-.48	0.1	.00	.00-.11	**.54** (5.2)
catsdogs	258	77	.38	.31-.46	1	.00	.00-.15	**.54** (5.6)
africanamereuropeanamer	254	39	.27	.20-.35	0.0	.00	.00-.09	**.55** (4.7)
canadianamerican	290	44	.27	.20-.34	0.5	.00	.00-.14	**.55** (4.7)
jazzteenpop	239	81	.41	.33-.48	1	.00	.00-.15	**.56** (6.1)
vegetablesmeat	234	76	.40	.32-.48	0.3	.00	.00-.14	**.56** (5.4)
taxreductionssocialprograms	188	77	.45	.36-.53	5	.15	.04-.28	**.57** (5.6)
usajapan	246	49	.31	.24-.39	0.0	.00	.00-.00	**.57** (5.2)
gunrightsguncontrol	216	85	.44	.36-.52	1	.04	.00-.19	**.59** (6.8)
gaypeoplestraightpeople	175	35	.31	.22-.40	0.1	.00	.00-.14	**.60** (5.3)
religionatheism	211	160	.61	.53-.69	2	.05	.00-.20	**.61** (7.1)
cokepepsi	250	71	.37	.30-.45	1	.00	.00-.16	**.66** (7.1)
liberalsconservatives	215	124	.53	.46-.61	1	.00	.00-.17	**.67** (6.9)
creationismevolution	231	99	.46	.39-.54	3	.08	.00-.21	**.68** (7.2)
feminismtraditionalvalues	226	75	.40	.33-.48	0.4	.00	.00-.15	**.71** (7.4)
gorebush	211	61	.37	.30-.46	0.0	.00	.00-.09	**.74** (7.2)
democratsrepublicans	195	42	.32	.24-.41	2	.08	.00-.23	**.75** (6.7)
prochoiceprolife	242	52	.32	.25-.40	0.4	.00	.00-.10	**.79** (8.6)
malesfemales	289	112	.44	.37-.51	*	*	*	*

Note. All 1-factor models have df = 2, and 2-factor models have df = 1. ε_a = root-mean-square error of approximation. CI = confidence interval. $t = r/se$. Factor correlations in boldface have $t \geq 2.0$.
* model did not converge.

Figure 1. Representative diagrams of the sequence of structural models fit to each of 57 data sets. Squares depict measured variables, circles depict latent factors. Darker shading indicates explicit measures/constructs, lighter shading indicates implicit measures/constructs.

One-factor model



Correlated two-factor model