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Cognitive Inertia and the Implicit Association Test

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Cognitive Inertia and the Implicit Association Test

The authors review the Implicit Association Test (IAT), its use in marketing, and the methodology and validity issues surrounding it. They focus then on a validity problem that has not been investigated so far, the impact of cognitive inertia on IAT-effects. Cognitive inertia denotes the difficulty in switching from one categorization rule to the opposite categorization rule. This difficulty causes IAT-effects to depend on the order in which the two IAT-blocks are administered. In study 1, an IAT-effect is observed when the 'compatible' block precedes the 'incompatible' block, but not when the 'compatible' block follows the 'incompatible' block. In studies 2 and 3, the IAT-effect changes its sign when the order of the blocks is reversed. Cognitive inertia distorts individual IAT-scores and diminishes correlations between IAT-scores and predictor variables when block-order is counterbalanced between-subjects. Study 4 shows that counterbalancing block-order repeatedly within-subjects can eliminate cognitive inertia effects on the individual level. The authors conclude that researchers should either interpret IAT-scores on the aggregate level or, when individual IAT-scores are of interest, counterbalance block-order repeatedly within-subjects.

Keywords: Implicit Association Test, cognitive inertia, validity

Marketing researchers are becoming increasingly interested in non-conscious influences on consumer behavior (cf., Fitzsimons et al. 2002). A central concept of this research is implicit attitudes, defined as "...introspectively unidentified (or inaccurately identified) traces of past experience that mediate favorable or unfavorable feeling, thought, or action toward social objects" (Greenwald and Banaji 1995, p. 8). Implicit attitudes are thought of as potentially better predictors of behavior than explicit (self-reported) attitudes, because consumers might be unwilling to reveal their attitudes concerning stigmatized behavior (e.g., racist attitudes), or might lack the ability to introspect correctly (Brunel, Tietje, and Greenwald 2004).

The Implicit Association Test (IAT) has become the most popular tool for measuring implicit attitudes, presumably because the IAT is characterized by a unique combination of impressive effect size and effortless implementation. The IAT was initially introduced to social psychology (Greenwald, McGhee, and Schwartz 1998), and has since been applied in clinical psychology (e.g., Teachman, Wilson, and Komarovskaya 2006), organizational behavior (e.g., Haines and Sumner 2006), law (cf., Mitchell and Tetlock 2006), and recently in marketing research (e.g., Brunel, Tietje, and Greenwald 2004).

We describe the IAT and its use in marketing, and review the methodology and validity issues surrounding it. In the IAT, respondents sort target concepts (such as brand names) and positive and negative concepts into categories, where response latencies reveal a respondent's automatic evaluation of the target concepts. The IAT requires respondents to apply two opposite categorization rules. We show that the difficulty in switching from one categorization rule to the opposite categorization rule, called cognitive inertia, causes IAT-effects to depend on the order in which the two IAT-blocks are administered. In study 1, we demonstrate an IAT-effect in favor of Coca-Cola when Coca-Cola is first paired with the positive stimuli, but no IAT-effect when

Coca-Cola is first paired with the negative stimuli. In studies 2 and 3 the IAT-effect not only changes in magnitude but also in sign when the order of the two IAT-blocks is reversed. These order-effects, caused by cognitive inertia, distort individual IAT-scores. When block-order is held constant, these distortions can bias correlations between IAT-scores and predictor criteria. When block-order is counterbalanced between-subjects, the distortions diminish correlations between IAT-scores and predictor criteria. In study 4, we demonstrate that repeated counterbalancing of the block-order within-subjects can eliminate cognitive inertia effects on the individual level. We conclude that researchers should either interpret aggregate IAT-scores (i.e., on the group level), or, when individual IAT-scores are of interest, counterbalance block-order repeatedly within-subjects.

THE IMPLICIT ASSOCIATION TEST

In the IAT, participants see stimuli presented sequentially on a computer screen and are asked to sort these into categories. For example, the stimuli might consist of pleasant (e.g., *heaven*) and unpleasant (e.g., *violence*) words, and the names of competing brands (e.g. Coca-Cola and Pepsi). With these stimuli, the IAT would measure the implicit association strength of the target concepts Coca-Cola and Pepsi with the evaluative poles pleasant and unpleasant. Rather than brand names, the target concepts can instead be faces of White and Black Americans, symbols representing homosexuality and heterosexuality, academic subjects such as math and history, etc. There are virtually no limits to the concepts that have been used in the IAT for measuring implicit attitudes.

The IAT procedure consists of five practice blocks and two main blocks. Participants have two response keys. In the first practice block, pleasant and unpleasant words are presented in random order on the screen. Participants are instructed to press the left key whenever a pleasant word is presented, and the right key whenever an unpleasant word is presented. Importantly, participants are asked to respond as fast as possible without making mistakes. In a second practice block the target concepts, such as Coca-Cola and Pepsi, are presented. Participants are instructed to press the left response key whenever Coca-Cola is presented on the screen, and press the right response key when Pepsi is presented. In a third practice block the two word lists are presented together. Whenever *either* a pleasant word *or* Coca-Cola is presented, participants press the left response key, and whenever *either* an unpleasant word *or* Pepsi is presented, they press the right response key. The fourth block is the first IAT main-block. The task is the same as in the third practice block (see Figure 1 left panel). Response latencies from this fourth block are used in the computation of the IAT-effect.

[Insert Figure 1 about here]

The fifth block is another practice block, in which the allocation of the response keys to the target concepts is switched. Now the left response key is to be pressed for Pepsi, and the right response key is to be pressed for Coca-Cola. In a sixth practice block, both word lists are again presented together. Whenever *either* a pleasant word *or* Pepsi is presented on the screen, participants are asked to press the left response key, and whenever *either* an unpleasant word *or* Coca-Cola is presented, they are asked to press the right response key. So in contrast to the previous main-block, Coca-Cola now shares a response key with unpleasant words, and Pepsi shares a response key with pleasant words (see Figure 1 right panel). The seventh and final block is the second IAT main-block, and the task is identical to the sixth practice block. As in the first main-block (the fourth block), response latencies in this second main-block are used for the computation of the IAT-effect. The order in which the two main-blocks and their preceding practice blocks are administered is counterbalanced between-subjects, so that half of the respondents run through the block-sequence 1-2-3-4-5-6-7, and the other half run through 1-5-6-7-2-3-4.

Response latencies are averaged within each of the two main blocks. The main-block with shorter response latencies is called the *compatible* block, and the main-block with longer response latencies is called the *incompatible* block. The IAT-effect is computed by subtracting mean response latencies of the compatible block from the mean response latencies of the incompatible block. For example, if the compatible block is the block where Coca-Cola was paired with the pleasant stimuli (and Pepsi was paired with the unpleasant stimuli), the IAT-effect would be interpreted as a stronger association of the attribute pleasant with the target Coca-Cola than the target Pepsi.

Applications of the IAT

Researchers have used the IAT to produce an impressive amount of research on implicit attitudes (over 300 published articles in psychology alone). Consumers can easily check their own implicit prejudice level on a wide variety of topics on the Project Implicit website (url: https://implicit.harvard.edu/implicit/), which returns individual IAT-scores categorized into no, slight, moderate, and strong automatic preference.

The IAT attracted massive media attention (e.g., in *Blink* by Gladwell 2005) and was featured on TV shows as a tool to uncover implicit racism (e.g., *The Oprah Winfrey Show* on

06/06/2007). Marketing consulting firms (e.g., Olson and Zaltman Associates, http://www.olsonzaltman.com/) use the IAT as a measure of "true" preferences and brand associations, and IAT-findings are currently being used in "Dukes vs. Wal-Mart", the largest class action employment discrimination case that has ever been convened to go forward against Wal-Mart, including more than two million women who have worked at any of the company's more than 4000 retail stores in the U.S. since Dec. 26 1998 (cf., CNNMoney.com 2007).

Recently, marketing academics have also become interested in the IAT. Researchers have used the IAT to demonstrate its validity (e.g., Brunel, Tietje, and Greenwald 2004; Maison, Greenwald, and Bruin 2004) or the validity of alternative implicit measures in marketing contexts (e.g., Huang and Hutchinson 2008; Dimofte and Yalch 2007a, b). The dissociation between conscious and non-conscious processes in consumer behavior has been explored theoretically by discussing IAT-findings (e.g., Cohen and Reed 2006; Hofmann, Strack and Deutsch 2008; Peracchio and Luna 2006; Fitzsimons et al. 2002), and empirically by showing that manipulations either impact conscious processes but not the IAT (e.g., Raghunathan, Walker Naylor and Hoyer 2006; Forehand and Perkins 2005) or impact the IAT but not conscious processes (e.g., Walker Naylor, Raghunathan and Ramanathan 2006; Gibson 2008). For a detailed review of IAT-related articles in marketing see Table 1.

[Insert Tables 1 and 2 about here]

Methodology and Validity Issues surrounding the IAT

Despite the massive number of IAT-applications in psychology, organizational behavior, the law, and marketing, a relatively small number of articles have identified methodological issues and construct validity concerns that cast doubt on the internal validity and predictive power of the IAT (for a review of these issues see Table 2). Predictive power and validity of the IAT are assessed by correlating IAT-scores with other implicit measures (e.g., Bosson, Swann, and Pennebaker 2000), explicit self-report measures (e.g., Brunel, Tietje, and Greenwald 2004), behavior, judgment, and choice (e.g., Maison et al. 2004), and physiological measures (e.g., Cunningham et al. 2004). Two meta-analyses have been published summarizing the findings of hundreds of correlational studies. Greenwald et al. (2009) analyzed 103 studies and found an average correlation of .27 with a wide range of behavior, judgment, and physiological measures. Likewise, Hofmann et al. (2005) report a mean correlation of .19 between IAT-scores and self-reported preferences, intentions, and behaviors (126 studies).

However, it is not clear how these correlations should be interpreted (Blanton et al. 2006; Mitchell and Tetlock 2006). Sometimes, high correlations are interpreted as evidence for the validity of the IAT (e.g., Greenwald, Nosek, and Banaji 2003; Nosek, Greenwald, and Banaji 2005). But elsewhere researchers have argued the opposite, that the IAT and explicit measures should not be expected to correlate highly because they represent conceptually distinct concepts (e.g., Greenwald, McGhee, and Schwartz 1998; Greenwald and Farnham, 2000; Greenwald et al. 2002). Shelton et al. (2005) interpreted even a negative correlation as evidence supporting the validity of the IAT. In their study, Blacks preferred to interact with people classified as implicit racists in the IAT. The authors argue that Whites who are more racially biased must make more of an effort to control racial bias in interactions with Blacks than Whites who are less racially biased.

Theoretically, IAT-scores should correlate more highly with behavior, judgment, and explicit measures when social desirability concerns are low (i.e., consumers are not afraid to report their true attitudes; Fazio and Olson 2003). Unfortunately, this qualification does not help to clarify the findings. In their meta-analysis of the predictive validity of the IAT, Greenwald et al. (2009) found no relationship between social desirability concerns and the strength of correlation between the IAT and behavior, judgment, and physiological measures. Even more frustrating, in Hofmann et al.'s (2005) meta-analysis social desirability had an opposite effect: Correlations between the IAT and self-reported preferences, intentions, and behaviors were higher across studies where social desirability was of concern.

Cognitive Inertia in the IAT

We believe that one reason for the inconclusive correlational results is that IAT-scores contain a lot of systematic error. IAT-effects are typically stronger when the compatible block precedes the incompatible block (cf., Greenwald, Nosek, and Banaji 2003; Hofmann et al. 2005). According to the logic of the IAT, however, IAT-effects should be the same regardless of the order of the blocks, because implicit attitudes should be invariant with respect to the instrument that measures them. The architect of the IAT, Anthony Greenwald, has called order-effects the "most noticeable internal validity problem of the IAT" (Greenwald and Nosek 2001, p. 87).

As we will show, order-effects occur because of cognitive inertia, the difficulty in switching from applying one categorization rule in the first block to applying the opposite categorization rule in the second block. In the cognitive literature this is called task-set inertia (cf., Allport and Wylie 1999). Cognitive inertia is thus akin to the depletion of mental resources in repeated choice decisions (cf., Bruyneel et al. 2006; Pocheptsova et al. 2009).

Consider a Coca-Cola versus Pepsi IAT. Participants in the compatible block learned to associate Coca-Cola with the pleasant words, but in the subsequent incompatible block they must respond in the opposite direction, associating Coca-Cola with unpleasant words. Switching from applying one categorization rule to applying an opposite categorization rule is cognitively demanding and requires time and practice. So, *ceteris paribus*, cognitive inertia leads to slower responses in the second block, regardless of whether it is compatible or incompatible. Order-effects now accrue from the interplay of cognitive inertia (slower responses in the second block) and the IAT-effect (faster responses in the compatible block). When the faster compatible block comes first, cognitive inertia slows down responses in the subsequent incompatible block, thereby augmenting the difference in response latencies between the two blocks (i.e. enlarging the IAT-effect). In contrast, when the incompatible block precedes the faster compatible block, cognitive inertia slows down responses in the faster compatible block (i.e., decreasing the IAT-effect)[1]. Study 1 is designed to test this hypothesis.

STUDY 1

Like Gibson (2008) and Maison et al. (2004), we conducted an IAT with the target stimuli Coca-Cola and Pepsi. The following six stimuli were chosen to represent the attribute concept *pleasant*: success, energy, enjoyment, vivacity, relaxation, and happiness. For the attribute concept *unpleasant* the six stimuli inanimateness, depression, ugliness, inferiority, idleness, and disaster were chosen. We measured the explicit associations between the target and attribute stimuli by asking 51 participants to rate how strongly they associate Coca-Cola and Pepsi with each of the pleasant and unpleasant attribute stimuli[2]. Paired comparisons showed that Coca-Cola was more strongly associated with the pleasant stimuli (mean rank = 25.84) than was Pepsi (mean rank = 4.33, $z = 5.90$, $p < .01$). Similarly, Coca-Cola was less associated with the unpleasant stimuli than Pepsi (mean rank = 21.98; mean rank = 19.11, respectively; z = 2.11, $p < .05$). Consequently, we expected to find an overall IAT-effect in favor of Coca-Cola. We will call the block in which Coca-Cola is paired with the pleasant attribute stimuli the compatible block, and the block in which Coca-Cola is paired with the unpleasant attribute stimuli the incompatible block. As is typically done in IAT-studies, we varied the order of the blocks between-subjects.

Method

Participants and Design. 51 students of a European university (M(AGE) = 21.47, SD(AGE) = 4.60) were recruited for a study in consumer behavior. As remuneration participants received a voucher in the amount of approximately $6 for the University's cafeteria. The experiment employed a 2 block (compatible vs. incompatible; within-subjects) x 2 block-order (compatible block first vs. incompatible block first; between-subjects) design.

Procedure. Participants were tested individually. The design of the IAT was identical to the typical IAT-design except that we included 144 trials in each of the two main blocks as opposed to the typical 40 to test whether order-effects continue despite learning over trials (cf., Nosek, Greenwald, and Banaji 2005). Following Maison et al. (2004), the target concepts were labeled with the colored brand labels of *Coca-Cola* and *Pepsi*, and the attribute concepts were labeled with the words *pleasant* and *unpleasant* (cf., Figure 1).

Results

Response latencies were measured in milliseconds. As is typically done with IAT-latencies, response latencies were log-transformed and averaged within the compatible and the incompatible blocks, and latencies from false, extremely fast (< 300 ms) and extremely slow (> 3000 ms) responses were discarded (Perkins et al. 2007). Our analyses are performed on these transformed latencies, but we report mean and standard deviations in milliseconds to facilitate understanding of the response times. We computed the IAT-effect by subtracting the mean response latency of the compatible block (Coca-Cola and pleasant) from the mean response latency of the incompatible block (Coca-Cola and unpleasant).

IAT- and Order-Effects. As expected, an overall IAT-effect (i.e., averaged across respondents) in favor of Coca-Cola was found ($M = 40.57$, $SD = 104.20$, t-test against 0: $t(50) = 3.33$, $p < .01$, $d = .47$). We then conducted an ANOVA with the independent variable block-order (compatible block first vs. incompatible block first between-subjects) on the IAT-effect. As hypothesized, the order of the blocks had a significant impact ($F(1, 49) = 15.26$, $p < .01$, $d = 1.12$). An IAT-effect in favor of Coca-Cola was found when the compatible block was administered first ($M = 93.53$, $SD = 111.14$, $t(24) = 4.41$, $p < .01$, $d = .88$), but no IAT-effect was observed when the incompatible block was administered first ($M = -10.35$, $SD = 66.02$, $t(25) = .05$, $p = .96$, $d = .01$; see Figure 2). When IAT-effects were computed as the improved scoring D (Greenwald, Nosek, and Banaji 2003) the observed order-effect became stronger ($d = 1.67$).

[Insert Figure 2 about here]

Cognitive Inertia and Learning Curves. The effects of cognitive inertia can be shown on two levels: on the outcome-level as differing IAT-effects depending on the order of the blocks, and on the process-level as learning within blocks. Respondents will learn to apply the categorization rules and become faster over time/trials. An important question thus is whether order-effects, caused by the difficulty in switching from applying one categorization rule to applying an opposite categorization rule, will wear off over repeated trials due to learning. In order to test this hypothesis, we analyzed the learning curves within the two main-blocks.

We modeled learning within each of the two blocks using the following exponential curve[3]:

$$\ln(rt) = b + e^{-rx}$$

where ln(rt) are the log-transformed reaction times

r is the rate of learning or the steepness of the learning curve

x is the trial number within a block

b is the base, that is the level to which the curve converges

The parameter r indicates the steepness of the learning curve, that is, how fast respondents learn to apply a categorization rule. The faster learning is (i.e., learning occurs only in the first trials and quickly converges to a reaction time base rate), the higher is r. The base parameter b indicates the base level to which the learning curve converges, that is the reaction time level that is reached when no further learning takes place. If order-effects vanish due to learning, the learning curve of both blocks should converge to the same base parameter b. In contrast, if order-effects persist despite learning over the 144 trials, the learning curve of the block that was administered second (no matter whether compatible or incompatible) should converge at a higher level than the learning curve of the block that was administered first.

In order to capture the full learning curve for each main-block, we included the 24 practice trials that precede each block. Because learning is non-linear, most of the learning will occur in the beginning, during the practice trials. We created two new blocks, each consisting of the 24 practice trials and the 144 main-block trials (168 trials per block). We then divided these 168 trials per block into 21 measurements by averaging over 8-trial intervals[4]. We estimated the parameters b and r with the SAS ‘PROC NLIN’ (non-linear) procedure which provides approximate standard errors for the parameter estimates[5].

We contrasted the learning curve of the first block with the learning curve of the second block (see Figure 3). Contrary to the hypothesis that order-effects vanish over repeated trials, the base parameter b of the learning curve of the second block is significantly higher (b = 6.5783, SE = .0069) than the base of the learning curve of the first block (b = 6.5218, SE = .0059; $b_{\text{second block}} - b_{\text{first block}}$ = .0565, lower 95% limit = 0.0387). For further analyses of the learning curves see the Web Appendix A.

[Insert Figure 3 about here]

Discussion

Study 1 used a Coca-Cola versus Pepsi IAT in which the pleasant stimuli were more strongly associated with Coca-Cola than with Pepsi, and the unpleasant stimuli were more strongly associated with Pepsi than Coca-Cola. Accordingly, an overall IAT-effect in favor of Coca-Cola was observed. However, on the individual level, IAT-effects differed greatly. When the compatible block (*Coca-Cola* and *pleasant* words) preceded the incompatible block (*Coca-Cola* and *unpleasant* words), participants showed an IAT-effect in favor of Coca-Cola. But when the order of the blocks was reversed, participants showed no IAT-effect at all.

This order-effect occurred because switching from applying one categorization rule in the first block to applying the opposite categorization rule in the second block is cognitively demanding and requires time and practice. Cognitive inertia thus caused whatever block was administered second to have higher response latencies. When the faster compatible block came first, cognitive inertia augmented the difference in response latencies between the two blocks (i.e. enlarged the IAT-effect). In contrast, when the incompatible block preceded the faster compatible block, cognitive inertia slowed down responses in the faster compatible block (i.e., decreased the IAT-effect). Looking at Figure 1, however, only the latencies of the compatible blocks seem to show this difference. The latencies of the incompatible blocks seem to be equal. According to the cognitive inertia hypothesis, the incompatible latencies should have been larger when the incompatible block came second, and should have been smaller when the incompatible block came first. In a replication of study 1 (see study 4 IAT1), we observed the hypothesized pattern for both blocks, compatible and incompatible. It thus seems that the deviations from the hypothesized pattern in study 1 were due to large variation in response latencies rather than to some systematic deviation from the hypothesized pattern. In conclusion, the results from study 1 (and study 4 IAT1) show that, because of cognitive inertia, IAT-effects are typically stronger when the compatible block is administered before the incompatible block.

Given this strong influence of cognitive inertia on IAT-effects, are there conditions in which cognitive inertia would produce IAT-effects when none should be there? Presumably, this would be the case when a) one target concept is more strongly associated with both the pleasant and the unpleasant attribute stimuli than the other target concept. In this case no IAT-effect would be observed on the aggregate level, but cognitive inertia would augment reaction times in whatever block is administered second and should thus sway the IAT-effect in opposite directions depending on the order of the blocks. The same reasoning holds for case b) when both target concepts are equally strongly associated with the pleasant and unpleasant attribute stimuli. Study 2 and study 3, respectively, are designed to test these hypotheses.

STUDY 2

In study 2, we chose pleasant and unpleasant attribute stimuli such that Coca-Cola would be more strongly associated with either attribute than Pepsi. This reasoning follows de Liver, van der Pligt, and Wigboldus (2006) who show that ambivalent attitudes toward a target are the result of the target being associated with both pleasant *and* unpleasant attributes. As in study 1, we pretested pleasant and unpleasant stimuli, and found the pleasant attributes freedom, heaven, swimming pool, loyalty, ocean, and water to be explicitly more strongly associated with Coca-Cola (mean rank = 25.49) than with Pepsi (mean rank = 9.50, $z = 5.09$, $p < .01$). We found the unpleasant attributes bloodbath, anger, rage, aggression, violence, and injury to be also more strongly associated with Coca-Cola (mean rank = 25.25) than with Pepsi (mean rank = 15.00, respectively; $z = 2.28$, $p < .05$). Given this set of attribute stimuli, we expected not to find an overall IAT-effect in either direction, because neither of the targets Coca-Cola or Pepsi were favored by the associations with the attribute stimuli. However, cognitive inertia will still slow down responses in the second block. This should result in an IAT-effect in favor of Coca-Cola when the *Coca-Cola and pleasant words* block comes first, and in an IAT-effect in favor of Pepsi when the *Coca-Cola and unpleasant words* block comes first.

Method

Participants, Design, and Procedure. 48 students of a European university (M(AGE) = 21.92, SD(AGE) = 4.38) were recruited for a study in consumer behavior. The procedure of study 2 is identical to study 1 except for the pleasant and unpleasant stimuli.

Results

As expected, no overall IAT-effect was found (M = -8.96, SD = 139.62, t-test against 0: t(47) = .80, *p* = .43, d = .12). As in study 1, we conducted an ANOVA with the independent variable block-order (*Coca-Cola and pleasant words* block first vs. *Coca-Cola and unpleasant words* block first between-subjects). The order of the blocks had a significant impact on the IAT-effect (F (1, 46) = 21.50, *p* < .01, d = 1.37). An IAT-effect in favor of Coca-Cola was found when the *Coca-Cola and pleasant words* block was administered first (M = 75.56, SD = 111.93, t(22) = 2.91, *p* < .01, d = .61), but an IAT-effect in favor of Pepsi was observed when the *Coca-Cola and unpleasant words* block was administered first (M = -86.71, SD = 116.40, t(24) = 3.66, *p* < .01, d = .73; see Figure 4). When IAT-effects were computed as the improved scoring D the observed order-effect became stronger (d = 1.57). For the analysis of cognitive inertia in the learning curves please see the Web Appendix A.

[Insert Figure 4 about here]

Discussion

In study 2, Coca-Cola was more strongly associated with both the pleasant and the unpleasant attribute stimuli than Pepsi. The target Coca-Cola thereby was equivalent to a concept towards which respondents had an ambivalent attitude (de Liver, van der Pligt, and Wigboldus. 2006). Accordingly, no overall IAT-effect was observed. But on the individual level, an IAT-effect in favor of Coca-Cola was observed when the *Coca-Cola and pleasant words* block came first, and an IAT-effect in favor of Pepsi was observed when the *Coca-Cola and unpleasant words* block came first.

These results bear an important implication for interpreting the IAT in marketing contexts. The absence of an overall IAT-effect is typically interpreted as both target concepts being equally strongly associated with pleasant and unpleasant. However, the results of study 2 demonstrate that the absence of an IAT-effect can also imply that one target concept is more ambivalent than the other target concept, as a concept can be more associated with both attributes, pleasant *and* unpleasant, than the other concept. For example, prominent brands are more likely to have pleasant *and* unpleasant associations, and are thus likely to be more ambivalent than less prominent brands. As a consequence, testing brands with the IAT might show that one is more prominent than the other rather than that they are equally implicitly preferred[6].

STUDY 3

Study 3 is designed to test whether cognitive inertia can produce IAT-effects when both target concepts are equally strongly associated with the pleasant and unpleasant attribute stimuli. Furthermore, study 3 is aimed at demonstrating that order-effects are not the result of using a specific stimulus set. Several studies have shown that IAT-effects crucially depend on the specific set of stimuli that represent the attributes pleasant and unpleasant (e.g., Steffens and Plewe 2001). The differing results of our studies 1 and 2 support these findings. Therefore, in study 3 we use the 25 pleasant and 25 unpleasant stimuli that were used in experiments 1 and 2 in the original IAT-article (Greenwald, McGhee, and Schwartz. 1998). Additionally, we increase the number of trials in the two critical IAT-blocks from 144 to 200 to further test whether cognitive inertia persists over trials.

Pleasant and unpleasant attribute stimuli were taken from Greenwald, McGhee, and Schwartz's (1998) experiment 1 and 2. As target stimuli we chose *coffee* and *black tea*, and asked 20 participants to rate the association of these targets with the 25 pleasant and the 25 unpleasant stimuli[7]. Respondents rated both coffee and black tea as more strongly associated with the pleasant stimuli (M = 2.29, SD = .73; M = 1.89, SD = .60) than the unpleasant stimuli (M = 1.35, SD = .27; M = 1.38, SD = .36, respectively, t(19) = 6.24, $p < .01$, d = 1.49). Consequently, we expected not to find an overall IAT-effect in either direction. Cognitive inertia, however, should lead to slower response latencies in the second block as compared to the first block. We therefore expected to find an IAT-effect in favor of coffee when the *coffee and pleasant words* block is administered first, and to find an IAT-effect in favor of black tea when the *black tea and pleasant words* block is administered first.

Method

Participants, Design, and Procedure. 60 students of a European university (M(AGE) = 21.98, SD(AGE) = 3.23) received either course credit or a box of chocolate costing approximately $5. The procedure of study 3 is identical to study 1 and 2 except for the target and attribute stimuli and the 200 instead of 144 trials per block.

Results

As expected, no overall IAT-effect was found (M = 3.20, SD = 99.03, t-test against 0: t(59) = .06, $p = .95$, d = .01). We conducted an ANOVA with the independent variable block-order (*coffee and pleasant words* block first vs. *coffee and unpleasant words* block first between-subjects) on the IAT-effect. As hypothesized, the order of the blocks had a significant impact (F

(1, 58) = 17.55, $p < .01$, d = 1.10). An IAT-effect in favor of coffee was found when the *coffee and pleasant words* block was administered first (M = 51.54, SD = 79.62, t(29) = 3.34, $p < .01$, d = .61), but an IAT-effect in favor of black tea was observed when the *coffee and unpleasant words* block was administered first (M = -45.14, SD = 93.71, t(29) = 2.68, $p < .05$, d = .49; see Figure 5). When IAT-effects were computed as the improved scoring D the observed order-effect became stronger (d = 1.92). For the analysis of cognitive inertia in the learning curves please see the Web Appendix A.

[Insert Figure 5 about here]

Discussion

In study three, the target words coffee and black tea were equally strongly associated with the pleasant attribute words, and equally weakly associated with the unpleasant attribute words. As a result, no overall IAT-effect was observed. On the individual level, however, an IAT-effect in favor of coffee was observed when the *coffee and pleasant words* block came first, but an IAT-effect in favor of black tea was observed when the *coffee and unpleasant words* block came first. This order-effect did not vanish over trials even though the number of trials per block was five times higher than in the typical IAT. As the attribute words representing pleasant and unpleasant were the same as in the original IAT-studies (Greenwald, McGhee, and Schwartz 1998), study 3 provides the strongest support for cognitive inertia causing order-effects and reversals of IAT-effects.

THE CONSEQUENCES OF ORDER-EFFECTS AND HOW TO CIRCUMVENT THEM

Counterbalancing Block-Order Between-Subjects. In order to minimize the influence of order-effects as shown in studies 1, 2, and 3, researchers have advised counterbalancing the order of the two IAT-blocks between subjects (e.g., Brunel, Tietje, and Greenwald 2004). Counterbalancing means that for half of the subjects, IAT-scores are inflated by cognitive inertia, and for the other half IAT-scores are reduced by cognitive inertia. Counterbalancing thus causes order-effects to cancel out on the aggregate level if there is an equal number of respondents in each block-order and cognitive inertia is equally strong in both order conditions. Individual IAT-scores, however, are still contaminated with order-effects. This contamination (statistically speaking noise) diminishes correlations of IAT-scores with predictor variables (i.e., increases type II errors).

Holding Block-Order Constant. Some researchers have recommended holding block-order constant when individual IAT-scores are of interest (e.g., Asendorpf, Banse, and Muecke 2002). In this case, cognitive inertia simply magnifies, or diminishes, all IAT-scores. We strongly advise against this method, because if cognitive inertia happens to be correlated with the predictor variable, the correlation between IAT-scores and the predictor variable will be biased.

Statistically Controlling for Order-Effects. Cognitive inertia magnifies IAT-scores in one block-order and diminishes them in the other. The average order-effect is thus equal to half of the difference between the two IAT-effects. Individual IAT-effects can thus be corrected by subtracting the average order-effect in the compatible-incompatible block-order, and by adding it in the incompatible-compatible block-order. This correction, however, assumes that cognitive inertia is equally strong in both block-orders. Furthermore, it assumes that there are no individual differences in cognitive inertia. The cognitive psychology literature has shown this to be not the case. For example, younger persons and persons with high fluid intelligence switch tasks faster than older persons or persons with low fluid intelligence (e.g., Dulaney and Rogers 1994; Kray and Lindenberger 2000). These findings are in accordance with Mierke and Klauer's (2003) result that nonsense IATs correlate with other IATs because of common method variance.

Given that cognitive inertia varies between individuals, neither correcting for average order-effects nor holding block-order constant will eliminate cognitive inertia effects on the individual level. In both cases, IAT-scores are contaminated with individual cognitive inertia effects, and correlations between the IAT and predictor criteria can be distorted (if block-order is held constant) or be diminished (when block-order is counterbalanced between-subjects).

Counterbalancing Block-Order Within-Subjects. Individual cognitive inertia-effects can be reduced by manipulating block-order within- instead of between-subjects. Let C denote the compatible block of a given IAT, and I the incompatible block. If the IAT is conducted with the block-sequences CIC and ICI, the first blocks, C and I, respectively, are free of cognitive inertia. The two successive blocks I and C, and C and I, respectively, will be affected by cognitive inertia. Thus, if the IAT-effect was computed as the difference in response latencies between the last two blocks, cognitive inertia would be present in both blocks but work in opposing directions and thus cancel out. IAT-effects in this case should be free of order-effects.

However, it might be that whatever categorization rule is learned first, the compatible or the incompatible rule, will produce a stronger cognitive inertia effect than the categorization rule that is learned second. Participants in the CIC sequence might find it easier to revert to the compatible rule in the third block, and respondents in the ICI sequence might find it easier to revert to the incompatible rule in third block. In this case an order-effect would still be present when the last two blocks of the CIC and ICI block-sequences are analyzed. Elimination of individual cognitive inertia effects might thus require counterbalancing block-order repeatedly within-subjects.

STUDY 4

In study 4 we manipulated the order of the blocks four times within-subjects using the same stimuli as in study 1. One group was administered the block-sequence CICIC where C denotes the block in which Coca-Cola is paired with the pleasant stimuli, and I denotes the block where Coca-Cola is paired with the unpleasant stimuli. The other group was administered the complementary block-sequence ICICI. When response latencies from the first two blocks were used to compute the IAT-effect, we expected to find the same order-effect as in study 1, that is, an IAT-effect in favor of Coca-Cola when the compatible block comes first, and no IAT-effect when the incompatible block comes first. For the subsequent blocks we expected a reduction of cognitive inertia effects.

Method

Participants, Procedure, and Design. 54 students of a European university (M(AGE) = 23.86, SD(AGE) = 4.84) received either course credit or a voucher in the amount of approximately $6 for the University's cafeteria. The first seven blocks (five practice and two main-blocks) were identical to the IAT in study 1 except that the two main-blocks consisted of 48 instead of 144 trials. These seven blocks were followed by additional six blocks, three main-blocks (48 trials each) and three practice blocks (24 trials each; each of the three main-blocks was thus preceded by a practice block). Half of the participants completed the sequence CICIC, the other half completed the complementary sequence ICICI. The experiment thus employs a 5 main-block (first vs. second vs. third vs. fourth vs. fifth) x 2 block-sequence (CICIC vs. ICICI) design.

Results

We computed an overall IAT-effect by subtracting the mean response latency in the compatible blocks from the mean response latency in the incompatible blocks[8]. Replicating the results from study 1, an overall IAT-effect in favor of Coca-Cola was found (M = 39.51, SD = 89.56, t-test against 0: t(52) = 3.59, $p < .01$, d = 1.00).

We then computed four IAT-effects: IAT1 is computed as the difference in response latencies between the first and the second block, IAT2 denotes the difference in response latencies between the second and the third block, IAT3 denotes the difference between the third and the fourth block, and IAT4 the difference between the fourth and the fifth block (all IAT-effects were computed such that the mean response latency of the compatible block was subtracted from the mean response latency of the incompatible block).

We conducted an ANOVA with the independent variables IAT-effect (IAT1 vs. IAT2 vs. IAT3 vs. IAT4, within-subjects) and block-sequence (CICIC vs. ICICI, between-subjects). The main-effect for block-sequence became significant (F (1, 51) = 7.49, $p < .01$, d = .77). In the CICIC-sequence, an IAT-effect in favor of Coca-Cola was observed (M = 66.94, SD = 77.01, t-test against 0: t(26) = 4.92, $p < .01$, d = 1.93), but in the ICICI-sequence no IAT-effect was observed (M = 11.03, SD = 94.06, t(25) = .68, $p = .51$, d = .27). As hypothesized, the interaction of IAT-effect and block-sequence is significant (F (3, 153) = 3.63, $p < .05$, $eta^2 = .067$), indicating that cognitive inertia effects decreased over the four IAT-effects (see Figure 6).

[Insert Figure 6 about here]

We conducted separate planned comparisons for each of the four IAT-effects. Replicating the result from study 1, the planned comparison on the IAT1-effect yielded an effect for the order of the blocks (F (1, 51) = 15.25, $p < .01$, d = 1.09). In the block-sequence CICIC an IAT-effect in favor of Coca-Cola was found (M = 87.12, SD = 86.40, t(26) = 5.33, $p < .01$, d = 2.09), and in the block-sequence ICICI no IAT-effect was found (M = -12.18, SD = 105.82, t(25) =.46, $p = .65$, d = .19).

The planned comparison on the IAT2-effect again yielded an effect for the order of the blocks, but this time smaller than in the previous case (F (1, 51) = 9.34, $p < .01$, d = .86). In the block-sequence CICIC an IAT-effect in favor of Coca-Cola was found (M = 74.32, SD = 113.87, t(26) = 3.71, $p < .01$, d = 1.45). In the block-sequence ICICI no IAT-effect was found (M = -5.80, SD = 96.52, t(25) = .28, $p = .78$, d = .11).

For the IAT3-effect the order-effect had vanished (F (1, 51) = 1.22, $p = .28$, d = .31). In the block-sequence CICIC an IAT-effect in favor of Coca-Cola was found (M = 46.63, SD = 92.04, t(26) = 2.64, $p < .05$, d = 1.04) but in the block-sequence ICICI no IAT-effect was found (M = 18.16, SD = 100.91, t(25) = .93, $p = .36$, d = .37).

For the IAT4-effect again no effect for the order of the blocks was obtained (F (1, 51) =.67, $p = .42$, d = .23). In the block-sequence CICIC an IAT-effect in favor of Coca-Cola was found (M = 59.68, SD = 76.17, t(26) = 4.74, $p < .01$, d = 1.86). In the block-sequence ICICI the IAT-effect was not significant (M = 43.94, SD = 161.53, t(25) = 1.41, $p = .17$, d = .56). A parallel analysis with IAT-effects computed as the improved scoring D produced similar results.

Discussion

In study 4 we manipulated block-order four times within-subjects. When looking only at the first two blocks (i.e., the part of the study that was equivalent to study 1), we replicated the findings from study 1. An IAT-effect in favor of Coca-Cola was found when the compatible block preceded the incompatible block, but no IAT-effect was found when the incompatible block preceded the compatible block. This order-effect was significantly reduced in the subsequent block-alterations. The more often respondents had to switch between categorization rules, the less of an impact cognitive inertia had on the IAT-effects. However, very much to our own surprise, cognitive inertia proved extremely resilient. It took three within-subjects variations of block-order to render order-effects insignificant.

GENERAL DISCUSSION

Cognitive inertia, the difficulty in switching from applying one categorization rule in the first block to applying the opposite categorization rule in the second block, slows down responses in the second block. IAT-effects thus depend on the order in which the compatible and the incompatible block are administered. When the compatible block precedes the incompatible block, cognitive inertia slows down responses in the second incompatible block and thus works in favor of the IAT-effect. When the incompatible block precedes the compatible block, cognitive inertia slows down responses in the second compatible block, and thus works against the IAT-effect (study 1). This explains why IAT-effects are typically stronger when the compatible block precedes the incompatible block.

Study 2 (Coca-Cola vs. Pepsi) and study 3 (coffee vs. black tea) showed that when neither target concept is favored by associations with the pleasant and the unpleasant attribute stimuli, cognitive inertia can produce IAT-effects itself. For example in study 2, Coca-Cola was more strongly associated with both the pleasant and the unpleasant attribute stimuli than Pepsi. The target Coca-Cola thereby was equivalent to a concept towards which respondents had an ambivalent attitude (de Liver, van der Pligt, and Wigboldus 2006). Due to cognitive inertia, an IAT-effect in favor of Coca-Cola was observed when the *Coca-Cola and pleasant words* block came first, but an IAT-effect in favor of Pepsi was observed when the *Coca-Cola and unpleasant words* block came first. On the aggregate level, no IAT-effect was observed.

These results bear an important implication for interpreting the IAT in marketing contexts. The absence of an overall IAT-effect is typically interpreted as both target concepts being equally strongly associated with pleasant and unpleasant. However, the results of study 2 demonstrate that the absence of an IAT-effect can also imply that one target concept is more ambivalent than the other target concept, as a concept can be more associated with both attributes, pleasant *and* unpleasant, than the other concept. For example, prominent brands are more likely to have pleasant *and* unpleasant associations, and are thus likely to be more ambivalent than less prominent brands. As a consequence, testing brands with the IAT might show that one is more prominent than the other rather than that they are equally implicitly preferred.

As shown in studies 1, 2 and 3, cognitive inertia introduces so much systematic error in IAT-measures that they can wipe out (study 1) and reverse individual IAT-effects (study 2 and 3). The common practice of counterbalancing block-order between-subjects cancels out order-effects on the aggregate level (when an equal number of participants do both block-orders), but on the individual level IAT-scores are still contaminated with cognitive inertia effects. Thus, individual IAT-scores should not be interpreted when block-order is manipulated between-subjects. Correlations between IAT-scores and predictor criteria will be unbiased but diminished in this case. Another way to control for order-effects is to hold block-order constant. However, we strongly advise against this practice, because correlations between IAT-scores and predictor criteria will be biased if cognitive inertia happens to be correlated with the predictor criteria.

Individual cognitive inertia effects can be reduced by manipulating block-order repeatedly within-subjects. This might be helpful when individual IAT-scores are to be interpreted (i.e., the IAT is used as a diagnostic instrument), or when the IAT is to be validated by correlating it with predictor criteria. We advise manipulating block-order at least four times within-subjects to effectively reduce/eliminate the impact of individual cognitive inertia effects on IAT-effects. However, cognitive inertia is not the only methodological issue that can reduce the validity of the IAT (cf., Table 2). In the Web Appendix B we provide a guide to best practices for IAT-research with suggestions of how most of the methodological and validity issues can be addressed.

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Footnotes

[1] This line of reasoning also holds for a variant of the IAT, the so-called Go/No-Go Association Task (Nosek and Banaji 2001).

[2] Associations were rated on 1024-pixel lines ranging from "not at all" (0) to "very much" (1024). Since the association ratings were positively skewed, we tested differences in association strength nonparametrically with Wilcoxon Signed Rank tests.

[3] We are grateful to Michel Wedel for this suggestion.

[4] Eight trials per interval were chosen to balance reliability (the more trials are included, the more reliable the measurements are) and capturing of learning effects (the more successive measurements are used, i.e. the fewer trials are included in each interval, the better learning effects are captured).

[5] Traditional significance tests are not available for non-linear estimations. A limitation of the nonlinear estimation is that the dependence of the observations is not accounted for. However, a repeated measures ANOVA in which the learning curves were linearly estimated yielded the same differences in slopes as the non-linear estimation.

[6] We thank the Editor for pointing out this implication.

[7] We used 5-point rating scales as opposed to the 1024-pixel lines in the previous studies because the pixel line scales did not seem to offer any advantage over the traditional rating scales.

[8] One participant had an average response latency of over 2000 milliseconds, deviating more than three standard deviations from the overall average of 790.25 milliseconds (SD = 237.96 ms), and was excluded from the analyses.

Tables

TABLE 1: IAT RELATED ARTICLES IN MARKETING RESEARCH

Article	Type of Article	IAT Stimuli	Correlation of IAT with Explicit Measure	Summary/ Interpretation of IAT Results
Hofmann, Strack, and Deutsch (2008)	theoretical	-	-	Consumer behavior is driven by impulsive and reflective mechanisms. IAT measures impulsive mechanisms.
Peracchio and Luna (2006)	theoretical	-	-	Speculate whether the IAT could measure a first spontaneous impression.
Cohen and Reed (2006)	theoretical	-	-	The Multiple Pathway Anchoring and Adjustment (MPAA) model of how attitudes guide behavior casts doubt on the validity of the IAT, because some IAT results fit the MPAA but other results do not.
Czellar (2006)	empirical – validity IAT	Target stimuli: prestige brand vs. common brand Attribute stimuli: pleasant vs. unpleasant	-	The IAT is not resistant to self representation. High self monitor participants can alter their IAT-effects to agree with the opinion of others.
Maison, Greenwald and Bruin (2004)	empirical – validity IAT	Target stimuli: study 1: Danone vs. Bakoma study 2: McDonald vs. Milk Bar study 3: Coke vs. Pepsi Attribute stimuli: study 1-3: pleasant vs. unpleasant	In all 3 studies the IAT correlates with explicit measures, but explicit measures predict behavior better than the IAT.	IAT is a valid measure of implicit brand attitudes.

Brunel, Tietje and Greenwald (2004)	empirical – validity IAT	study 1: target stimuli: Mac vs. PC attribute stimuli: self vs. other study 2: target stimuli: Black vs. White spokesperson attribute stimuli: pleasant vs. unpleasant	In study 1 the IAT correlates with explicit measures, in study 2 it does not.	Supports the validity of the IAT in consumer cognition. Absence of correlations with external criteria is interpreted as chance to measure processes which could not be measured with explicit measures.
Dimofte and Yalch (2007a, b)	empirical – assessing validity of the SMAART scale	Target stimuli: Cingular vs. Verizon Attribute stimuli: accessible vs. inaccessible	not reported	The SMAART (Secondary Meaning Access via Automatic Route) scale measures differences in the tendency to recognize multiple meanings in brand slogans. Participants who recognized the additional negative meaning of a brand slogan have more negative IAT-effects than participants who did not recognize the negative meaning.
Huang and Hutchinson (2008)	empirical - assessing validity of a new reaction-time measure	-	-	Evidence for the new implicit measure which predicts consumer attitudes. The new measure is compared to the IAT as a measure where consumers have little conscious control.
Raghunathan, Walker Naylor, and Hoyer (2006)	empirical	Target stimuli: unhealthy food vs. healthy food Attribute stimuli: enjoyable vs. not enjoyable	IAT-effects of participants who enjoy healthy food do not differ from those who enjoy unhealthy food.	Unhealthy food is implicitly associated with taste and enjoyment. The independence of the IAT-effects and explicit beliefs is interpreted as robustness of the association of unhealthy and tasty.

Forehand and Perkins (2005)	empirical	Target stimuli: celebrity vs. non-celebrity Attribute stimuli: pleasant vs. unpleasant and four brand IATs	not reported	The more consumers like a celebrity, the more they are influenced by their voice-overs, but only if they cannot identify the celebrity. The hypotheses are supported only by the explicit measures, suggesting that the processes require explicit evaluation.
Gibson (2008)	empirical	Target concepts: Coca Cola vs. Pepsi attributes: positive vs. negative	In study 1 the IAT correlated with explicit attitudes (.47-.55). In study 2 the explicit attitudes predicted forced choice, the IAT improved prediction under cognitive load.	Evaluative conditioning of Coca-Cola or Pepsi does not change explicit attitudes but changes IAT-effects when participants have no prior attitude toward Coca-Cola and Pepsi. It is concluded that the IAT predicts only spontaneous behavior.
Walker Naylor, Raghunathan and Ramanathan (2006)	empirical	Target stimuli: in-store promotions vs. other marketing material pleasant vs. unpleasant	not reported	Exposure to in-store promotions provokes a spontaneous evaluative response (measured by the IAT), suggesting that the IAT measures a spontaneous first evaluation.

TABLE 2: OVERVIEW OF METHODOLOGY AND VALIDITY ISSUES IN THE IAT

<table>
<tr><th>Validity Issue</th><th>Problematic Finding/Methodological Issue</th><th>Evidence</th></tr>
<tr><td rowspan="3">Construct Validity</td><td>IAT-effect is a relative measure and so probably not suited for predicting purchases</td><td>The IAT is a relative measure of associations (Brendl, Markman, and Messner 2001). For example, a relative preference of Coca-Cola over Pepsi could mean that one likes both soft drinks, but likes Coca-Cola a little bit more than Pepsi, or that one dislikes both soft drinks, but Coca-Cola a little bit less than Pepsi. Thus, the IAT allows for no conclusion about the attitude toward one soft drink alone (Brendl, Markman, and Messner 2005). It is therefore questionable whether the IAT can predict product purchase.</td></tr>
<tr><td>Associations ≠ attitudes</td><td>Several authors (e.g., Arkes and Tetlock 2004) argued that associations, whether implicit as measured by the IAT or explicit, do not necessarily indicate attitudes or preferences. For example, a human rights activist, like a racist, might associate poverty more with Black than White. The IAT might thus measure general cultural knowledge rather than individual preferences.</td></tr>
<tr><td>The IAT is not an implicit measure</td><td>Participants, when doing the IAT, can easily infer that it measures relative preferences of the two target concepts. In this respect the IAT is not an implicit measure (Fiedler, Messner & Blümke 2006). In other implicit measures (e.g., evaluative priming) what the procedure is intended to measure is not apparent to participants.</td></tr>
<tr><td>Predictive Validity</td><td>Low predictive validity</td><td>In most cases, explicit measures predict behavior better than the IAT (Greenwald et al. 2009). The authors conclude that the IAT possesses incremental validity beyond that of explicit measures.</td></tr>
<tr><td>Convergent Validity</td><td>Ambiguous evidence for convergent validity</td><td>While several researchers reported near to zero correlations between the IAT and other implicit measures (e.g., Bosson, Swann and Pennebaker 2000; Olson and Fazio 2003), Cunningham, Preacher, and Banaji (2001) reported satisfactory convergent validity.</td></tr>
</table>

Internal Validity	IAT-effects depend on which attribute stimuli are used	Sign and size of the IAT-effect depend on which attribute stimuli are used (e.g., Steffens and Plewe 2001; see also study 1 and 2). Furthermore, the IAT effect depends on how the categories are labeled (De Houwer 2001).
	IAT-effects might depend on stimulus familiarity	While several researchers concluded that IAT-effects are not impacted by stimulus familiarity (e.g., Dasgupta et al. 2000), Brendl, Markman, and Messner (2001) and Ottaway, Hayden, and Oakes (2001) found stimulus familiarity to influence IAT-effects.
	Alternative explanations for IAT-effects	Alternative accounts do not interpret IAT-effects as indicative of implicit preferences but as the result of a) category salience asymmetries (Rothermund and Wentura 2004), stimulus response compatibilities (De Houwer 2001), and response criterion shifts (Brendl, Markman, and Messner 2001).
	The IAT measurement model is not empirically supported	The way the IAT-effect is computed presumes that the more participants associate one target concept (e.g., Coca-Cola) with one attribute (e.g., pleasant), the more they associate the other target concept (e.g., Pepsi) with the other attribute (unpleasant), however, empirically this assumption is not supported (Blanton et al. 2006). Violation of this assumption can lead to serious distortions of IAT-effects (Stüttgen et al. 2009).
	Reliability too low for using the IAT as diagnostic test	Test-retest reliabilities (ranging from r = .16 to r = .69; Cunningham, Preacher, and Banaji 2001; Bosson, Swann and Pennebaker 2000) fall short of the psychometric property standards for diagnostic tests (Fiedler, Messner and Blümke 2006).
	IAT-effects not immune to social desirability and other situational influences	Participants can fake their IAT responses if they want to appear in a positive light (e.g., Czellar 2006). Also, reading a short story is sufficient to change the IAT effect (Foroni and Mayr 2005).
	IAT-effects contain common method variance	Nonsense IATs correlate with other IATs (Mierke and Klauer 2003)

Figure 1

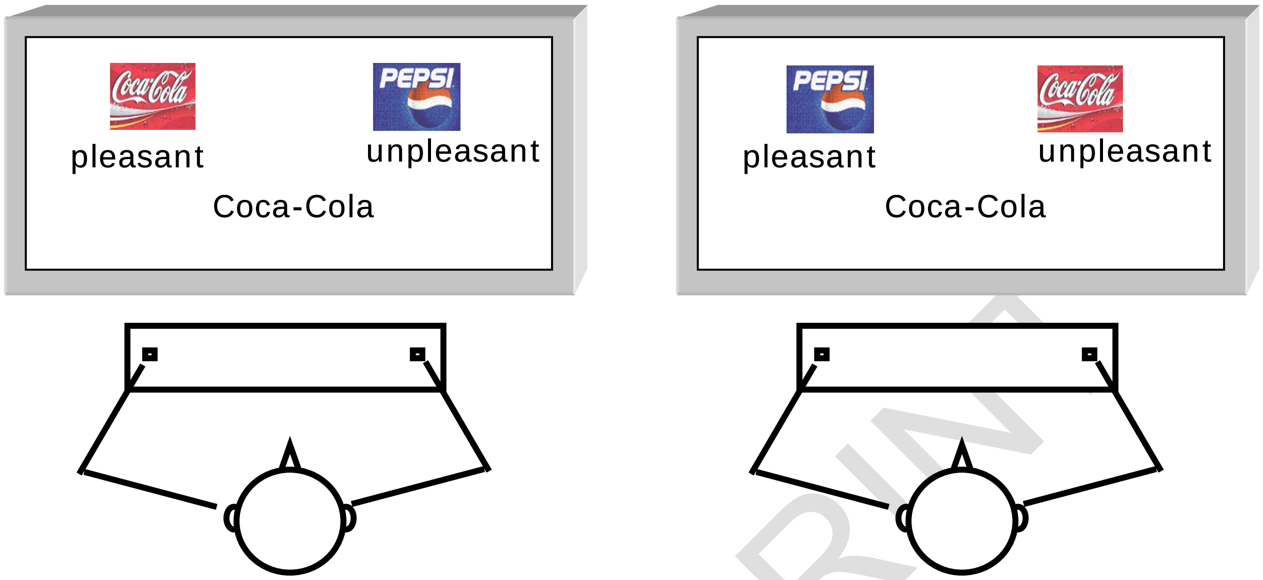

Figure 1. Schematic representation of the two IAT main-blocks.

Figure 2

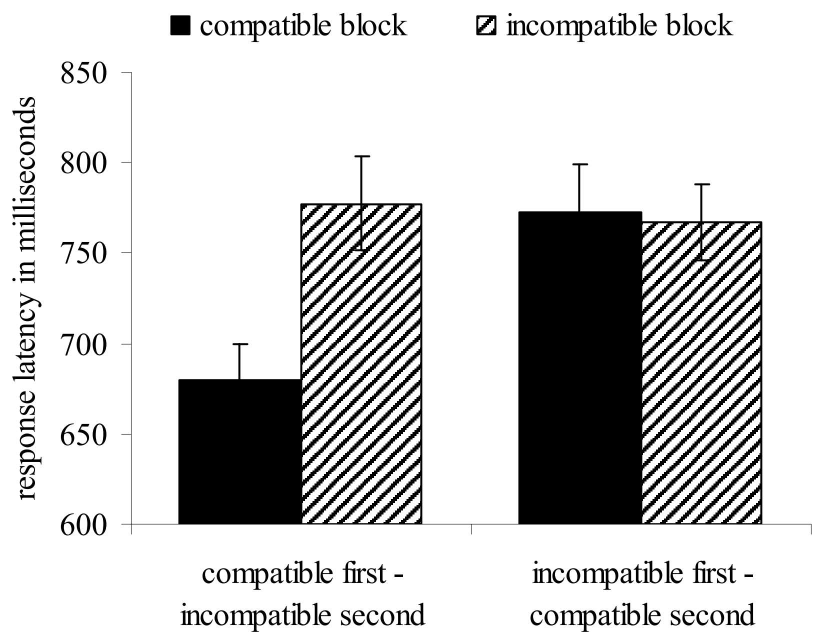

Figure 2. Mean response latencies of the compatible (Coca-Cola and pleasant) and the incompatible (Coca-Cola and unpleasant) block as a function of block-order (compatible block first vs. incompatible block first; error bars show standard errors).