CLAUDE MESSNER and JOACHIM VOSGERAU*

The authors review the implicit association test (IAT), its use in marketing, and the methodology and validity issues that surround it. They focus on a validity problem that has not been investigated previously, namely, the impact of cognitive inertia on IAT effects. Cognitive inertia refers to the difficulty in switching from one categorization rule to another, which causes IAT effects to depend on the order of administration of the two IAT blocks. In Study 1, the authors observe an IAT effect when the compatible block precedes the incompatible block but not when it follows the incompatible block. In Studies 2 and 3, the IAT effect changes its sign when the order of the blocks reverses. Cognitive inertia distorts individual IAT scores and diminishes the correlations between IAT scores and predictor variables when the block order is counterbalanced between subjects. Study 4 shows that counterbalancing the block order repeatedly within subjects can eliminate cognitive inertia effects on the individual level. The authors conclude that researchers should either interpret IAT scores at the aggregate level or, if individual IAT scores are of interest, counterbalance the block order repeatedly within subjects.

Keywords: implicit association test, cognitive inertia, validity, implicit attitudes, order effects

Cognitive Inertia and the Implicit Association Test

Marketing researchers are becoming increasingly interested in unconscious influences on consumer behavior (Fitzsimons et al. 2002). A central concept of this research is that implicit attitudes are “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 believed to offer better predictors of behavior than explicit (self-reported) attitudes because consumers might be unwilling to reveal their attitudes toward stigmatized behavior (e.g., racist attitudes) or might lack the ability to introspect correctly (Brunel, Tietje, and Greenwald 2004).

The implicit association test (IAT) provides the most popular tool for measuring implicit attitudes, presumably because it is characterized by a unique combination of impressive effect sizes and effortless implementation. The IAT initially appeared in social psychology studies (Greenwald, McGhee, and Schwartz 1998) and since then has been applied in research in clinical psychology (e.g., Teachman, Wilson, and Komarovskyka 2006), organizational behavior (Haines and Sumner 2006), law (Mitchell and Tetlock 2006), and marketing (Brunel, Tietje, and Greenwald 2004).

We first describe the IAT and its use in marketing and then review the methodology and validity issues that surround it. In the IAT, respondents sort target concepts (e.g., brand names) and positive and negative concepts into categories, such that the response latencies reveal their attitudes toward stigmatized behavior (e.g., racist attitudes) or might lack the ability to introspect correctly (Brunel, Tietje, and Greenwald 2004).

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constant, the distortions can bias the correlations between IAT scores and predictor criteria, and when the block order is counterbalanced between subjects, the distortions diminish the correlations between IAT scores and predictor criteria. In Study 4, we demonstrate that repeated counterbalancing of the block order within subjects can eliminate these cognitive inertia effects on the individual level. Therefore, researchers should either rely on aggregate IAT scores (i.e., at the group level) or counterbalance the block order repeatedly within subjects when they require individual IAT scores.

**THE IAT**

In the IAT, participants see stimuli presented sequentially on a computer screen and sort them 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 measures the implicit association strength between the target concepts Coca-Cola and Pepsi and the evaluative poles pleasant and unpleasant. Rather than brand names, the target concepts might feature the faces of white and black people, symbols representing homosexuality and heterosexuality, academic subjects such as math and history, and so on. There are virtually no limits to the concepts that the IAT can use to measure 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 appear in random order on the screen. Participants press the left key when they see a pleasant word and the right key when they see an unpleasant word. The instructions ask them to respond as fast as possible without making mistakes. The second practice block presents the target concepts, such as Coca-Cola and Pepsi, and participants receive instructions to press the left response key whenever they see Coca-Cola and the right response key when they see Pepsi. In a third practice block, the two word lists appear together. When a pleasant word or Coca-Cola appears, participants press the left response key; when an unpleasant word or Pepsi appears, they press the right response key.

The fourth block is the first main IAT block. The task is the same as in the third practice block (see Figure 1, Panel A), and the response latencies from this fourth block provide input for computing the IAT effect. The fifth block is another practice block, in which the allocation of the response keys to the target concepts switches, such that the left response key must be pressed for Pepsi and the right response key for Coca-Cola. In a sixth practice block, both word lists again appear together. If participants see a pleasant word or Pepsi, they are asked to press the left response key, and if they see an unpleasant word or Coca-Cola, they should press the right response key. That is, in contrast with the previous main block, Coca-Cola shares a response key with unpleasant words, and Pepsi shares a response key with pleasant words (see Figure 1, Panel B). The seventh and final block is the second IAT main block, with a task identical to that in the sixth practice block. As in the first main block (i.e., fourth overall block), the response latencies provide the input for computing the IAT effect.

According to the counterbalanced order of the two main blocks and their preceding practice blocks between subjects, half the respondents proceed through the block sequence 1–2–3–4–5–6–7, and the other half proceed through 1–5–6–7–2–3–4. The response latencies for each of the two main blocks are averaged. The main block with shorter response latencies is the compatible block, whereas that with longer response latencies is the incompatible block. The IAT effect equals the difference of the mean response latencies for the compatible and incompatible blocks. Therefore, if the compatible block pairs Coca-Cola with the pleasant stimuli (and Pepsi with the unpleasant stimuli), the IAT effect indicates the association of the attribute pleasant with the target Coca-Cola rather than the target Pepsi.

### Applications of the IAT

Researchers have used the IAT to produce an impressive amount of research on implicit attitudes (i.e., more than 300 published articles in psychology journals alone). Consumers can check their own implicit prejudice levels for various topics on the Project Implicit Web site (https://implicit.harvard.edu/implicit/), which categorizes individual IAT scores into no, slight, moderate, and strong automatic preferences.

The IAT also has attracted widespread media attention as a tool to uncover implicit racism (e.g., Gladwell 2005; *The Oprah Winfrey Show* 2007). Marketing consulting firms (e.g., Olson and Zaltman Associates) use the IAT as a measure of “true” preferences and brand associations, and IAT findings are currently informing the largest class-action employment discrimination case in history, brought against Wal-Mart by more than two million female employees (CNNNMoney.com 2007).

Marketing academic interest in the IAT is relatively recent and includes efforts to demonstrate its validity (e.g., Brunel, Tietje, and Greenwald 2004; Maison, Greenwald, and Bruin 2004) or the validity of alternative implicit measures (e.g., Dimofte and Yalch 2007a, b; Huang and Hutchinson 2008) in marketing contexts. Other researchers theoretically explore the dissociation between conscious and nonconscious processes in consumer behavior according to IAT findings (e.g., Cohen and Reed 2006; Fitzsimons et al. 2002; Hofmann, Strack, and Deutsch 2008; Peracchio and Luna 2006) and empirically show that manipulations either influence conscious processes but not the IAT (e.g., Forehand and Perkins 2005; Raghunathan, Walker Naylor, and Hoyer 2006) or affect the IAT but not conscious processes (e.g., Gibson 2008; Walker Naylor, Raghunathan, and Ramanathan 2006). Table 1 provides a detailed review of IAT-related marketing articles.
<table>
<thead>
<tr>
<th>Article</th>
<th>Type of Article</th>
<th>IAT Stimuli</th>
<th>Correlation of IAT with Explicit Measure</th>
<th>Summary/Interpretation of IAT Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hofmann, Strack, and Deutsch (2008)</td>
<td>Theoretical</td>
<td>—</td>
<td>—</td>
<td>Consumer behavior is driven by impulsive and reflective mechanisms. The IAT measures impulsive mechanisms.</td>
</tr>
<tr>
<td>Peracchio and Luna (2006)</td>
<td>Theoretical</td>
<td>—</td>
<td>—</td>
<td>Can the IAT measure a first spontaneous impression?</td>
</tr>
<tr>
<td>Cohen and Reed (2006)</td>
<td>Theoretical</td>
<td>—</td>
<td>—</td>
<td>A 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.</td>
</tr>
<tr>
<td>Czellar (2006)</td>
<td>Empirical: validity of the IAT</td>
<td>Target stimuli: prestige brand versus common brand. Attribute stimuli: pleasant versus unpleasant</td>
<td>—</td>
<td>The IAT is not resistant to self-representation. High self-monitoring participants can alter their IAT effects to agree with the opinion of others.</td>
</tr>
<tr>
<td>Maison, Greenwald, and Bruin (2004)</td>
<td>Empirical: validity of the IAT</td>
<td>Target stimuli: Danone versus Bakoma, McDonald’s versus milk bar, and Coke versus Pepsi. Attribute stimuli: pleasant versus unpleasant</td>
<td>In three studies, the IAT correlates with explicit measures, but explicit measures predict behavior better than the IAT.</td>
<td>The IAT is a valid measure of implicit brand attitudes.</td>
</tr>
<tr>
<td>Brunel, Tietje, and Greenwald (2004)</td>
<td>Empirical: validity of the IAT</td>
<td>Study 1 target stimuli: Mac versus PC and attribute stimuli: self versus other. Study 2 target stimuli: black versus white spokes-person and attribute stimuli: pleasant versus unpleasant</td>
<td>In one study, the IAT correlates with explicit measures, whereas in the other, it does not.</td>
<td>Supports the validity of the IAT in consumer cognition. Absence of correlations with external criteria indicates the chance to measure processes that could not be measured with explicit measures.</td>
</tr>
<tr>
<td>Dimofte and Yalch (2007a, b)</td>
<td>Empirical: Assess validity of the SMAART scale</td>
<td>Target stimuli: Cingular versus Verizon. Attribute stimuli: accessible versus inaccessible.</td>
<td>Not reported</td>
<td>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 exhibit more negative IAT effects than participants who did not recognize the negative meaning.</td>
</tr>
<tr>
<td>Huang and Hutchinson (2008)</td>
<td>Empirical: Assess validity of a new reaction time measure</td>
<td>—</td>
<td>—</td>
<td>New implicit measure of consumer attitudes is compared with the IAT as a measure of where consumers have little conscious control.</td>
</tr>
<tr>
<td>Raghunathan, Walker Naylor, and Hoyer (2006)</td>
<td>Empirical</td>
<td>Target stimuli: unhealthy versus healthy food. Attribute stimuli: enjoyable versus not enjoyable.</td>
<td>The IAT effects of participants who enjoy healthy food do not differ from those of people who enjoy unhealthy food.</td>
<td>Unhealthy food is implicitly associated with taste and enjoyment. The independence of the IAT effects and explicit beliefs indicates the robustness of the association between unhealthy and tasty.</td>
</tr>
<tr>
<td>Forehand and Perkins (2005)</td>
<td>Empirical</td>
<td>Target stimuli: celebrity versus non-celebrity. Attribute stimuli: pleasant versus unpleasant, with four brand IATs</td>
<td>Not reported</td>
<td>The more consumers like a celebrity, the more they are influenced by his or her voice-overs, but only if they cannot identify the celebrity. Only the explicit measures support the hypotheses, which suggests that the processes require explicit evaluation.</td>
</tr>
<tr>
<td>Gibson (2008)</td>
<td>Empirical</td>
<td>Target concepts: Coca-Cola versus Pepsi. Attribute stimuli: positive versus negative</td>
<td>In one study, the IAT correlates with explicit attitudes (.47–.55). In another study, the explicit attitudes predict forced choice, and the IAT improves prediction under cognitive loads.</td>
<td>Evaluative conditioning of Coca-Cola or Pepsi does not change explicit attitudes but alters IAT effects when participants have no prior attitude toward Coca-Cola or Pepsi. The IAT predicts only spontaneous behavior.</td>
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</table>
Methodology and Validity Issues Surrounding the IAT

Despite the massive number of IAT applications in psychology, organizational behavior, the law, and marketing, relatively few articles have identified the methodological issues and construct validity concerns that cast some doubt on the internal validity and predictive power of the IAT (see Table 2). These assessments reflect the correlation of IAT scores with other implicit measures (e.g., Bosson, Swann, and Pennebaker 2000); explicit self-reported measures (e.g., Brunel, Tietje, and Greenwald 2004); behavior, judgment, and choice (e.g., Maison, Greenwald, and Bruin 2004); and physiological measures (e.g., Cunningham et al. 2004). Two meta-analyses summarize the findings of hundreds of correlational studies. Specifically, Greenwald and colleagues (2009) analyzed 103 studies and find an average correlation of .27 across a range of behavior, judgment, and physiological measures. Hofmann and colleagues (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). High correlations might be evidence of the validity of the IAT (e.g., Greenwald, Nosek, and Banaji 2003; Nosek, Greenwald, and Banaji 2005), but some researchers argue that the IAT and explicit measures should not correlate highly, because they represent conceptually distinct concepts (e.g., Greenwald et al. 2002; Greenwald and Farnham 2000; Greenwald, McGhee, and Schwartz 1998). Shelton and colleagues (2005) even interpret a negative correlation as evidence in support of the validity of the IAT. In their study, black respondents preferred to interact with people classified as implicit racists by the IAT, which led these authors to argue that white people who are more racially biased must make more of an effort to control their racial bias in interactions with black people than white respondents who are less racially biased.

Theoretically, IAT scores should correlate more closely with behavior, judgment, and explicit measures when social associations, whether implicit as measured by the IAT or explicit, do not necessarily indicate attitudes or preferences (e.g., Arkes and Tetlock 2004). For example, a human rights activist and a racist both might associate poverty more with black people than with white people. The IAT might measure general cultural knowledge rather than individual preferences.

Construct validity

<table>
<thead>
<tr>
<th>Validity Issue</th>
<th>Problematic Finding/Methodological Issue</th>
<th>Evidence</th>
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<tbody>
<tr>
<td>The IAT effect is a relative measure and probably not well suited for predicting purchases.</td>
<td>The IAT is a relative measure of associations (Brendl, Markman, and Messner 2001). For example, a relative preference for Coca-Cola over Pepsi could mean the consumer likes both soft drinks but likes Coca-Cola a little bit more than Pepsi or that he or she dislikes both soft drinks but Coca-Cola a little bit less than Pepsi. Thus, the IAT allows for no conclusions about the attitude toward one soft drink alone (Brendl, Markman, and Messner 2005). It is questionable whether it can predict product purchase.</td>
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<tr>
<td>The IAT is not an implicit measure.</td>
<td>Participants can easily infer that the IAT measures relative preferences for the two target concepts, so the IAT is not an implicit measure (Fiedler, Messner, and Blümke 2006). In other implicit measures (e.g., evaluative priming), what the procedure is intended to measure is not apparent to participants.</td>
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<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). Greenwald and colleagues (2009) conclude that the IAT possesses incremental validity beyond that of explicit measures.</td>
</tr>
<tr>
<td>Convergent validity</td>
<td>Ambiguous evidence of convergent validity.</td>
<td>Several researchers reported nearly null correlations between the IAT and other implicit measures (e.g., Bosson, Swann, and Pennebaker 2000; Olson and Fazio 2003). Cunningham, Preacher, and Banaji (2001) report satisfactory convergent validity.</td>
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<tr>
<td>Internal validity</td>
<td>IAT effects depend on the attribute stimuli.</td>
<td>The sign and size of the IAT effect depend on the attribute stimuli (e.g., Steffens and Plewe 2001) and on how the categories are labeled (De Houwer 2001).</td>
</tr>
<tr>
<td>IAT effects might depend on stimulus familiarity.</td>
<td>While several researchers conclude that IAT effects are not affected by stimulus familiarity (e.g., Dasgupta et al. 2000), Brendl, Markman, and Messner (2001) and Ottaway, Hayden, and Oakes (2001) find that stimulus familiarity influences IAT effects.</td>
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<tr>
<td>Alternative explanations for IAT effects.</td>
<td>Alternative accounts do not interpret IAT effects as indicative of implicit preferences but as the result of category salience asymmetries (Rothermund and Wentura 2004), stimulus response compatibilities (De Houwer 2001), and response criterion shifts (Brendl, Markman, and Messner 2001).</td>
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<tr>
<td>The IAT measurement model is not empirically supported.</td>
<td>The computation of the IAT effect 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). Empirically, this assumption is not supported (Blanton et al., 2006), and the violation of this assumption can lead to serious distortions of IAT effects (Stüttgen et al. 2009).</td>
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<tr>
<td>Reliability too low to use the IAT as a diagnostic test.</td>
<td>The test–retest reliabilities (ranging from r = .16 to .69; Bosson, Swann, and Pennebaker 2000; Cunningham, Preacher, and Banaji 2001) fall short of the psychometric property standards for diagnostic tests (Fiedler, Messner, and Blümke 2006).</td>
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<td>IAT effects are not immune to social desirability and other situational influences.</td>
<td>Participants can fake their IAT responses if they want to appear in a positive light (e.g., Czellar 2006). Reading a short story is sufficient to change the IAT effect (Foroni and Mayr 2005).</td>
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<tr>
<td>IAT effects contain common method variance.</td>
<td>Nonsense IATs correlate with other IATs (Mierke and Klauer 2003).</td>
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</table>
Cognitive Inertia in the IAT

One reason for these inconclusive correlational results may be the systematic error contained in IAT scores. Specifically, IAT effects are typically stronger when the compatible block precedes the incompatible block (Greenwald, Nosek, and Banaji 2003; Hofmann et al. 2005). According to the logic of the IAT, however, the effects should be the same regardless of the block order because implicit attitudes should be invariant with respect to the instrument that measures them. The architect of the IAT, Anthony Greenwald, calls order effects the “most noticeable internal validity problem of the IAT” (Greenwald and Nosek 2001, p. 87).

As we show, order effects occur because of cognitive inertia, which is the difficulty of switching from one categorization rule in the first block to an opposite categorization rule in the second block. Cognitive literature refers to this as task-set inertia (Allport and Wylie 1999). Thus, cognitive inertia is akin to the depletion of mental resources in repeated choice decisions (Bruyneel et al. 2006; Pochepstaova et al. 2009).

Consider a Coca-Cola versus Pepsi IAT. Participants in the compatible block learn to associate Coca-Cola with pleasant words, but in the subsequent incompatible block, they must respond in the opposite direction and associate Coca-Cola with unpleasant words. Switching between these categorization rules is cognitively demanding and requires time and practice. All else being equal, cognitive inertia leads to slower responses in the second block, regardless of whether it is compatible or incompatible. Order effects 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 the responses in the subsequent incompatible block and augments the difference in the 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 the responses in the latter block (i.e., decreasing the IAT effect).1 We test this proposition in Study 1.

STUDY 1

Similar to Gibson (2008) and Maison, Greenwald, and Bruin (2004), we conducted an IAT using the target stimuli Coca-Cola and Pepsi. Six stimuli represented the pleasant attribute concept: success, energy, enjoyment, vivacity, relaxation, and happiness. For the unpleasant attribute concept, the six stimuli were inanimateness, depression, ugliness, inferiority, idleness, and disaster. We measured the explicit associations between the target and attribute stimuli by asking 51 participants to rate how strongly they associated Coca-Cola and Pepsi with each of the pleasant and unpleasant attribute stimuli.2 The paired comparisons show that participants associate Coca-Cola more strongly with the pleasant stimuli (mean rank = 25.84) than Pepsi (mean rank = 4.33; z = 5.90, p < .01). Similarly, they associate Coca-Cola less with the unpleasant stimuli than Pepsi (mean ranks = 21.98 and 19.11, respectively; z = 2.11, p < .05). Consequently, we expect an overall IAT effect in favor of Coca-Cola. We call the block in which Coca-Cola pairs with the pleasant attribute stimuli the compatible block and the block in which Coca-Cola pairs with the unpleasant attribute stimuli the incompatible block. As is typical in IAT studies, we varied the order of the blocks between subjects.

Method

Participants and design. The 51 participants, students at a European university (M(age) = 21.47, SD(age) = 4.60), were recruited for a consumer behavior study. As remuneration, participants received a voucher for approximately $6 at the university’s cafeteria. The experiment employed a 2 block (compatible versus incompatible, within-subjects) × 2 block order (compatible block first versus 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 trials, to test whether order effects continue despite learning over trials (Nosek, Greenwald, and Banaji 2005). Following Maison, Greenwald, and Bruin (2004), we labeled the target concepts with colored brand labels for Coca-Cola and Pepsi, and the attribute concepts took labels with the words “pleasant” and “unpleasant” (Figure 1).

Results

As is typical of IAT studies, the response latencies, measured in milliseconds, were log-transformed and averaged for the compatible and incompatible blocks; latencies for false, extremely fast (<300 milliseconds), and extremely slow (>3000 milliseconds) responses were discarded (Perkins et al. 2007). Our analyses are performed on these transformed latencies, but we report the means 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, we find an overall IAT effect (i.e., averaged across respondents) in favor of Coca-Cola (M = 40.57, SD = 104.20; t(50) = 3.33, p < .01, d = .47). We conducted an analysis of variance (ANOVA) of the influence of the independent variable block order (compatible versus incompatible block first, between subjects) on the IAT effect. As we hypothesized, the order of the

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1This line of reasoning also holds for a variant of the IAT, the so-called go/no-go association task (Nosek and Banaji 2001).

2The association ratings use 1024-pixel lines, ranging from “not at all” (0) to “very much” (1024). Because the association ratings are positively skewed, we tested for differences in association strength nonparametrically with Wilcoxon signed rank tests.
blocks has a significant impact ($F(1, 49) = 15.26, p < .01, d = 1.12$). An IAT effect in favor of Coca-Cola occurs when the compatible block appears first ($M = 93.53, SD = 111.14; t(24) = 4.41, p < .01, d = .88$), but we observe no IAT effect when the incompatible block is administered first ($M = -10.35, SD = 66.02; t(25) = .05, p = .96, d = .01$; see Figure 2). When we compute the IAT effects as the improved scoring D (Greenwald, Nosek, and Banaji 2003), the observed order effect grows stronger ($d = 1.67$).

**Cognitive inertia and learning curves.** The effects of cognitive inertia pertain to two levels: the outcome level, such that different IAT effects depend on the order of the blocks, and the process level, in the form of learning within blocks. Respondents learn to apply the categorization rules and become faster over time and trials, so order effects caused by cognitive inertia may wear off over repeated trials as a result of learning. To test this hypothesis, we analyze the learning curves within the two main blocks.

We modeled learning within each block using an exponential curve, $\ln(rt) = b + e^{-rx}$, 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, and $b$ is the base or level to which the curve converges.\(^3\) Faster learning (i.e., learning occurs only in the first trials and quickly converges to a reaction time base rate) induces a higher $r$. If the order effects vanish because of 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 administered second (whether compatible or incompatible) should converge at a higher level than the learning curve of the block that was administered first.

To capture the full learning curve for each main block, we included 24 practice trials preceding each block; because learning is nonlinear, most learning occurs in the beginning, during the practice trials. We created two new blocks, each with the 24 practice trials and the 144 main block trials (168 trials per block). We then divided the 168 trials into 21 measurements by averaging over 8-trial intervals.\(^4\) We estimated the parameters $b$ and $r$ with the SAS proc nlin (nonlinear) 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). Contr-
trary to the possibility that order effects would 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 = .0387). We provide further analyses of the learning curves in Web Appendix A (http://www.marketingpower.com/jmrapril10).

Discussion

In Study 1, we use a Coca-Cola versus Pepsi IAT, in which the pleasant stimuli associate more strongly with Coca-Cola than with Pepsi, and the unpleasant stimuli have a stronger association with Pepsi than with Coca-Cola. Accordingly, we observe an overall IAT effect in favor of Coca-Cola, though at the individual level, the IAT effects differ greatly. When the compatible block (Coca-Cola and pleasant words) precedes the incompatible block (Coca-Cola and unpleasant words), participants reveal an IAT effect in favor of Coca-Cola; when the order of the blocks is reversed, participants indicate no IAT effect at all.

This order effect occurs because switching from the application of one categorization rule in the first block to the application of the opposite categorization rule in the second block is cognitively demanding and requires time and practice. Cognitive inertia thus causes the second-administered block to prompt higher response latencies. When the faster compatible block comes first, cognitive inertia augments the difference in response latencies between the two blocks (i.e., enlarges the IAT effect). In contrast, when the incompatible block precedes the faster compatible block, cognitive inertia slows down responses (i.e., decreases the IAT effect). However, only the latencies of the compatible blocks seem to exhibit this difference; the latencies of the incompatible blocks appear equal. According to the cognitive inertia hypothesis, the incompatible latencies should have been greater when the incompatible block came second and smaller when the compatible block came first. In a replication of Study 1 (which we describe in Study 4’s discussion), we observe the hypothesized pattern for both compatible and incompatible blocks. Thus, it seems that the deviations from the hypothesized pattern in Study 1 are due to great variation in response latencies rather than to some systematic deviation from the hypothesized pattern. In conclusion, the results from Study 1 show that because of cognitive inertia, IAT effects typically are stronger when the compatible block is administered before the incompatible block.

With this strong influence of cognitive inertia on IAT effects, are there some conditions in which cognitive inertia produces IAT effects when none should be there? Presumably, this would occur when one target concept holds a stronger association with both the pleasant and the unpleasant attribute stimuli than the other target concept. In this case, no IAT effect would occur at the aggregate level, but cognitive inertia would augment reaction times for the block administered second and thus should sway the IAT effect in opposite directions, depending on the order of the blocks. The same reasoning holds if both target concepts are equally strongly associated with pleasant and unpleasant attribute stimuli. We designed Studies 2 and 3, respectively, to test these hypotheses.

STUDY 2

For 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’s (2006) findings 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; the pleasant attributes freedom, heaven, swimming pool, loyalty, ocean, and water are explicitly more strongly associated with Coca-Cola (mean rank = 25.49) than with Pepsi (mean rank = 9.50; \( z = 5.09, p < .01 \)). The unpleasant attributes bloodbath, anger, rage, aggression, violence, and injury are more strongly associated with Coca-Cola (mean rank = 25.25) than with Pepsi (mean rank = 15.00; \( z = 2.28, p < .05 \)). With this set of attribute stimuli, we expected not to find an overall IAT effect in either direction, because neither of the targets received favored associations with the attribute stimuli. However, cognitive inertia still should slow down the responses in the second block, resulting in an IAT effect in favor of Coca-Cola when the Coca-Cola and pleasant words block comes first but an IAT effect in favor of Pepsi when the Coca-Cola and unpleasant words block comes first.

Method

Forty-eight 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 was identical to that of Study 1 except for the pleasant and unpleasant stimuli.

Results

As expected, we find no overall IAT effect (M = –8.96, SD = 139.62; 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 versus 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 occurs when the Coca-Cola and pleasant words block appears first (M = 75.56, SD = 111.93; t(22) = 2.91, \( p < .01, d = .61 \)), but the IAT effect favors Pepsi when the Coca-Cola and unpleasant words block is administered first (M = –86.71, SD = 116.40; t(24) = 3.66, \( p < .01, d = .73 \); see Figure 4). When we compute IAT effects as the improved scoring D, the observed order effect strengthens (d = 1.57). We provide the analysis of cognitive inertia in the learning curves in Web Appendix A (http://www.marketingpower.com/jmrapril10).

Discussion

In Study 2, the participants associate Coca-Cola more strongly with both the pleasant and the unpleasant attribute stimuli than they do Pepsi. Thus, the target Coca-Cola is equivalent to a concept toward which respondents have an ambivalent attitude (De Liver, Van der Pligt, and Wigboldus 2006). We observe no overall IAT effect. However, on the individual level, we find an IAT effect in favor of Coca-Cola when the Coca-Cola and pleasant words block comes first and an IAT effect in favor of Pepsi when the Coca-Cola and unpleasant words block comes first.
These results have important implications for interpreting IAT effects in marketing contexts. Researchers typically interpret the absence of an overall IAT effect as evidence that both target concepts are equally strongly associated with pleasant and unpleasant stimuli. 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 because a concept can be more closely associated with both pleasant and unpleasant attributes than the other concept. For example, prominent brands are more likely to have pleasant and unpleasant associations and thus are more likely to be more ambivalent than less prominent brands. Testing brands with the IAT might indicate that one is more prominent than the other instead of identifying them as equally implicitly preferred.\(^6\)

**STUDY 3**

Study 3 tests whether cognitive inertia can produce IAT effects when both target concepts are equally strongly associated with the pleasant and unpleasant attribute stimuli. Furthermore, in Study 3, we attempt to demonstrate that order effects do not result from using a specific stimulus set. Several studies have shown that IAT effects crucially depend on the specific set of stimuli that represent pleasant and unpleasant attributes (e.g., Steffens and Plewe 2001). The differing results across Studies 1 and 2 support these findings. Therefore, in Study 3, we use the 25 pleasant and 25 unpleasant stimuli from the original IAT article (Greenwald, McGhee, and Schwartz 1998). We also increase the number of trials in the two critical IAT blocks from 144 to 200 to test whether cognitive inertia persists across trials.

The pleasant and unpleasant attribute stimuli come from Greenwald, McGhee, and Schwartz’s (1998) Experiments 1 and 2. As target stimuli, we used 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 (\(M = 2.29, SD = .73; M = 1.89, SD = .60\), respectively) than with 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 than in the first block, so we expected to find an IAT effect in favor of coffee when the coffee and pleasant words block is first and an IAT effect in favor of black tea when the black tea and pleasant words block is first.

**Method**

The 60 students of a European university (\(M(\text{age}) = 21.98, SD(\text{age}) = 3.23\)) who participated received either course credit or a box of chocolate worth approximately $5. The procedure of Study 3 is identical to those of Studies 1 and 2 except for the target and attribute stimuli and the 200 instead of 144 trials per block.

**Results**

As expected, we find no overall IAT effect (\(M = 3.20, SD = 99.03; t(59) = .06, p = .95, d = .01\)). We conducted an ANOVA with the independent variable block order (coffee and pleasant words block first versus coffee and unpleasant words block first, between subjects) on the IAT effect. As we 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 emerges when the coffee and pleasant words block appears first (\(M = 51.54, SD = 79.62; t(29) = 3.34, p < .01, d = .61\)), but we observe an IAT effect in favor of black tea when the coffee and unpleasant words block is first (\(M = -45.14, SD = 93.71; t(29) = 2.68, p < .05, d = .49\); see Figure 5). When we compute the IAT effects as the improved scoring D, the observed order effect becomes stronger (\(d = 1.92\)). We provide the analysis of cognitive inertia in the learning curves in Web Appendix A (http://www.marketingpower.com/jnrapril10).

**Discussion**

In Study 3, the target words “coffee” and “black tea” are equally strongly associated with the pleasant attribute words and equally weakly associated with the unpleasant attribute words. As a result, we observe no overall IAT effect. On the individual level, however, an IAT effect in favor of coffee occurs when the coffee and pleasant words block comes first, whereas the IAT effect favors black tea when the coffee and unpleasant words block appears first. This order effect does not vanish over trials, even with five times the number of trials per block than in a typical IAT. Because the attribute words representing pleasant and unpleasant stimuli are the same as those in the original IAT studies (Greenwald, McGhee, and Schwartz 1998), Study 3 provides strong support for the proposition that cognitive inertia causes order effects and reversals of IAT effects.

**Consequences of Order Effects and Circumventing Them**

Counterbalancing block order between subjects. To minimize the influence of order effects, researchers have advised

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\(^6\)We thank the editor for pointing out this implication.

\(^7\)We used five-point rating scales rather than the 1024-pixel lines because the pixel line scales do not seem to offer any advantage over traditional rating scales.

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counterbalancing the order of the two IAT blocks between subjects (e.g., Brunel, Tietje, and Greenwald 2004). Counterbalancing means that for half the participants, cognitive inertia inflates the IAT scores, whereas for the other half, it reduces the IAT scores. Thus, counterbalancing causes the order effects to cancel each other out at the aggregate level if there are equal numbers of respondents in each block order and cognitive inertia is equally strong in both order conditions. However, the individual IAT scores are still contaminated by the order effects. This contamination (statistically, noise) diminishes the correlations of the IAT scores with the predictor variables (i.e., increases Type II errors).

**Holding the block order constant.** Some researchers recommend holding the block order constant in investigations of individual IAT scores (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, which means that the average order effect is equal to half the difference between the two IAT effects. Individual IAT effects can be corrected by subtracting the average order effect in the compatible–incompatible block order or adding it in the incompatible–compatible block order. However, this correction assumes that cognitive inertia is equally strong in both block orders. Furthermore, it assumes no individual differences in cognitive inertia, an assumption that cognitive psychology literature shows is inaccurate. For example, younger people and people with high fluid intelligence switch tasks faster than older people or people with low fluid intelligence (e.g., Dulaney and Rogers 1994; Kray and Lindenberger 2000). These results are in accordance with Mierke and Klauer’s (2003) finding that nonsense IATs correlate with other IATs because of common method variance.

Because cognitive inertia varies between subjects, neither correcting for average order effects nor holding the block order constant can eliminate cognitive inertia effects on the individual level. In both cases, IAT scores become contaminated with individual cognitive inertia effects, and the correlations between the IAT and predictor criteria can be distorted (if block order remains constant) or diminished (with counterbalanced block order between subjects).

**Counterbalancing block order within subjects.** Manipulating the block order within instead of between subjects can reduce the individual cognitive inertia effects. For example, let C denote the compatible block of a given IAT and I the incompatible block. If the IAT uses the block sequence CIC and ICI, the first C and I block, respectively, are free of cognitive inertia. The two successive blocks I and C or C and I, respectively, instead reveal the effect of cognitive inertia. Thus, if the IAT effect were computed as the difference in response latencies between the last two blocks, cognitive inertia would appear in both blocks but work in opposing directions and thus cancel out. The IAT effects in this case should be free of order effects.

However, the first learned categorization rule, whether compatible or incompatible, might produce a stronger cognitive inertia effect than the categorization rule learned second. In this case, participants in the CIC sequence would 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. An order effect still would occur in the last two blocks of the CIC and ICI block sequences. Thus, eliminating individual cognitive inertia effects might require counterbalancing the 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 pairs with the pleasant stimuli and I denotes the block in which Coca-Cola pairs with the unpleasant stimuli. The other group received the complementary block sequence ICICI. When we use response latencies from the first two blocks to compute the IAT effect, we expect 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 expect a reduction of cognitive inertia effects.

**Method**

The 54 students of a European university (M(age) = 23.86, SD(age) = 4.84) who participated 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 preceded six additional blocks, namely, three main blocks (48 trials each) and three practice blocks (24 trials each; each of the three main blocks was preceded by a practice block). Half the participants completed the sequence CICIC, and the other half
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favor of coca-cola (m = 66.94, sd = 77.01; t(26) = 4.92, p < .01, d = 1.93), but in the ICICI sequence, we find no IAT effect (m = 11.03, sd = 94.06; t(25) = .68, p = .51, d = .27). As we hypothesized, the interaction of the IAT effect and block sequence is significant (F(3, 153) = 3.63, p < .05, \( \eta^2 = .067 \)), which indicates that cognitive inertia effects decrease over the four IAT effects (see Figure 6).

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 yields an effect for the order of the blocks (F(1, 51) = 15.25, p < .01, d = 1.09). In the CICIC block sequence, we find an IAT effect in favor of Coca-Cola (m = 87.12, sd = 86.40; t(26) = 5.33, p < .01, d = 2.09), whereas in the ICICI block sequence, we find no IAT effect (m = –12.18, sd = 105.82; t(25) = .46, p = .65, d = .19).

The planned comparison of the IAT2 effect again yields an effect for the order of the blocks, though smaller than in the previous case (F(1, 51) = 9.34, p < .01, d = .86). In the CICIC block sequence, we find an IAT effect in favor of Coca-Cola (m = 74.32, sd = 113.87; t(26) = 3.71, p < .01, d = 1.45), whereas in the ICICI block sequence, no IAT effect occurs (m = –5.80, sd = 96.52; t(25) = .28, p = .78, d = .11).

For the IAT3 effect, the order effect vanishes (F(1, 51) = 1.22, p = .28, d = .31). In the CICIC block sequence, we find an IAT effect in favor of Coca-Cola (m = 46.63, sd = 92.04; t(26) = 2.64, p < .05, d = 1.04), but in the ICICI block sequence, we find no IAT effect (m = 18.16, sd = 100.91; t(25) = .93, p = .36, d = .37).

Finally, we again find no block order effect for the IAT4 effect (F(1, 51) = .67, p = .42, d = .23). In the CICIC block sequence, the IAT effect favors Coca-Cola (m = 59.68, sd = 76.17; t(26) = 4.74, p < .01, d = 1.86), whereas in the

The experiment employs a 5 main block (first versus second versus third versus fourth versus fifth) \( \times 2 \) block sequence (CICIC versus 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, we find an overall IAT effect in favor of Coca-Cola (m = 39.51, sd = 89.56; t(52) = 3.59, p < .01, d = 1.00).

We then computed four IAT effects: IAT1 is the difference in response latencies between the first and second blocks, IAT2 denotes the difference in response latencies between the second and third blocks, IAT3 equals the difference between the third and fourth blocks, and IAT4 is the difference between the fourth and fifth blocks. (We compute all IAT effects by subtracting the mean response latency of the compatible block from the mean response latency of the incompatible block.)

We conducted an ANOVA with two independent variables, IAT effect (IAT1 versus IAT2 versus IAT3 versus IAT4, within subjects) and block sequence (CICIC versus ICICI, between subjects). The main effect for the block sequence becomes significant (F(1, 51) = 7.49, p < .01, d = .77). In the CICIC sequence, we observe an IAT effect in favor of Coca-Cola (m = 66.94, sd = 77.01; t(26) = 4.92, p < .01, d = 1.93), but in the ICICI sequence, we find no IAT effect (m = 11.03, sd = 94.06; t(25) = .68, p = .51, d = .27).

8 One participant achieved an average response latency of greater than 2000 milliseconds, which is more than three standard deviations away from the overall average of 790.25 milliseconds (sd = 237.96 milliseconds); we exclude this participant from the analyses.

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**Figure 6**

Mean IAT effects computed as the difference in response latencies of compatible and incompatible blocks

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Notes: Half the respondents proceeded through block sequence CICIC, and the other half received the block sequence ICICI. The four IAT effects equal the difference between the first and second, second and third, third and fourth, and fourth and fifth blocks within each sequence. Response latencies are in milliseconds, and the error bars show the standard errors.
ICICI block sequence, the IAT effect is 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 produces similar results.

**Discussion**

In Study 4, we manipulate the block order four times within subjects. In the first two blocks (i.e., equivalent to Study 1), we replicate the findings from Study 1, namely, an IAT effect in favor of Coca-Cola when the compatible block precedes the incompatible block but no IAT effect when the incompatible block precedes the compatible block. This order effect declines significantly 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, to our surprise, cognitive inertia proves extremely resilient, such that it takes three within-subjects variations of block order to render the order effects insignificant.

**GENERAL DISCUSSION**

Cognitive inertia, or the difficulty associated with switching between categorization rules across blocks, slows down responses in the second block. Thus, the IAT effects depend on the order of administration of compatible and incompatible blocks. When the compatible block precedes the incompatible block, cognitive inertia slows down responses in the second incompatible block and 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). Therefore, IAT effects are typically stronger when the compatible block precedes the incompatible block.

Study 2 (Coca-Cola versus Pepsi) and Study 3 (coffee versus black tea) show that when the associations with the pleasant and unpleasant attribute stimuli do not favor either target concept, cognitive inertia can produce IAT effects. For example, Coca-Cola is more strongly associated with both the pleasant and the unpleasant attribute stimuli than Pepsi in Study 2. Therefore, the target Coca-Cola is equivalent to a concept toward which respondents have an ambivalent attitude (De Liver, Van der Pligt, and Wigboldus 2006). As a result of cognitive inertia, the IAT effect favors Coca-Cola when the Coca-Cola and pleasant words block comes first but favors Pepsi when the Coca-Cola and unpleasant words block comes first. At the aggregate level, we observe no IAT effect.

These results have an important implication with regard to interpreting the IAT in marketing contexts. The absence of an overall IAT effect typically implies that both target concepts are equally strongly associated with pleasant and unpleasant stimuli. However, the results of Study 2 demonstrate that the absence of an IAT effect can mean one target concept is more ambivalent than the other, such that it is more closely associated with both pleasant and unpleasant attributes than the other concept. Prominent brands often have both associations, which implies that they are likely to be more ambivalent than less prominent brands. Testing brands with the IAT might indicate which is more prominent rather than showing that they are equally implicitly preferred.

As we show in Studies 1–3, cognitive inertia introduces so much systematic error in IAT measures that it can eliminate (Study 1) or reverse (Studies 2 and 3) individual IAT effects. The common practice of counterbalancing the block order between subjects cancels out the order effects at the aggregate level (when an equal number of participants view both block orders), but on the individual level, IAT scores still suffer the contamination of cognitive inertia effects. Therefore, researchers should not use individual IAT scores in a between-subjects block order manipulation. Correlations between the IAT scores and predictor criteria will be unbiased but diminished in this case. Another way to control for order effects is to hold the block order constant, though we advise against this practice, because correlations between IAT scores and predictor criteria will be biased if cognitive inertia happens to correlate with the predictor criteria.

Manipulating block order repeatedly within subjects can reduce individual cognitive inertia effects. This effort might be helpful for research focused on individual IAT scores (i.e., IAT as a diagnostic instrument) or studies that attempt to validate the IAT by correlating it with predictor criteria. We advise manipulating the block order at least four times within subjects to reduce or eliminate the impact of the individual cognitive inertia effects. However, cognitive inertia is not the only methodological issue that can reduce the validity of the IAT (Table 2). In Web Appendix B (http://www.marketingpower.com/jmrapril10), we provide a guide to best practices for IAT research, including suggestions for addressing most of the methodological and validity issues.

**REFERENCES**


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