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Predictive models of implicit and explicit attitudes

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Explicit attitudes have long been assumed to be central factors influencing behaviour. A recent stream of studies has shown that implicit attitudes, typically measured with the Implicit Association Test (IAT), can also predict a significant range of behaviours. This contribution is focused on testing different predictive models of implicit and explicit attitudes. In particular, three main models can be derived from the literature: (a) additive (the two types of attitudes explain different portion of variance in the criterion), (b) double dissociation (implicit attitudes predict spontaneous whereas explicit attitudes predict deliberative behaviour), and (c) multiplicative (implicit and explicit attitudes interact in influencing behaviour). This paper reports two studies testing these models. The first study ($N = 48$) is about smoking behaviour, whereas the second study ($N = 109$) is about preferences for snacks versus fruit. In the first study, the multiplicative model is supported, whereas the double dissociation model is supported in the second study. The results are discussed in light of the importance of focusing on different patterns of prediction when investigating the directive influence of implicit and explicit attitudes on behaviours.

The automatic, effortless, and implicit aspects of human information processing are currently at the centre of attention in social psychology and in attitude research, in particular. Several recent studies have shown that implicit attitudes can be activated automatically and guide behaviour directly outside of conscious awareness (Bargh, Chen, & Burrows, 1996; Chen & Bargh, 1999; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Fazio & Dunton, 1997; Greenwald & Banaji, 1995). A number of paradigms to measure implicit attitudes have been developed in recent years, such as the affective priming (Fazio, Sanbonmatsu, Powell, & Kardes, 1986), the Go/no go task (GNAT, Nosek & Banaji, 2001), the Extrinsic affective Simon task (EAST, De Houwer, 2003), and the masked affective priming (Frings & Wentura, 2003). Unfortunately, the reliability of these measurement methods is either unknown (EAST, masked affective priming), or is very low based on the handful of studies where it has been tested (e.g. affective priming, $\alpha = .26$, Banse, 2001; GNAT, split-half reliability = .20, Nosek & Banaji, 2001). The most reliable procedure to measure implicit attitudes has been the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). Several studies

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have shown good IAT internal consistency values (usually $\alpha = .80$), and reasonable test–retest values (usually $r = .60$). The IAT is also the most widely used procedure, with the greatest evidence of construct and predictive validity.

Briefly, the IAT is a computerized method for indirectly measuring the strength of the association between a target concept and a valence attribute via a double-categorization task. It relies on the assumption that, if a target concept and an attribute dimension are highly associated (congruent), the task will be easier, and, therefore, quicker when they share the same response key than when they require a different response key. The IAT needs one target category (e.g. flowers), one contrast category (e.g. insects), one target attribute (e.g. positive), and one contrast attribute (e.g. negative), each represented by a series of stimuli. In the critical combined task, stimuli from all four classes are presented in random sequence, and participants are asked to assign them correctly to one of the two combined category-attribute pairs (e.g. left key for flowers [pleasant] and right key for insects [unpleasant]). This combined task is successively switched such that the pair category-attribute is different (e.g. left key for insects [pleasant] and right key for flowers [unpleasant]). An IAT score is computed as a function of the difference of the mean response times between the two versions of the combined task. Thus, for instance, respondents will generally be quicker to associate flowers with pleasant, compared to flowers with unpleasant (or, conversely, will be slower to associate insects with pleasant, compared to insect with unpleasant), therefore, revealing a positive implicit attitude towards flowers relative to insects (for more details about the procedure, see Greenwald *et al.*, 1998; Greenwald & Nosek, 2001). Since the original paper by Greenwald and colleagues, there has been a profusion of studies on implicit attitudes using the IAT on a wide range of topics such as prejudice (Dasgupta, McGhee, Greenwald, & Banaji, 2000), self-esteem (Greenwald & Farnham, 2000), cognitive balance (Greenwald *et al.*, 2002), smoking (Swanson, Rudman, & Greenwald, 2001) consumers' choice of drinking products (Maison, Greenwald, & Bruin, 2001), alcohol (Wiers, van Woerden, Smulders, & de Jong, 2002), high-fat food (Roefs & Janssen, 2002), homesexuality (Banse, Seise, & Zerbes, 2001), and condom use (Marsh, Johnson, & Scott-Sheldon, 2001). In general, there is accumulated empirical evidence that the IAT can predict specific behaviours, although in some studies it failed to do so (e.g. Karpinski & Hilton, 2001).

Different accounts have been put forward as far as the cognitive processes underlying the functioning of the IAT are concerned. Although the IAT is clearly related to associative knowledge structures (Greenwald *et al.*, 2002), it appears unlikely that they alone make up the processes underlying the IAT. Alternative models of the IAT functioning have been articulated in terms of a random walk process (Brendl, Markmann, & Messner, 2001), a figure-ground asymmetry (Rothermund & Wentura, 2001), a task-switching account (Mierke & Klauer, 2001), and a stimulus-response compatibility (De Houwer, 2001). Each of these models has supporting evidence, and it appears premature at this stage to draw conclusions about which of them offers the most adequate explanation of the cognitive processes underlying the IAT.

On the other hand, there is a long-standing tradition within attitude research of approaches that focus on the explicit, deliberative, and volitional aspects of decision making. In general, in these models, explicit attitudes are one of the determinants of behaviour and intentions are assumed to mediate the impact of attitudes and of the other predictors on behaviour. For instance, Ajzen's theory of planned behaviour (Ajzen, 1991, 2001) assumes that, alongside attitudes, subjective norms (i.e. the perceived social pressure to perform a given behaviour) and perceived behavioural

control (i.e. the perceived ease or difficulty of performing the given behaviour) are influencing one's intention, which, in turn, is the proximal cause of behaviour. Additionally, the model of goal-directed behaviour (Perugini & Bagozzi, 2001; Perugini & Conner, 2000) assumes that anticipated emotions and past behaviour influence desire, which, in turn, influences intention and mediates the influence of previous constructs (i.e. attitudes, subjective norms, perceived behavioural control, anticipated emotions) on intention. Recent reviews (Armitage & Conner, 2001; Perugini & Bagozzi, 2004) support these models (explaining between 39% and 68% of the variance in intentions and between 27% and 30% of the variance in behaviour). Thus, models of decision making within the deliberative approach have shown robust predictive power for a range of behaviours.

Theoretical and predictive models of implicit and explicit attitudes

The two traditions of implicit and explicit attitudes have developed largely in isolation, and few attempts have been made to develop comprehensive frameworks. Based on the existing literature and empirical evidence, we can distinguish between three main theoretical frameworks that are loosely associated with three alternative predictive models.[1]

One of the most recent and influential theoretical frameworks is the proposal by Wilson, Lindsey, and Schooler (2000) of a model of dual attitudes, defined as different evaluations, one implicit and one explicit, of the same attitude object. In fact, Wilson and colleagues explicitly allow for the coexistence in memory of independent implicit and explicit attitudes toward the same attitude object. They distinguish between four main cases (repression, independent systems, motivated overriding, and automatic overriding), corresponding to the combination of awareness of the implicit attitude, once activated, and the amount of motivation and cognitive effort needed for the explicit attitude to override the implicit one. Given that implicit and explicit attitudes can coexist in memory, one important question becomes how they direct behaviours. Implicit attitudes are assumed to influence spontaneous or implicit responses; that is, responses that are uncontrollable or with no attempts to control them, whereas explicit attitudes are expected to influence deliberative or explicit responses; that is, responses that are under conscious control or are perceived as expressive of the relevant explicit attitude. This theoretical framework would, therefore, predict a double-dissociation pattern, which, indeed, has been confirmed in a few studies, although typically tested in a weak form (e.g. Dovidio, Kawakami, & Gartner, 2002; Fazio, Jackson, Dunton, & Williams, 1995; McConnell & Leibold, 2000; Spalding & Hardin, 1999).

The evidence for the existence of two independent systems is, however, inconclusive. Usually, the two systems are inferred, rather than directly tested (cf. Fazio & Olson, 2003). From this perspective, implicit and explicit attitudes can be best understood as implicit or explicit measures of the same attitude. Their typically low correlation (usually between 0.20 and 0.30) should be taken not as evidence of the existence of two independent systems, but of the discriminant validity between two different types of measures, one relying on self-report and on explicit evaluations; the

[1] *The correspondence between theoretical frameworks and predictive models is only partial, because all three frameworks are flexible enough to accommodate the three predictive models. Therefore, even though from each framework is possible to articulate a corresponding predictive model, the empirical evidence should not be taken directly as evidence of the superiority of a specific framework, but it should be seen in light of the specific conditions and the accumulated evidence that favour any given theoretical model.*

other relying on reaction times, which are assumed to indicate the associative strength between target and evaluation in a task without explicit evaluation. In this line of thinking, the question sometimes becomes what is the 'real' attitude (cf. Fazio *et al.*, 1995). If we follow this assumption of a single system with a single attitude representation and two different measures, the most direct predictive model is an *additive pattern*, whereby both explicit and implicit attitudes can give a unique contribution to the prediction of behaviours. Of course, the specific predictive power may change from behaviour to behaviour, and in some cases, may be such that only one of the attitudes has predictive power. However, the general case should be that both measures of the same attitude provide a distinctive prediction of behaviour.

A careful reading of the theoretical framework proposed by Wilson *et al.* (2000) reveals a subtle bias. Practically all theoretical definitions, conceptual examples, and evidence collected in support of the theoretical framework are focused on cases where a negative implicit attitude conflicts with a positive explicit attitude. For instance, the four main cases previously described are all organized around the notion of potential conflict between implicit and explicit systems. So far, little theoretical work has explicitly focused on what happens when the two attitudes are congruent and not conflicting. However, relevant elaborations can be found in recent developments within the study of the self and in a recent model of social behaviour. The concepts of defensive and secure self-esteem have been defined in terms of combinations between implicit and explicit self-esteem. Specifically, defensive self-esteem is defined as an incongruence between high explicit self-esteem and low implicit self-esteem, whereas secure self-esteem is defined as the congruence between high explicit and high implicit self-esteem (Bosson, Brown, Zeigler-Hill, & Swann, 2003; Jordan, Spencer, Zanna, Hoshino-Browne, & Correll, 2003). Participants with secure self-esteem have been found to be less narcissistic, to show less in-group bias, and to engage less in dissonance reduction compared to participants with defensive self-esteem (Jordan *et al.*, 2003). A more general theoretical framework of social behaviour has been developed recently by Strack and Deutsch (2004). The author's framework relies on the interaction between a reflective system, characterized by propositional representations and explicit decision making processes, and an impulsive system, conceived as a simple associative network, whose processes are usually working automatically and without a specific personal conscious awareness. Although behaviour is elicited through different processes, there is a common executive pathway to overt behaviour. In other words, the two systems use different operations, but they activate the same behavioural schemata. A crucial corollary of this theoretical account is that when both systems contribute synergistically to the activation of the same behavioural schemata, behaviour is facilitated, the cognitive capacity required to control the execution decreases, and behaviour may be accompanied by a positive hedonic feeling of fluency (Winkielman & Cacioppo, 2001). Thus, a considerable proportion of behaviour in human life falls somewhere in between the two extreme forms of totally uncontrolled and totally controlled and involves a mix of both automatic and controlled components, with the latter more likely to act as a hierarchical self-regulatory system (Vancouver & Scherbaum, 2000) or as an overriding mechanism (Baumeister & Sommer, 1997). We can hypothesize, therefore, that when implicit and explicit attitudes are congruent, their joint directive function on behaviour is strongest. The corresponding predictive model would call for an *interactive pattern*.

To sum up, it is possible to articulate three predictive models that reflect the three different theoretical frameworks about explicit and implicit attitudes and their relation with behaviours. The three models correspond to the situation when implicit and

explicit attitudes provide unique predictive information about behaviour (*additive pattern*), implicit attitude predicts spontaneous behaviour and explicit attitudes predict deliberative behaviour and not vice versa (*double dissociation pattern*), and implicit and explicit attitude interact synergistically to predict behaviour (*interactive pattern*).

Aim of this contribution

The main aim of this contribution is to test these three predictive models in two studies. Particular attention will be paid to the interactive pattern because it is the most novel and least tested predictive account of the effects of implicit and explicit attitudes on behaviour. Two studies on two different health related domains, smoking behaviour and eating snacks versus fruit, will be presented. More specifically, the first study will compare an additive and an interactive pattern, and it will use a know-group design by comparing smokers with non-smokers. The second study will compare all three patterns simultaneously about their prediction of both a spontaneous and a deliberative behaviour concerning the relative preference of snacks over fruit.

STUDY 1

The first study concerns smoking behaviour. The role of implicit attitudes in predicting smoking behaviour has been investigated by Swanson *et al.* (2001) in three experiments. The results of the experiments showed mixed evidence for the predictive validity of the IAT. In the first two experiments, the IAT effect was not significantly different for smokers compared to non-smokers. In the third experiment, the difference was significant, with smokers showing relatively more positive implicit attitudes than non-smokers. However, both groups had a clear negative implicit evaluation of smoking, as indicated by the average reaction times. On the other hand, explicit attitudes were clearly and consistently more positive for smokers than for non-smokers, although, again, negative for both groups in absolute values. The authors played down the inconsistent pattern of results for implicit attitudes, and preferred to explain their findings in terms of cognitive dissonance between implicit and explicit attitudes due to smoking being a stigmatized behaviour. The presence of additive or multiplicative effects of implicit and explicit attitude was not tested.

Method

Participants

The sample consisted of 50 participants recruited on campus, 37 female and 13 male, with an average age of 22.7 ($SD = 4.1$). Two participants were discarded for different reasons, leaving a total of 48, of whom 25 were smokers and 23 non-smokers. One participant was discarded because of the excessive number of very short latencies (more than 25% of the trials below 400 ms), and one because of the excessive number of very long latencies (more than 25% of the trials above 3,000 ms).

Materials and procedure

The experimental task was closely modelled after Swanson *et al.* (2001; Study 1). It consisted of a questionnaire and a computerized task (IAT). The questionnaire

contained questions concerning both smoking and exercise, and were identical except that they were phrased for smoking and exercise, respectively. The items were chosen to measure explicit attitudes with 11 bipolar scales (bad – good, harmful – harmless, foolish – wise, unpleasant – pleasant, boring – exciting, not enjoyable – enjoyable, sexy – not sexy, healthy – unhealthy, sociable – unsociable, glamorous – ugly, calming – stressful) on a 7-step answer scale ranging from −3 to +3. The pairs of adjectives reflected those originally used by Swanson *et al.* (2001).

The computerized categorization task is the Implicit Association Test (IAT), and it is described in detail in several articles (e.g. Greenwald *et al.*, 1998; Greenwald & Nosek, 2001). The task was programmed using Psyscope 1.2.5 for Macintosh. The target concept was smoking and its contrast was exercise, whereas the attribute categories were pleasant and unpleasant. The choice of exercise as a contrast category mirrored one of the contrast categories used by Swanson *et al.* (2001) and it is justified by their finding that the IAT results did not differ as a function of using a different contrast category (i.e. sweets). Participants were required to assign stimuli as fast as possible to their appropriate categories by pressing one of two response keys. Each task followed the standard 5-step IAT sequence (cf. Greenwald *et al.*, 1998). Steps 1, 2 and 4 are practice phases, whereas the critical steps are the third and the fifth. In the third step, participants assigned stimuli to the four different categories combined in pairs. For instance, participants were required to press the left key in response to stimuli belonging to either the smoking or the pleasant category, and the right key in response to stimuli belonging to the exercise or the unpleasant category. In the fifth step, the task was the same but with the reversed response for the target stimuli; namely, left for smoking and unpleasant, and right for exercise and pleasant. For each category, six stimuli were used (see Appendix). All practice blocks consisted of 20 trials and each critical block consisted of 41 trials.[2]

Participants were individually contacted on campus and invited to participate in an experimental session. They were paid £2 plus the possibility of winning a lottery with a £20 prize. Each participant was seated in a cubicle at a table with a desktop computer and was debriefed at the end of the experiment. The IAT task was completed before the questionnaire to minimize potential carry-over effects (cf. Egloff & Schmukle, 2002).

Results

Trials with reaction times below 300 ms or above 3,000 ms were recoded to 300 ms and 3,000 ms, respectively. The first trial of each block was also removed due to typically longer reaction latency. The participants made an average of 7.5% errors. Only correct responses were considered for the calculation of the IAT score (cf. Mierke & Klauer, 2001).[3] The IAT score was calculated by taking the difference in reaction times between Phase 3 and 5 and, thus, reflected the implicit positive evaluation of smoking relative to

[2] *Note that the order of Step 3 and Step 5 was not counterbalanced, as often done with the standard IAT. This procedure of a fixed presentation order for all participants should lead to higher validity coefficients (cf. Egloff & Schmukle, 2002). However, the usual counterbalancing convention was followed in the second study.*

[3] *Unfortunately, only correct responses were saved and therefore the new algorithm developed by Greenwald, Nosek, and Banaji (2003) could not be used in this study. This problem was corrected for the second study in which the new algorithm has been used.*

exercise. The reliability of the IAT score was good ($\alpha = .80$).[4] For purposes of analyses, data were log-transformed to meet normality assumptions. The explicit attitude score was calculated by subtracting the aggregate score for exercise from the one for smoking (ranging from -6 to $+6$), thus indicating a positive evaluation for smoking relative to exercise so that its interpretation is the same as for the IAT. The reliability of this composite score was very good ($\alpha = .92$).

Both implicit and explicit attitudes revealed a similar pattern of results. Smokers had significantly more positive implicit and explicit attitudes towards smoking than non-smokers, $F(1, 47) = 8.17$, $p = .006$, and $F(1, 47) = 31.77$, $p < .001$, respectively. The means are reported in Table 1. Note that all values are negative, indicating that for both smokers and non-smokers alike, smoking is evaluated negatively relative to exercise. However, non-smokers tended to evaluate smoking much more negatively (-3.57 vs. -1.44) and were much quicker to associate smoking with negative words (-214 ms vs. -89 ms) compared to smokers. These results are reflected in significant correlations of 0.64 and 0.48 between being a smoker and explicit and implicit attitude, respectively. These values correspond to effect sizes (Cohen's *d*) of 1.67 and of 1.09, respectively, which would be classed as large according to standard conventions (Cohen, 1988). The implicit and explicit attitudes towards smoking were moderately correlated ($r = .48$).

Table 1. Means, medians, and standard deviations for the IAT smoking score ($N = 48$)

	Smokers			Non-smokers				
	M	*SD*	Median	*M*	*SD*	Median	*F*(1, 47)	*p*
IAT (ms)	−89	162	−67	−214	172	−170	8.17	.006
Explicit attitude	−1.44	1.08	−1.54	−3.57	1.55	−3.52	31.77	<.001

A hierarchical logistic regression was performed to investigate both the unique contributions of implicit and explicit attitudes (additive pattern) and the presence of a multiplicative effect (interactive pattern). At the first step, both attitudes were entered as predictors of being a smoker. The model explained 54.8% of variance, but explicit attitudes were a significant predictor ($B = 2.02$, $SE = 0.63$, $p = .001$), whereas implicit attitudes were not significant ($B = 0.45$, $SE = 0.44$, $p = .31$). The multiplicative term was entered at the second step and it improved the overall prediction (Nagelkerke $R^2 = 0.60$, R^2 change = 5.2%), although showing only a trend towards significance $\chi^2_1 = 3.22, p = .073$). This trend towards significance was reflected in the multiplicative term ($B = 1.03$, $SE = 0.56$, $p = .064$). To inspect the meaning of this interaction in further detail, the predicted probabilities of being a smoker as derived from the logistic model were plotted for a range of standardized values of the IAT for three values corresponding to positive ($z = 1$), neutral ($z = 0$), and negative ($z = -1$) explicit attitudes (Jaccard, 2001; see Fig. 1).

[4] *Different methods can be adopted to calculate the reliability, meant as internal consistency, of an IAT score. In this study, given that only correct responses were available, the two key steps of 40 stimuli each were divided into four blocks each and an IAT effect was calculated for each block. The four blocks were then used as items to calculate Cronbach's alpha. In the second study, where all responses were available, Cronbach's alpha was calculated by using all 40 items in the two critical steps, each calculated as an IAT effect.*

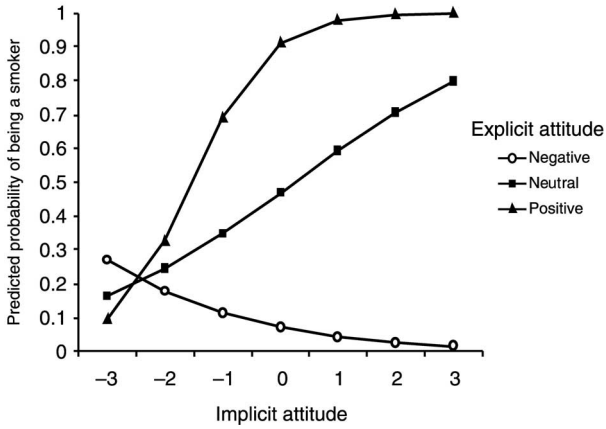

Figure 1. Interaction between implicit and explicit attitudes in predicting smoking behaviour (Study 1, $N = 48$).

The presence of the interactive effect can be interpreted in this way. For neutral explicit attitude towards smoking, the likelihood of being a smoker increases with an increasing positive implicit attitude. However, for negative explicit attitudes, the likelihood tends to decrease, even with increasingly positive implicit attitudes. However, for positive explicit attitudes, the likelihood increases very sharply with increasingly positive implicit attitudes so to reach quickly a value of almost 100%. This shows that the explicit attitude towards smoking moderates sharply the impact of the corresponding implicit attitudes.

To summarize, the results show that the additive pattern is not supported, given that when both attitude measures are entered simultaneously as predictors in the same equation, only one (the explicit attitude measure) predicts significantly whether someone is a smoker or a non-smoker. The interactive pattern is empirically supported and suggests that the prediction of being or not a smoker is more effective when implicit and explicit attitudes are in the same direction. This appears to be especially true for the likelihood of being a smoker, given that even small increases in the implicit attitude score when joint with a positive explicit attitude have a sharp effect in terms of predicted probability.

STUDY 2

The results of the first study confirmed the importance of the interactive effect between implicit and explicit attitudes, although it did not provide supporting evidence for an additive effect. In the second study, a double dissociation pattern will be tested in a different behavioural domain; namely, preferences towards snacks versus fruit. One study is particularly relevant in this respect. In their second study, Karpinski and Hilton (2001) examined the predictive power of implicit and explicit attitudes with respect to candy bars versus apples. After the measurement session of the experiment was over, participants were presented with a Snickers candy bar and a Red Delicious apple and asked to choose one of them. This choice represented their behavioural criterion. The main results were as follows. Firstly, Karpinski and Hilton found that implicit and explicit attitudes did not correlate significantly between each other.

Secondly, both the IAT and the explicit attitude measures showed a preference for apples over candy bars. Thirdly, the IAT failed to predict the behavioural criterion, whereas the explicit attitude did predict it significantly.

The present study expands on Karpinski and Hilton's (2001) second study in a number of ways. Firstly, the examined attitudes are towards the more general categories of snacks and fruit rather than candy bars and apples. Secondly, while retaining their behavioural criterion (though modified to allow for a choice between different types of snacks and fruit), an additional self-reported behavioural measure of regular consumption of fruit and snacks was also obtained. The first behavioural criterion can be classed as concerning mostly a spontaneous behaviour, whereas the second behavioural criterion can be defined as mostly deliberative. Finally, the presence of two behaviours thus differentiated will allow a test of the double dissociation pattern, as well as a test of additive and interactive effects. These issues were not addressed by Karpinski and Hilton.

Method

Participants

The sample consisted of 113 participants recruited on campus, 62 female and 51 male, with an average age of 25.1 ($SD = 6.8$). Four participants were discarded for different reasons, leaving a total of 109. One participant was discarded because the computer failed to save the reaction latency data, one because of the excessive errors (above 30% of the trials), one because of the excessive number of very short latencies (25% of the trials below 400 ms), and one because of both (above 20% of the trials with errors, and above 20% of trials below 400 ms).

Materials and procedure

The experimental task mirrored the one described in the first study and consisted of a questionnaire and a computerized task. The questionnaire contained questions concerning attitudes towards both eating snacks and eating fruit. They were assessed with six bipolar scales (bad – good, unpleasant – pleasant, negative – positive, not enjoyable – enjoyable, unhealthy – healthy, unattractive – attractive) on a 7-step answer scale ranging from -3 to $+3$. Behaviour was measured in two ways. Firstly, *self-reported* behaviour (SRB) was measured with three items. The first referred to self-perception (e.g. 'To what extent would you describe yourself as a person who regularly eats snacks [fruit]?' with a 7-step answer scale from *not at all* to *very much*). The second referred to the average weekly consumption of a series of types of snacks and fruit. Snacks included chocolate bars, plain biscuits, chocolate biscuits, confectionery, cakes/pastries, bars, and other sweet snacks. Fruit included apple, banana, pear, kiwi, grapes, berries, and other fruit. Participants were asked to estimate how many in each category they were eating during an average week. The score was obtained by adding up these answers. The third item asked for the frequency of eating snacks [fruit] during an average day. Secondly, behavioural choice (BC) was measured at the end of the experiment (cf. Karpinski & Hilton, 2001). After the experiment was finished, participants were informed that in addition to the standard fee and the lottery ticket, they could choose a free snack or fruit to take with them. They were presented two bowls containing a selection of fruit and snacks and asked to choose one of them.

The computerized categorization task was the IAT. The target concept was snacks and its contrast was fruit, whereas the attribute categories were pleasant and unpleasant. For each category, six stimuli were used (see Appendix). All practice blocks consisted of

20 trials and each critical block consisted of 41 trials. In this second study the order of Step 3 and Step 5 was counterbalanced. Furthermore, the presentation order (IAT first vs. questionnaire first) was also counterbalanced. Participants were individually contacted on campus and invited to participate in an experimental session. They were paid £2 plus the possibility to win a lottery with a £20 prize. Each participant was seated in a cubicle at a table with a desktop computer. At the end of the experiment, they were asked to exit the cubicle, pointed towards two bowls on a nearby table containing snacks and fruit, asked to choose a free snack or fruit, and debriefed afterwards.

Results

The first trial of each block was removed due to a typically longer reaction latency. The IAT score was calculated using the new algorithm developed by Greenwald, Nosek, and Banaji (2003), specifically the algorithm D_6 (deletion of latencies below 400 ms and above 10,000 ms, errors replaced with the mean of the correct responses plus 600 ms).[5] The participants made on average 5.8% of errors. The reliability of the IAT score was good ($\alpha = .86$). The explicit attitude score was obtained by subtracting the sum of the scores for snacks from those for fruit, such that it expresses a relative preference for snacks over fruit, and showed a good reliability ($\alpha = .80$). The self-reported behaviour (SRB) index was obtained by adding up the difference in z scores of the three items for snacks minus those for fruit. The index was reliable ($\alpha = .82$).

The results show that there was a generalized preference for fruit over snacks. In fact, the mean raw IAT score ($M = -38$ ms, $SD = 206$), as well as the explicit attitude score ($M = -2.26$, $SD = 1.10$), express a preference for fruit over snacks. The preference is confirmed also for the behavioural choice (53.2% of participants choose a fruit).

The implicit and explicit attitude measures were correlated with the two behavioural measures (see Table 2).

The IAT had a significant relation with the spontaneous behaviour (behavioural choice), whereas the explicit attitude was significantly related with the deliberative behaviour (self-reported behaviour), whereas the cross-relations were not statistically significant. In terms of effect sizes, the IAT had values corresponding to $d = 0.45$ and $d = 0.32$ for behavioural choice and self-reported behaviour, respectively, whereas explicit attitudes had $d = 0.33$ and $d = 0.82$, respectively. These effect sizes would be classed as medium to large. Implicit and explicit attitudes were not significantly correlated with each other ($r = .09$). To investigate the relation between attitudes and behaviours and to test the three predictive models, a structural equation approach was adopted. There are manifold advantages in using this approach over a traditional regression approach: (a) it yields an overall test of goodness of fit, (b) it takes into account measurement error, (c) it allows formal tests of specific hypotheses, (d) it allows for simultaneous testing of the double dissociation and the additive patterns.[6]

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[5] *Differently from the algorithm D_6, only the critical trials (40 stimuli) for each key step (3 and 5) were used. The specific instructions that were adopted did emphasize the distinction between practice and critical trials. Therefore, it was deemed appropriate to use trials for which participants were explicitly asked to perform at their best as opposed to practice the task at hand.*

[6] *It should be noted that one DV is dichotomous, therefore, strictly speaking, it would be statistically inappropriate to use a full SEM. However, given that the distribution of the DV (behavioural choice) is very balanced, the distortion in the parameters and standard errors is likely to be very small and basically irrelevant for the main results, as can be seen by comparing the results of the LISREL model with the other results (raw correlations and simpler predictive models). Overall, the advantages of using a SEM approach clearly outweigh this caveat.*

Table 2. Correlations between implicit and explicit attitudes and snacks (vs. fruit) choice and consumption behaviours ($N = 109$)

	IAT	EA	BC	SRB
IAT	1.00			
EA	0.09	1.00		
BC	0.22*	0.17	1.00	
SRB	0.16	0.38**	0.26**	1.00

*$p < .05$, **$p < .01$.
Note. IAT = Implicit Association Test; EA = Explicit attitude; BC = Behavioural choice; SRB = Self-reported behaviour. All scores coded in the direction of preference for snacks.

Unfortunately, the interactive pattern could not be tested using the full structural equation model approach suggested by Jöreskog and Yang (1996), due to the relatively small sample size in respect to the algebraic complexity, and the high number, of parameters in the equations involved (i.e. the asymptotic covariance matrix was not positive definite). A simpler two stage least squares (TSLS) approach[7] was used for the continuous variable self-reported behaviour, as recommended by Jöreskog, Sörbom, du Toit, and du Toit (2000), and a logistic regression model was used for the dichotomous variable behavioural choice.

The first structural equation model testing for the double dissociation pattern is reported in Fig. 2. The fit was excellent ($\chi^2_7 = 5.10$, $p = .65$, CFI = 1.00). The parameters clearly support the double dissociation pattern, with implicit attitudes predicting significantly spontaneous (behavioural choice; $\gamma = .24$), but not deliberative behaviour (self-reported behaviour; $\gamma = .14$). However, explicit attitudes showed the opposite pattern ($\gamma = .17$ and $\gamma = .44$ for spontaneous and deliberative behaviour, respectively). To test formally for an additive effect, a modified model without the additive crossed paths (i.e. implicit attitudes on deliberative behaviour and explicit attitudes on spontaneous behaviour) was run. This model is a more restricted model given that two parameters are fixed to zero. The two models are nested and, therefore, it is possible to perform a formal test of the need for the additive effects. If the more restricted model will not be significantly different from the less restricted model, one can conclude that it is statistically superfluous to consider the additive effects. This is indeed what the result suggests ($\chi^2_{d(2)} = 5.70$, $p = .058$). This conclusion is reinforced by noticing that (a) the two additive parameters are not statistically significant in the less restricted model, and (b) the overall fit of the more restricted model is already excellent ($\chi^2_9 = 5.70$, $p = .29$, CFI = 0.99), therefore, suggesting that any less restricted model is at high risk of over fitting (Anderson & Gerbing, 1988).

The interactive pattern was tested separately for the two dependent variables. The two stage least squares model showed a significant effect for explicit attitudes ($\gamma = .57$, $SE = 0.15$, $t = 3.91$) and non-significant effects for both implicit attitudes ($\gamma = .24$, $SE = 0.16$, $t = 1.56$) and, crucially, for the interactive term ($\gamma = .20$, $SE = 0.16$, $t = 1.23$). The logistic regression indicates a significant effect for implicit attitudes ($B = 0.42$, $SE = 0.20$, $p = .039$) and non-significant effects for both explicit

[7] *The TSLS model takes into account measurement error in the variables, but it does not provide indicators about the goodness of the fit.*

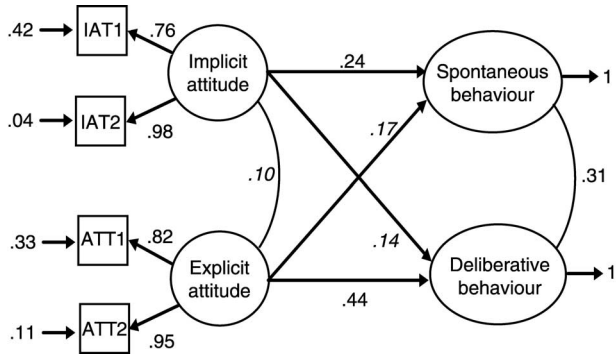

Figure 2. Standardized parameters for the structural equation model testing for the double dissociation pattern (Study 2, $N = 109$). Significant structural paths are in bold, non-significant paths are in italics.

attitudes ($B = 0.39$, $SE = 0.23$, $p = .085$) and, crucially, for the interactive term ($B = -0.27$, $SE = 0.22$, $p = .224$). These results, while indirectly confirming the double dissociation pattern, do not support the interactive pattern. Both interactive terms do not reach the significance level, although they show a slight tendency towards it.

GENERAL DISCUSSION

The results of the two studies underscore the importance of assessing both implicit and explicit attitudes and of testing different predictive models. The most relevant issues raised by the results will be discussed next.

Predictive validity of implicit attitudes

The efficacy of implicit attitudes to predict relevant behaviour has been confirmed in the two studies. Implicit attitudes, as emerging from the associated IATs, have shown significant correlations with being a smoker and with snack choice during the experimental session. In the first study, the best predictor of being a smoker has been the explicit attitude towards smoking. When considered simultaneously with the implicit attitude measure, only the former has emerged as a significant predictor. However, the influence of implicit attitudes has emerged also in the interactive term. Modelling explicit attitudes as the moderator, it has been shown that implicit attitudes seem particularly relevant when associated with positive explicit attitudes, so that small positive increases in the implicit attitude towards smoking sharply change the predicted probability of being a smoker. On the other hand, when explicit attitudes are negative, they predict being a non-smoker even with increasing positive implicit attitudes. Finally, when the explicit attitudes are neutral, implicit attitudes predict linearly the probability of being a smoker. The second study has shown that implicit attitudes predict more spontaneous behaviour, such as a rapid choice about whether to take a free snack or piece of fruit on the spot. It is interesting to note that this result contrasts with what has been found by Karpinski and Hilton (2001). It is likely that the difference can be explained by details in the selection of the stimuli as well as in the operationalization of the behaviours. Firstly, four of the five stimuli used by Karpinski and Hilton in their IAT (red, Macintosh, pie, and cider) were related to apples, but not necessarily revealing

about implicit preferences towards apples as a fruit. Therefore, the resulting IAT score might be less predictive of actually choosing an apple. Secondly, Karpinski and Hilton focused on apples (a single fruit) versus snacks (a bundle of different products) and their behavioural choice was the preference of a specific Red Delicious apple versus a specific Snickers candy bar. In this study, the focus was on fruit and snacks, both defined as a bundle of different products, and the behavioural choice has been between a selection of fruit and a selection of snacks, so that it was likely to include whatever specific fruit or snack each participant preferred.

Predictive models of implicit and explicit attitudes

One of the most important issues emerging from this contribution is the necessity to test for alternative predictive models when studying the directive function of implicit and explicit attitudes. Among the several possible validity criteria, the correlation between implicit and explicit attitudes is the weakest one for at least two reasons. Firstly, it is an inherently ambiguous piece of information. For instance, a low correlation can be taken as evidence of dissociation between the two types of attitudes, as independence between different types of measures, but also as lack of convergent validity between them. Equally, higher correlations can be interpreted in both ways. Therefore, although the correlation between implicit and explicit attitudes is useful on a descriptive level, it is much less useful as far as predictive validity is concerned. In this respect, the key information should be sought in the capability of both implicit and explicit attitudes to predict relevant behavioural criteria. The question thus becomes what kind of behaviours can be predicted, under which conditions, and in which way. It has been argued that is worth examining at least three key predictive models that are loosely related to three different theoretical frameworks: additive, double dissociation, and interactive patterns. In the first study, the interactive model has been supported more than the additive model, although the double dissociation pattern could not be properly tested given the presence of a single criterion. The second study, where all models have been tested, has provided clear support for the double dissociation pattern. Of course, this does not necessarily discredit the additive model. It is highly possible that there will be behaviours and situations where the specific results might change, and the additive model might provide a superior explanation of the results. More research and accumulated empirical evidence will be needed before any given model can be either discounted or considered as superior, including experimental manipulations of key parameters expected to influence the outcome. Indeed, it is likely that the accumulated empirical evidence will result in a clearer articulation of conditions and behaviours that can be explained preferentially by any of these models. In other words, the key information to be sought concerns the ideal and boundary conditions for the validity of each model rather than a 'survival of the fittest' competition. The main message of this contribution is that, whenever possible, all predictive models are compared for their ability to predict the outcomes of specific studies, so that this crucial information is gained over time.

The interplay between implicit and explicit attitudes

Among the three predictive models, the most novel and perhaps interesting appears to be the interactive pattern. The key message is that implicit and explicit attitudes can interact in influencing behaviour. This is probably the first time that this hypothesis has been tested within the attitude field. The interactive hypothesis is compatible with both

a dual and a single system account of attitudes, and it is directly connected with the theoretical framework proposed by Strack and Deutsch (2004). In the first study, the hypothesis has been supported, whereas in the second study it has not. Yet, it represents a fundamental perspective that needs to be taken into account when examining the interplay between implicit and explicit attitudes. There has been often a bias in the literature towards providing evidence of dissociation between implicit and explicit attitudes. This bias can be seen in models within the tradition of dual theories, such as Fazio's (1990) motivation and opportunity as determinant of behaviour (MODE) and Wilson, Lindsey, and Schooler (2000) model of dual attitudes. Albeit in different ways, both models share an either/or perspective, and focus on when and how explicit or implicit attitudes are more likely to direct behaviour. Neither model focuses on the possibility that implicit and explicit attitudes can jointly direct behaviour, nor on attempts to incorporate the specific mechanisms in a more comprehensive network of theoretical constructs known to influence behaviour alongside attitudes. The theoretical framework proposed by Strack and Deutsch (2004) appears an important contribution that might correct this bias and highlight the crucial notion that implicit and explicit attitudes can, and often do, work synergistically in influencing behaviour. Little is known about when this is more likely to happen, and for what kind of behaviours. Several carefully planned studies will be needed to advance the understanding of this important issue.

Limitations and conclusions

Some limitations of this contribution should be acknowledged. First, it would be desirable to extend these findings in domains other than health related behaviours, to which both studies of this contribution pertain. Second, it would be desirable to manipulate experimentally key parameters such that specific causal mechanisms could be tested. For instance, one can expect that experimental conditions where the central executive capabilities are reduced (e.g. dual attention tasks, cognitive load paradigms) when executing behaviour should favour the predictive power of implicit attitudes. Third, methods other than the IAT should also be used to measure implicit attitudes, otherwise the risk is that method and construct will become too closely overlapping. The IAT has a series of limitations, such as, for instance, the necessity to define both a target and a contrast category. Often, choosing a contrast category is neither easy nor uncontroversial. Therefore, it is important to use also alternative methods. There are some promising alternative paradigms (EAST, masked affective priming) that could and should be used to complement or even supplement the IAT, if warranted by empirical evidence.

Despite these limitations, we believe that the results are clear enough to provide an interesting picture of the predictive validity of implicit and explicit attitudes. Models of explicit attitude functioning have been very important in improving the understanding and prediction of a wide range of relevant behaviours. More recently, models of implicit attitudes have added to this understanding by clarifying the importance of automatic processes directing behaviours. An important challenge for the future will be to develop and test more comprehensive models of human decision making, incorporating findings from both fields in a unified theoretical account. The framework proposed by Strack and Deutsch (2004) seems an important step forward in this direction, although several issues still need clarification. Among these, is the systematic examination of alternative

predictive models that articulate the influence of implicit and explicit attitudes along theoretical lines.

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Appendix

Implicit association test stimuli for Study 1

Pleasant: Rainbow, happy, smile, joy, peace, pleasure
Unpleasant: Pain, death, poison, agony, sickness, vomit
Smoking: Cigarette, tobacco, smoke, ashtray, smoker, lighter
Exercise: Run, biking, gymnastics, tennis, swim, jog

Implicit Association Test stimuli for Study 2

Pleasant: Rainbow, happy, smile, joy, peace, pleasure
Unpleasant: Pain, death, poison, agony, sickness, vomit
Snacks: Candy, chocolate, cookie, pastry, cake, snacks
Fruit: Fruit, apple, banana, grapes, kiwi, pears