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USING THE IMPLICIT ASSOCIATION TEST AND THE IMPLICIT RELATIONAL ASSESSMENT PROCEDURE TO MEASURE ATTITUDES TOWARD MEAT AND VEGETABLES IN VEGETARIANS AND MEAT-EATERS

Dermot Barnes-Holmes, Louise Murtagh, and Yvonne Barnes-Holmes

National University of Ireland, Maynooth

Ian Stewart

National University of Ireland, Galway

The current study aimed to assess the implicit attitudes of vegetarians and non-vegetarians towards meat and vegetables, using the Implicit Association Test (IAT) and the Implicit Relational Assessment Procedure (IRAP). Both measures involved asking participants to respond, under time pressure, to pictures of meat or vegetables as either positive or negative stimuli. Response latency data gathered from both the IAT and the IRAP discriminated at a statistically significant level between vegetarians and meat-eaters. Furthermore, both measures correlated with some features of the explicit self-report measure that was employed in the study. The implicit measures also provided similarly small but statistically significant increases in predictive validity over the explicit measures.

Key words: implicit attitudes, vegetarian, meat-eater, response latency, predictive validity.

The most common method in the social sciences for obtaining information about what people think and believe involves asking participants to fill out relevant questionnaires and/or conducting an interview or focus group. Such methods require that participants reflect on what they think and then report accordingly. Although clearly useful, questionnaires and the like may fail to pick up on so-called implicit cognitions, which are thoughts, feelings, and beliefs that participants may attempt to conceal, or of which they are not consciously aware, such as racial or sexual stereotypes (see Greenwald & Banaji, 1995, for a detailed discussion).

The most well established measure of what have been called *implicit attitudes* is the implicit association test, or IAT (Greenwald, McGhee, & Schwartz, 1998). The central postulate underlying the method is that

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Address correspondence concerning this article to Dermot Barnes-Holmes, Department of Psychology, National University of Ireland, Maynooth, Co. Kildare, Ireland (email: Dermot.Barnes-Holmes@nuim.ie).

individuals should respond quickly when asked to emit the same response for two concepts that are closely associated in memory, but should respond more slowly when the two concepts are not associated. The seminal IAT study by Greenwald et al. involved asking participants to categorize the names of flowers with positive words and the names of insects with negative words, and in another task these categorizations were reversed (flowers–negative and insects–positive). Results yielded the predicted IAT effect between the two tasks. That is, because most people evaluate flowers positively and insects negatively, the participants responded faster on flower–positive and insect–negative trials than on the reversed counterparts. Subsequent studies have demonstrated predicted IAT effects across a wide range of domains (see Nosek, Greenwald, & Banaji, 2006, for a recent review), and, most controversially, the effect has been obtained repeatedly in socially sensitive areas, such as racism (e.g., Dasgupta, Greenwald, & Banaji, 2003).

Although the IAT has become the most widely used test of implicit cognition, one of its main weaknesses is that it provides a measure of relative associative strength, which can obfuscate the exact nature of the attitudes under study. If an IAT effect indicates that participants respond more quickly when *flower* is paired with *positive* and *insect* with *negative* than vice versa, this result could reflect a range of different attitudes. For example, it could indicate that flowers and insects are both liked but flowers are liked more than insects, or it could indicate that both flowers and insects are disliked but insects are disliked more than flowers. To identify attitudes to individual objects, a different type of test than the IAT is required, and researchers have attempted to develop such tests, including, for example, the *Extrinsic Affective Simon Test* (EAST; De Houwer, 2003) and the *Go/No-Go IAT* (GNAT; Nosek & Banaji, 2001).

Another non-relative measure that has been proposed is the Implicit Relational Assessment Procedure (IRAP; Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, in press; Barnes-Holmes et al., 2006; Barnes-Holmes, Hayden, Barnes-Holmes, & Stewart, 2008; McKenna, Barnes-Holmes, Barnes-Holmes, & Stewart, 2007). This procedure is based on a relatively recent account of human language and cognition known as Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001). According to RFT, the core units of human language and cognition are not associations per se, but derived stimulus relations. One of the main methodologies to emerge from the theory is the Relational Evaluation Procedure (REP). The REP allows participants to report on a stimulus relation that is presented on a given trial. For example, two identical shapes might be presented with the relational terms *Same* and *Opposite*, and participants are required to indicate, typically without time pressure, that the relation is *Same*. The REP has now been used across a range of studies to examine reasoning and other forms of higher cognition (O'Hora, Barnes-Holmes, Roche, & Smeets, 2004; O'Hora, Pelaez, Barnes-Holmes, & Amesty, 2005; Stewart, Barnes-Holmes, & Roche, 2002, 2004). Critically, the REP provided the basis for the development of the IRAP, which is basically a combination of the IAT and the REP (see Barnes-Holmes et al., 2006; Barnes-Holmes et al., 2008).

The IRAP involves presenting words, statements, or pictures on each trial, and participants are required to respond to these stimuli in ways that either agree or disagree with their pre-experimentally determined verbal relations. For example, in the recent study by Barnes-Holmes et al. (2008), participants were presented with one of two attribute stimuli ("Pleasant" or "Unpleasant"), a positive (e.g., "Love") or negative (e.g., "Murder") target stimulus, and two relational terms, *Similar* and *Opposite*, as response options. Participants were required to respond as quickly and accurately as possible across blocks of trials, with half of the blocks requiring responses that were deemed consistent (e.g., Pleasant–Love–Similar), and the other half inconsistent (e.g., Pleasant–Love–Opposite), with natural verbal relations. As predicted, response latencies were faster for consistent than for inconsistent trials (e.g., participants responded more quickly to Pleasant–Love–Similar than to Pleasant–Love–Opposite). These results have since been replicated across a small number of other studies (e.g., Barnes-Holmes, Murphy, Barnes-Holmes, & Stewart, 2010; Barnes-Holmes, Waldron, Barnes-Holmes, & Stewart, 2009; Cullen, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009; Dawson, Barnes-Holmes, Gresswell, Hart & Gore, 2009; McKenna et al., 2007; Power, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009; Roddy, Stewart, & Barnes-Holmes, in press; Vahey, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009). Nevertheless, research on the IRAP as an implicit measure is very limited, and further empirical study is required before its reliability and validity can be determined. Contributing toward this research program was a key purpose of the current study.

One approach to assessing the validity of an implicit measure is to adopt the known-groups approach, which involves identifying two groups that clearly differ along a particular dimension. De Houwer and De Bruycker (2007) adopted this strategy in attempting to assess the validity of the EAST. Based on the well-established difference between vegetarians and meat-eaters, an IAT and an EAST were designed to assess the implicit attitudes of these two groups toward meat and vegetables. For the EAST, participants were presented with square pictures contained within a yellow frame and rectangular (portrait or landscape) pictures without a frame. When a square picture (with frame) was presented, participants were required to press a right key if the content of the picture was positively valenced and to press a left key if the picture was negatively valenced. The purpose of these trials was to establish the right key as extrinsically positive and the left key as extrinsically negative. On those trials when the picture was rectangular (with no frame), participants were asked to ignore the picture content and simply to press the right key for portrait and the left key for landscape pictures. Critically, the rectangular pictures contained photographs of either meat or vegetables. This procedure thus allowed the researchers to calculate an EAST effect for each class of pictures (meat or vegetables) by comparing trials on which the positively versus negatively valenced keys had to be pressed. It was predicted, for example, that response latencies for vegetarians should be shorter when pressing the negative key for pictures of meat, rather than the positive key for those same pictures. In effect, the difference in response latencies should provide an index of the participants' attitudes toward that class of pictures.

In De Houwer and De Bruycker's (2007) version of the IAT, images of meat (e.g., bacon) and vegetables (e.g., cabbage), a positive object (e.g., smiling baby), and a negative object (e.g., crying baby) appeared on the screen. Participants were required to categorize each of these pictures, depending on its category label, by pressing one of two keys. In the MEAT + POSITIVE IAT task, the first key was pressed for meat and positive pictures and the second key for vegetables and negative pictures. In the VEGETABLE + POSITIVE IAT task, participants were required to press the first key for vegetable and positive images and the other for meat and negative pictures. The difference between the response latencies across the two tasks provided an index of the bias toward meat or vegetables. The data from both the EAST and the IAT indicated that vegetarians preferred vegetables over meat to a greater degree than the meat-eaters. Furthermore, there was a significant correlation between the IAT and the EAST, and both correlated with an explicit rating measure. Neither the IAT nor the EAST provided any incremental predictive validity over the explicit measure.

The present research was a partial replication of the study by De Houwer and De Bruycker (2007), but using the IRAP instead of the EAST. As such, the present study is the first to attempt to use the IRAP as a measure of the implicit attitudes of vegetarians and nonvegetarians toward meat and vegetables. The research also constitutes one of the first studies to test the predictive validity of the IRAP using the "known-groups" approach. In short, a core aim of the present research was to determine if the IRAP discriminates between vegetarians and meat-eaters to the same degree as the IAT.

METHOD

Participants

Participants were 16 vegetarians and 16 meat-eaters, and were nonpsychology majors attending the National University of Ireland, Maynooth. Their ages ranged from 17 to 28 years. Each group contained equal numbers of men and women. No financial reward was offered for participation in the study, and all participants were experimentally naïve. Approximately half of the vegetarian group reported that they did not consume meat, fish, or crustaceans, with the remaining individuals reporting that they did not consume meat but did eat fish or crustaceans on occasion. Although the latter half of the vegetarian group was not strictly vegetarian, they were regarded as such because our primary concern was attitudes toward meat and vegetables, rather than attitudes toward fish (the same approach was adopted by De Houwer and De Bruycker, 2007). All participants in the meat-eater group reported that they ate both red and white meat.

Apparatus and Materials

Our experiment employed the same five pictures of meat (steak, hamburger, dried sausages, pâté, and bacon), and five pictures of vegetables (cabbages, carrots, beans, broccoli, and peas) as were used by De Houwer and De Bruycker (2007); these pictures were used in both the implicit and explicit measures. Another 10 pictures, used only with the IAT, were positively and negatively valenced images (smiling and crying babies, respectively) taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997, picture numbers 2070, 2345, 7580, 8120, 8190, 2800, 3168, 3181, 3300, and 9340). Again, these were the same images that were employed by De Houwer and De Bruycker.

The IRAP and IAT software was run on standard Pentium 4 personal computers (software available from the first author upon request). The explicit rating measure was the same as that employed by De Houwer and De Bruycker (2007). The first part of this measure consisted of the 10 vegetable and meat pictures presented individually on a computer screen; participants were asked to rate each picture on a separate 9-point Likert scale (1 = *not tasty at all*, 9 = *very tasty*). The second part of the explicit measure consisted of a questionnaire assessing attitudes toward vegetables (5 items) and meat (25 items). The questions pertaining to meat were adapted from Berndsen and van der Pligt (2004). All questions were presented as statements, such as "I like vegetables so much, I could eat them all day" or "The smell of meat is delicious," and participants responded on a 9-point Likert scale ranging from 1 (*totally disagree*) to 9 (*totally agree*). The questionnaire also included a number of demographic items and assessed dietary habits in order to identify participants as meat-eaters or vegetarians (i.e., the meat-eater vs. vegetarian classification was made on the basis of self-report).

Procedure

Prior to commencement of the experiment, participants were briefed as to the general nature of the study. They were informed that the experiment would include two computer-based tasks and a short questionnaire. Each participant completed the study individually in a small room that was free from visual and audio distraction. The order in which the IAT and the IRAP were presented was counterbalanced across participants. Having completed both implicit measures, participants completed the questionnaire assessing attitudes toward vegetables and meat, and rated the 10 pictures of vegetables and meat as described above.

Implicit Association Test

A detailed description of the generic IAT procedure employed in the current study has been provided elsewhere (O'Toole, Barnes-Holmes, & Smyth, 2007), and thus a less detailed version will be presented here. Participants were seated in front of the computer, which presented the instructions for the IAT and the stimuli, and recorded all of the responses. Two IAT sequences were employed—pro-vegetable to pro-meat or pro-meat to pro-vegetable (explained below). These sequences were counterbalanced across participants.

Pro-vegetable to pro-meat IAT sequence. Participants were presented with detailed instructions for the IAT itself. Instructions informed the participants that images would appear one by one on the computer screen, and that they were to categorize the images as positive, negative, meat, or vegetable by pressing the left key (D) or the right key (K) of a QWERTY keyboard. Key assignment for category labels was visible in the top left- and right-hand corners of the screen during each trial. For some blocks of trials, the key assignment was reversed, and the instructions provided prior to such blocks alerted participants to this change. Participants were required to pay close attention to key assignment notification and to respond as quickly and as accurately as possible (see Figure 1 for examples of IAT trials).

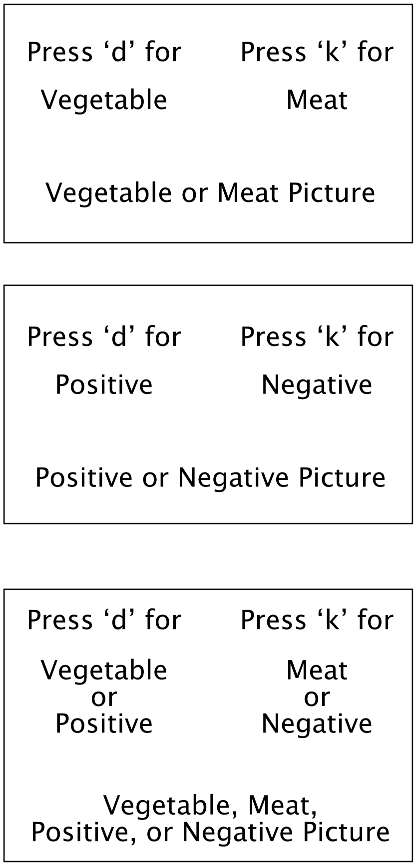

Figure 1. The three panels show how IAT trials were presented to participants, with the upper and middle panels representing trials that involved categorizing one of two stimuli, and the bottom panel representing trials that involved categorizing one of four stimuli On each trial, one of the picture stimuli appeared in the center of the screen until either the “d” or “k” key was pressed. If the response was correct, the picture stimulus was removed and the next stimulus appeared 400 ms later. If the participant’s response was incorrect, a red *X* appeared below the picture and remained there until the participant emitted the correct response, which was followed by the 400-ms intertrial interval.

For each trial, a picture stimulus appeared in the center of the screen until a response was registered. If the response was correct, the picture was removed and the next picture appeared 400 ms later. If the participant’s response was deemed incorrect, a red *X* appeared in the middle of the screen and remained there until the participant emitted the correct response, which was followed by the 400-ms intertrial interval. Before each block commenced, instructions were presented on the screen regarding key assignment for the upcoming block.

Stimuli employed in the IAT were as follows. The positively and negatively valenced pictures taken from the IAPS served as the attribute stimuli. The target stimuli were the pictures of meat and vegetables. Target and attribute stimuli were presented in a quasirandom order during each block of the IAT; specific constraints on the random presentations are detailed below. Block 1 of the IAT was a target practice phase, consisting of 24 trials in which each of the five meat and five vegetable stimuli was presented at least twice. Block 2 was an attribute practice phase of 24 trials in which each IAPS image was presented at least twice. Block 3 involved the attribute and target phases combined into a single block of 24 practice trials, and each target and attribute stimulus was presented at least once. Block 4 was similar to Block 3, except that 40 trials were presented, and each target and attribute stimulus was presented twice. Block 5 was similar to Block 1, except the left–right positions of the vegetable and meat labels were reversed. Blocks 6 and 7 were similar to Blocks 3 and 4, except for the reversed vegetable and meat labels (see Table 1 for an overview of the IAT procedure employed in the current study).

Table 1
Overview of the IAT Employed in the Present Study

		Stimuli assigned to left response key[a]	Stimuli assigned to right response key[a]
Block	Trial	IAT Pro-Vegetable to Pro-Meat Sequence[b]	
1	24	Vegetable	Meat
2	24	Positive	Negative
3	24	Vegetable + Positive	Meat + Negative
4	40	Vegetable + Positive	Meat + Negative
5	24	Meat	Vegetable
6	24	Meat + Positive	Vegetable + Negative
7	40	Meat + Positive	Vegetable + Negative

[a] Assignment of stimuli to left and right response keys was counterbalanced across participants. [b] For the Pro-Meat-to-Pro-Vegetable sequence, Blocks 1, 3 and 4, were switched with Blocks 5, 6, and 7, respectively.

For all blocks of the IAT, half of the participants pressed the left key for positive pictures and the right key for negative pictures; the left key was assigned for vegetables and the right key for meat in Blocks 1, 3, and 4, but in Blocks 5, 6, and 7 this key assignment was reversed. For the remaining participants, the left key was pressed for negative and the right key for positive pictures for all blocks, with the left key for meat and the right key for vegetables in Blocks 1, 3, and 4 and a reversal in this key assignment in Blocks 5, 6, and 7. Once all seven blocks were completed, a message appeared on the screen informing participants that the task was finished and to alert the experimenter. If a participant was part of the group that received the IAT first, then he or she was encouraged to take a short break (5–10 min) before the IRAP task commenced.

Pro-meat to pro-vegetable IAT sequence. The procedure for the participants exposed to this IAT sequence was similar to that described above, except that the positions of Blocks 1, 3, and 4 were switched with those of 5, 6 and 7, respectively.

Implicit Relational Assessment Procedure

As with the IAT, each participant was seated in front of the computer, which provided the instructions, presented the stimuli, and recorded all of the responses. Similar to the IAT, participants were assigned to one of two IRAP sequences: pro-vegetable to pro-meat or the reverse (assignment was counterbalanced across participants). Prior to the commencement of the experiment, participants were presented with instructions that outlined the general nature of the study and provided a detailed introduction to the IRAP with illustrative examples of the task (all materials available from the first author upon request).

Participants were informed that in some parts of the experiment they would be required to respond in ways that appeared to contradict their beliefs, but that doing so was part of the experiment (note, however, that at no point were participants informed as to which part of the experiment would be contradictory to their beliefs). Participants were also told that they would be required to respond as quickly (below an average of 3 s) and as accurately (at least 80% correct on each block of trials) as possible. They were also told that if they did not meet these performance criteria across two practice blocks, they would be re-exposed until the criteria were met.

For each trial of the IRAP, the attribute stimulus "Pleasant" or "Unpleasant" appeared at the top of the screen with one of the target images of meat (steak, hamburger, dried sausages, pâté, and bacon) or vegetable (cabbages, carrots, beans, broccoli, and peas), centered in the middle of the screen. The two response options "True" and "False" appeared individually in the bottom left- and right-hand corners of the screen. The key assignment for left and right response options (D and K keys) also appeared on screen. The left–right locations of the *True* and *False* response options varied randomly across trials, with the constraint being that they did not appear in the same locations across more than two successive trials (see Figure 2 for a diagrammatic representation of the IRAP trials).

Participants were instructed to choose one response option per trial, and if that option was deemed correct for that block of trials then all stimuli were removed from the screen and the next trial started 400 ms later. If the response was deemed incorrect, then a red *X* appeared in the center of the screen below the target stimulus. Until the correct response was registered, the red *X* remained on the screen. Once the red *X* was removed, the next trial commenced 400 ms later. Participants were forewarned to pay close attention to the key assignments, as they would change unpredictably across trials. Participants were also informed after each block of trials that the feedback contingencies would be reversed in the next block. In effect, the instructions and feedback contingencies determined which responses were defined as correct and incorrect within each block of trials.

Pro-vegetable to pro-meat sequence. The complete IRAP comprised a minimum of two practice blocks and six test blocks. Each block consisted of 40 trials, with the 10 target stimuli (5 meat and 5 vegetable) being presented twice each in the presence of the two labels, *Pleasant* and *Unpleasant.* The pro-vegetable-to-pro-meat IRAP commenced with a block of pro-vegetable trials. Participants were required to respond *True* to *Pleasant–Vegetable* and to *Unpleasant–Meat* trial types, and to respond *False* to *Unpleasant–Vegetable* and to *Pleasant–Meat* trial types. When all 40 trials were complete, the screen cleared and the participant's percentage of correct responses and median response latency were presented on-screen. By pressing the spacebar, the participant proceeded onto the next block. Block 2 was also a practice block and was similar to Block 1, except that participants were required to respond in a pro-meat pattern: *False* to *Pleasant–Vegetable* and to *Unpleasant–Meat* trial types and *True* to *Unpleasant–Vegetable* and to *Pleasant–Meat* trial types. Before each practice block the following message appeared on the screen: "This is practice—errors are expected."

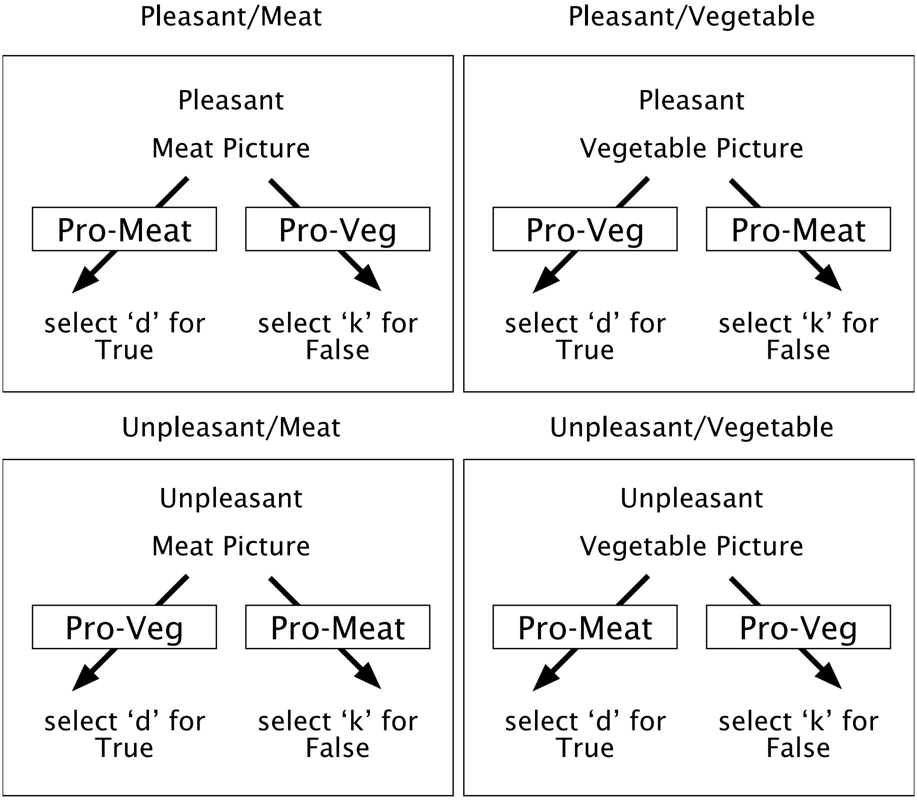

Figure 2. The four IRAP trial-types. The label (Pleasant or Unpleasant), target word (pictures of meat or vegetables), and response options (True and False) appeared simultaneously on each trial. Arrows with superimposed textboxes indicate which responses were deemed pro-meat or pro-vegetable (boxes and arrows did not appear on screen). Selecting the pro-meat response option during a pro-meat block, or the pro-vegetable option during a pro-vegetable block, cleared the screen for 400 ms before the next trial was presented; if the pro-meat option was chosen during a pro-vegetable block, or the pro-vegetable option during a pro-meat block, a red X appeared on screen until the participant emitted the alternative response. The IRAP consisted of a minimum of two practice blocks and a set of six test blocks. Each block presented 40 trials, with the 10 target stimuli, 5 meat and 5 vegetable, each presented twice in the presence of the two labels, *Pleasant* and *Unpleasant.* Trials were presented quasirandomly, with the constraint that the same trial type was not repeated across two successive trials. The left–right locations of the *True* and *False* response options varied randomly across trials.

If the participant did not reach the specified criteria (80% or higher in correct responses and a median response latency under 3000 ms in each block), then he or she was given the opportunity to repeat the two practice blocks by pressing the spacebar. If participants failed to achieve the performance criteria after four exposures to the two practice blocks, they were thanked and debriefed, and the data were discarded. Participants who completed the practice blocks successfully were allowed to continue to the six test blocks. The test blocks were similar to the practice blocks except that no performance criteria were imposed to proceed from one block to the next, and the following message preceded each block: “This is a test. Go fast; making a few errors is ok.”

The test blocks were presented in a pro-vegetable/pro-meat alternating sequence across the six blocks. Once the test blocks were completed, a message appeared on the screen alerting the participant that this part of the experiment was finished and to contact the experimenter. If the participant was part of the group that received the IRAP first, he or she was encouraged to take a 5- to 10-min break before the commencement of the IAT task.

Pro-meat to pro-vegetable sequence. Participants were exposed to the same procedure described above, except that the practice and test blocks proceeded in a pro-meat/pro-vegetable alternating sequence.

RESULTS

Implicit Association Test

The primary datum was response latency, defined as the time in milliseconds that elapsed between the onset of the trial and a correct response emitted by a participant. The response latency data for each participant were transformed into *D*-scores using the *D*-algorithm developed by Greenwald, Nosek, and Banaji (2003). The *D* transformation functions to minimize the impact of factors such as age, motor skills, and/or cognitive ability on latency data, allowing researchers to measure differences between groups using a response-latency paradigm with reduced contamination by individual differences associated with extraneous factors (Greenwald et al., 2003).

The version of the *D*-algorithm employed for the current study was computed as follows: (a) Latencies above 10,000 ms from the dataset were eliminated; (b) all data for a participant were removed if he or she produced more than 10% of trials with latencies less than 300 ms; (c) means were computed for trials in each of the four blocks (3, 4, 6, and 7); (d) 1 *SD* was calculated for all trials in Blocks 3 and 6, and another for Blocks 4 and 7; (e) difference scores were computed between Blocks 3 and 6 and between Blocks 4 and 7, taking the pro-vegetable from the pro-meat blocks; (f) each difference score was divided by its associated standard deviation; and (g) these two scores were added and then divided by 2. A positive *D*-score signifies a preference for vegetables over meat, whereas a negative score indicates a preference for meat over vegetables.

Figure 3 presents the overall mean IAT *D*-scores for the two groups (vegetarian and meat-eaters). Both groups showed an implicit preference for vegetables over meat, but the vegetarian preference was far stronger than the meat-eaters' preference. A one-way between-groups ANOVA indicated that this difference was significant, $F(1, 30) = 6.365$, $p < .05$, $\eta^2 = .17$. Two one-sample *t* tests indicated that the IAT effect for the vegetarians differed significantly from zero, $t(15) = 4.785$, $p < .001$, but the effect for the meat-eaters did not ($p = .19$). As predicted, therefore, the IAT identified a significant between-group difference, with follow-up tests indicating a pro-vegetable/anti-meat bias for the vegetarians, with no significant bias for the meat-eaters.

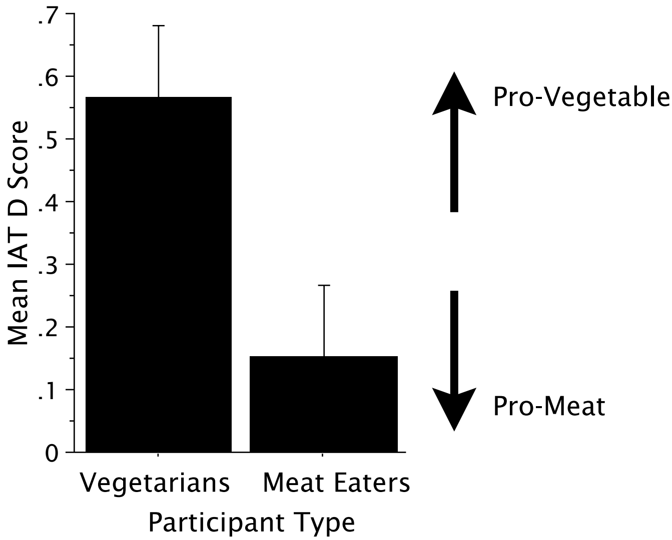

Figure 3. Mean IAT *D*-scores, with standard error bars, for vegetarians and meat-eaters. A greater pro-vegetable bias is indicated by larger positive scores—responding more quickly on Vegetable+Positive and Meat+Negative trials than on Vegetable+Negative and Meat+Positive trials.

Split-Half Correlations

To assess the internal consistency of the IAT, a split-half reliability score was calculated for the *D*-IAT measure. Two scores were first calculated in the same way as for the *D*-score, except that the algorithm described previously was applied separately to odd trials and to even trials. The split-half correlation between odd and even scores, applying a Spearman-Brown correction, proved to be strong and significant, $r = .76$, $n = 32$, $p < .0001$.

Implicit Relational Assessment Procedure

Similar to the IAT, the primary datum was response latency, defined as the time in milliseconds that elapsed between the onset of the trial and a correct response emitted by a participant. The response latency data for each participant were transformed into *D*-IRAP scores (Barnes-Holmes, et al., in press; Cullen & Barnes-Holmes, 2008) using an adaptation of the

Greenwald et al. (2003) *D*-algorithm described above.[1] The steps involved in calculating the *D*-IRAP scores were as follows: (a) Only response latency data from test blocks were used; (b) latencies above 10,000 ms from the dataset were eliminated; (c) all data for a participant were removed if he or she produced more than 10% of test-block trials with latencies less than 300 ms; (d) 12 standard deviations for the four trial types were computed: 4 for the response latencies from test blocks 1 and 2, 4 from the latencies from test blocks 3 and 4, and a further 4 from test blocks 5 and 6; (e) 24 mean latencies for the four trial types in each test block were calculated; (f) difference scores were calculated for each of the four trial types, for each pair of test blocks, by subtracting the mean latency of the pro-vegetable block from the mean latency of the corresponding pro-meat block; (g) each difference score was divided by its corresponding standard deviation from Step 4, yielding 12 *D*-IRAP scores—one score for each trial type for each pair of test blocks; (h) four overall trial-type *D*-IRAP scores were calculated by averaging the three scores for each trial type across the three pairs of test blocks; (i) two *D*-IRAP scores, one for vegetables and one for meat, were then calculated by averaging the two vegetable and then the two meat trial-type scores; (j) an overall relative *D*-IRAP score was calculated by averaging all 12 trial-type *D*-IRAP scores from (g).

Figure 4 presents the overall mean *D*-IRAP scores for vegetarians and meat-eaters on the two IRAP trial types. For the vegetable trial type, both groups exhibited an implicit pro-vegetable bias, although the vegetarians' *D*-IRAP effect was approximately twice that of the meat-eaters. For the meat trial type, the vegetarians showed an anti-meat bias and the meat-eaters showed a small pro-meat effect. A 2 × 2 mixed repeated measures ANOVA was conducted, with group (vegetarian vs. meat-eater) as the between-participants variable and IRAP trial type (vegetable vs. meat) as the repeated measure. The ANOVA revealed a significant main effect for group, $F(1, 30) = 8.641$, $p < 0.01$, $\eta_p^2 = .22$, and for IRAP trial type, $F(1, 30) = 8.641$, $p < 0.001$, $\eta_p^2 = .33$, with a nonsignificant interaction ($p > .3$). Two one-way between-participant ANOVAs yielded significant differences for both vegetable, $F(1, 30) = 4.792$, $p < .05$, $\eta_p^2 = .14$, and meat, $F(1, 30) = 8.427$, $p < .01$, $\eta_p^2 = .22$, trial types. Two one-sample *t* tests indicated that the two *D*-IRAP effects for the vegetarians differed significantly from zero: vegetables, $t(15) = 6.358$, $p < .0001$; meats, $t(15) = 6.358$, $p < .05$. For the meat-eaters, however, the effect for vegetables was only marginally significant, $t(15) = 2.089$, $p = .054$, and the effect for meat was nonsignificant, $p = .29$. Overall, therefore, the IRAP indicated pro-vegetable and anti-meat biases for the vegetarians that differed significantly from the meat-eaters' pro-vegetable and pro-meat biases. Follow-up tests indicated that the vegetarian's pro-vegetable and anti-meat biases were significant, but the meat-eaters' pro-vegetable and pro-meat biases were not, although the former approached significance.

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1 Employing an adapted version of the D-IAT measure was deemed important in order to permit relatively direct comparisons between the IAT and the IRAP. It is also worth noting that a recent study has shown that when IRAP difference scores are calculated without using the D-transformation, they correlate significantly with intelligence (O'Toole & Barnes-Holmes, 2009), which may serve to confound the IRAP measure when factors other than IQ are being assessed. When the D-IRAP transformation was applied to the same data, however, no significant correlations with IQ were observed (data not reported in the article).

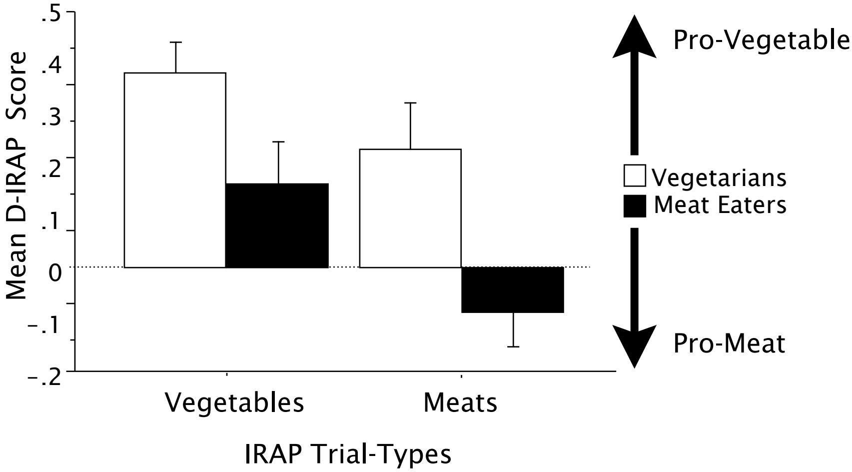

Figure 4. Mean vegetable and meat *D*-IRAP trial-type scores, with standard error bars, for vegetarians and meat-eaters. Positive *D*-IRAP scores reflect a pro-vegetable bias and negative *D*-IRAP scores reflect a pro-meat bias. The zero-point reflects no bias. A pro-vegetable bias for vegetables was produced if participants responded more quickly to "Pleasant–Vegetable–True" and "Unpleasant–Vegetable–False" than to "Pleasant–Vegetable–False" and "Unpleasant–Vegetable–True" (the opposite pattern indicated a pro-meat bias on vegetable trials). A pro-meat bias for meats was produced if participants responded more quickly to "Pleasant–Meat–True" and "Unpleasant–Meat–False" than to "Pleasant–Meat–False" and "Unpleasant–Meat–True" (the opposite pattern indicated a pro-vegetable bias on meat trials).

Split-Half Correlations

To assess the internal consistency of the IRAP, three split-half reliability scores were calculated, one for vegetable trial type, one for meat trial type, and one for the overall *D*-IRAP measure. In each case, two scores were calculated, one for odd trials and the second for even trials, and these were obtained in the same way as for the vegetable, meat, and overall *D*-score, except that the algorithm described previously was applied separately to all odd trials and to all even trials. The three split-half correlations between odd and even scores, applying Spearman-Brown corrections, proved to be moderate and significant for vegetable, $r = .582$, $n = 32$, $p < .001$, and meat, $r = .526$, $n = 32$, $p < .01$, trial types, and strong and significant for the overall *D* measure, $r = .715$, $n = 32$, $p < .0001$. These data thus indicated a reasonably strong level of internal consistency for the IRAP, particularly for a response-time measure (see Nosek et al., 2006).

Explicit Rating Measures

Consistent with De Houwer and De Bruycker (2007), the vegetarians' and meat-eaters' explicit attitudes toward vegetables and meat were calculated by averaging all the questionnaire and picture items with respect to vegetables (10 items) and meat (30 items). Table 2 presents the individual means and standard deviations, and this shows that the vegetarians rated vegetables as more positive than meats, but the meat-eaters rated meat as more positive than vegetables (but only slightly). A 2 × 2 mixed repeated measures ANOVA revealed no main effect for group, $p = .3$, but a significant effect for attitude object, $F(1, 30) = 23.620$, $p < .0001$, $\eta_p^2 = .44$, with a significant interaction, $F(1, 30) = 10.184$, $p < .01$, $\eta_p^2 = .14$. Two one-way between-participant ANOVAs indicated that the vegetarians' explicit rating of vegetables was significantly more positive than the meat-eaters' rating, $F(1, 30) = 5.45$, $p < .05$, $\eta^2 = .15$, but with the difference for meats only approaching significance, $F(1, 30) = 3.993$, $p = .055$, $\eta^2 = .12$.

Table 2
Descriptive Statistics for Vegetarian and Nonvegetarian Ratings of Meat and Vegetable Pictures and Questionnaire Items

	Attitude object	*M*	*SD*
Vegetarians	Vegetables	6.04	.26
	Meats	3.92	.21
Meat-eaters	Vegetables	4.19	.41
	Meats	4.47	.18

Explicit ratings for pictures alone for both groups indicated that vegetarians rated the meat as significantly more negative ($M = 1.76$, $SD = 1.03$) than the meat-eating group ($M = 4.91$, $SD = 1.96$), $t(30) = -5.69$, $p < .0001$). Ratings of the vegetables, however, were more positive for the vegetarians ($M = 6.93$, $SD = 1.86$) than the meat-eaters ($M = 5.29$, $SD = 2.60$, $t(30) = 2.05$, $p < .05$).

Correlations Between Implicit and Explicit Measures

A correlation matrix of the implicit and explicit measures is presented in Table 3. An explicit relative rating measure was created by subtracting the average rating for meat items from the average rating for vegetable items (i.e., a positive score indicated a pro-vegetable bias). The explicit vegetable rating correlated in a weak but significant manner with the IAT, the IRAP meat trial type, and the overall IRAP measure. The correlation between the IRAP meat trial type and the relative explicit measure approached significance. In addition to the correlations presented in Table 3, we also found that the IAT correlated significantly with the overall IRAP measure, $r = .54$, $p < .01$; the IRAP vegetable trial type, $r = .54$, $p < .01$; and the IRAP meat trial type, $r = .43$, $p < .02$.

Table 3
Correlations Between the IAT and IRAP D-Scores and the Explicit Rating Measures

Explicit Measures	IAT	IRAP Meat	IRAP Vegetable	IRAP Overall
Explicit Meat	0.19	0.02	0.13	0.08
Explicit Vegetable	0.36*	0.36*	0.28	0.36*
Explicit Relative	0.22	0.30#	0.18	0.27

#p < .10. *p < .05.

Prediction of Group Status

Two separate hierarchical logistic regression analyses were conducted. For both models the explicit relative rating measure was entered as a predictor of group status (vegetarian or meat-eater) in the first step. The relative rating measure proved to be a relatively weak but significant predictor of group status, $B = -.88$, $p = .02$, accounting for 21% of the variance. For the first model, the IAT measure was entered into the second step, and this produced an increment in predictive validity, $B = -2.57$, $p = .04$, accounting for 34% of the variance (R^2 change = .13). For the second model the overall *D*-IRAP measure was entered into the second step, and this produced a similar increment to the IAT, $B = -4.26$, $p = .03$, accounting for 35% of the variance (R^2 change = .14). In effect, the implicit measures served to increase, by 13% or 14%, the predictive validity of the self-report measure.

DISCUSSION

The current study employed the known-groups approach to assess the validity of the IRAP as a potential measure of the implicit attitudes of vegetarians and meat-eaters towards meat and vegetables. The IAT and an explicit measure of attitudes were also employed with comparative analyses conducted to assess differences and similarities among the measures. The results from the IAT showed that it discriminated at a statistically significant level between vegetarians and meat-eaters, although the *D*-scores indicated that both groups possessed a preference for vegetables over meat. Follow-up one-sample *t* tests indicated that the pro-vegetable bias was significant for vegetarians but not for meat-eaters. Similar to the IAT, the IRAP also discriminated between the groups at a statistically significant level, and demonstrated a pro-vegetable bias in both the vegetarian and meat-eater groups. Given the nonrelative structure of the IRAP, it was possible to determine that the vegetarians' preference for vegetables was approximately twice that of the meat-eaters, and that the meat-eaters produced a small pro-meat effect but the vegetarians showed the opposite. One-sample *t* tests indicated that the vegetarians produced a significant IRAP effect for both trial types, whereas the meat-eaters' IRAP effects approached significance only for the vegetable trial-type.

The IRAP thus provided more information than the IAT, in that the latter measure simply indicated a pro-vegetable bias for both groups (although the bias was weaker for the meat-eaters). Based on the IAT alone, one cannot determine if the meat-eaters were pro-vegetable and also anti-meat or strongly pro-vegetable and weakly pro-meat. In contrast, the IRAP showed that the meat-eaters were generally pro-vegetable but also slightly pro-meat. Furthermore, the IRAP yielded a reasonably strong level of internal consistency. Indeed, the split-half correlations (Meat = .58, Vegetables = .53, Overall IRAP = .71) compared well with those reported by De Houwer and De Bruycker (2007) for the IAT (.81; this was .76 in the current study) and for the three EAST measures (meat trials = .63, vegetable trials = .64, overall EAST = .62). In summary, therefore, the IRAP discriminated between the two groups to the same degree as the IAT and possessed a similar level of internal consistency, but also provided additional information not available from the IAT data alone.

On the explicit measures the vegetarians rated vegetables more positively than the meat-eaters, but the difference between the groups in their ratings of the meats only approached significance. The ratings of the meat and vegetable images employed in both the IAT and IRAP tasks indicated that the vegetarians rated the pictures of meat as more negative and the pictures of vegetables as more positive in comparison to the meat-eaters. The correlational analyses among the explicit and implicit measures showed that the explicit vegetable rating correlated in a weak but significant manner with the IAT, the IRAP meat trial type, and the overall IRAP measure. The fact that the IRAP, like the IAT, correlated with the explicit vegetable measure suggests that the two methods overlap functionally as indices of implicit attitudes. Hierarchical logistic regression analyses demonstrated that the relative rating measure (explicit) proved to be a weak but significant predictor of group status. The IAT and the IRAP separately produced moderate increases of 13% and 14%, respectively, thus indicating again that the IAT and IRAP overlap functionally as implicit measures, at least in the context of the current study.

In comparison to the previous findings by De Houwer and De Bruycker (2007), the explicit measure proved only to be a poor predictor of group status. The previous study found that the explicit measure produced an R^2 of .93, but the current research produced an R^2 of only .21. The reason behind the difference between the two studies remains unclear at the present time, but one possible explanation is the nature of the samples that were employed. Specifically, anecdotal evidence indicated that some of the meat-eaters in the current sample, particularly among the females, perceived meat to be a fattening food, and thus, although they ate meat, their self-reported evaluations may have been suppressed by this dietary consideration. If such an effect occurred, this would likely reduce the predictive validity of the explicit measures.

On a related note, it is interesting that the meat-eaters did show an implicit bias on both the IAT and the IRAP towards vegetables, and that the pro-meat bias on the IRAP was relatively small and nonsignificant (the vegetable bias was marginally significant). Overall, therefore, the meat-eaters showed a solid trend toward preferring vegetables to meat. Intriguingly, such an effect was not obtained in the study by De Houwer and De Bruycker (2007), which produced a small negative (pro-meat) IAT effect. Once again, this points to a possible difference in the Irish and Belgian meat-eating samples that were employed across the two studies. As suggested previously, perhaps the Irish meat-eaters' perception of meat was generally negative, viewed as a fattening and unhealthy food item, which contrasted with vegetables as a healthy and slimming option. Of course, this interpretation is entirely speculative, but it is consistent with the low predictive validity of the explicit measure, and the fact that the meat-eaters showed an implicit preference for vegetables over meat.

In summary, both the IAT and the IRAP discriminated at a statistically significant level between vegetarians and meat-eaters, with both methods correlating with some features of the explicit self-report measures. The implicit methods also provided small but statistically significant increases in predictive validity over the explicit ratings. The current findings thus support the work of De Houwer and De Bruycker (2007) in showing that the implicit attitudes of vegetarians and meat-eaters toward meat and vegetables may be detected using the IAT. The current study extended this earlier work, however, by showing that the IRAP, instead of the EAST, provides an equally effective measure in this domain.

In closing, it is important to acknowledge that the current findings do not allow us to conclude that the IRAP is an *implicit* measure. Such measures, it has been argued, must meet one or more of the following criteria: Participants (a) are not aware that the targeted attitude is being measured; (b) do not have conscious access to the attitude; or (c) have limited control over the outcome of the measure (see De Houwer, 2006). Participants in the current study were almost certainly aware that their attitudes to meat and vegetables were being assessed. Furthermore, the participants had at least some access to their attitudes, given that they were *self-reported* meat-eaters or vegetarians. Finally, the current study was not designed to determine if the participants could control the measurement outcome (e.g., by asking a vegetarian to fake a pro-meat IRAP performance). It should be noted, however, that recent research does indicate that participants possess limited control over the IRAP effect (McKenna, et al., 2007), and when socially or psychologically sensitive issues are targeted, the IRAP may generate effects that diverge from consciously reported attitudes (Barnes-Holmes, Murphy, et al., 2010; Dawson, et al., 2009; Power, et al., 2009; Roddy, et al., in press). At the current time, therefore, there is some evidence that the IRAP meets the second two criteria for an implicit measure. Given this evidence, and the current findings, further research exploring both the implicitness and validity of the IRAP certainly seems warranted.

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