# Assessment of Individual Differences in Implicit Cognition

## A Review of IAT Measures

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**Abstract.** This review discusses basic features of Implicit Association Tests (IATs) that are relevant in order to estimate their suitability of IATs for the valid assessment of individual differences. We start with a description of the essential characteristics of the procedures of IATs and also refer to theoretical accounts for IAT effects. Then, we provide an overview of research on the psychometric properties of IATs including their reliability and incremental validity for the prediction of behavior over and above explicit measures. Finally, we describe some alternatives to IAT measures and offer an outlook for future research.

**Keywords:** Implicit Association Test, implicit measures, explicit measures, social cognition, automaticity

## Introduction

Assessment procedures that avoid explicit questionnaire or interview methods have always been highly attractive to both laypersons and professional psychologists. Social cognition research made evident the reasons for this attractiveness by describing two main limitations of explicit assessment methods (Greenwald & Banaji, 1995). First, explicit measures can be biased by self-presentation strategies. Second, explicit measures are bound to introspective limits. Introspective limits can be explained by dual-process models (e.g., Strack & Deutsch, 2004) as differences between a propositional and an associative system of information processing. The propositional system corresponds to explicit reasoning processes and operates consciously but slowly. The associative system corresponds to spread of activation processes and operates quickly but with limited conscious accessibility.

New implicit measurement procedures, most prominently the Implicit Association Tests (IATs; Greenwald, McGhee, & Schwartz, 1998), aim to provide access to automatic associative processes and to overcome the main limitations of explicit self-report. We refer to IATs in the plural in order to make obvious that they can be adapted to various assessment domains and represent a general procedure rather than a specific test. In this review, we first describe the essential characteristics of IAT procedures and briefly discuss theoretical accounts for IAT effects. Then, we review research on the psychometric properties of IATs including their reliability and their predictive validity over and above explicit self-report measures (incremental validity). Finally, we describe some alternatives to IAT measures and offer an outlook for future research.

## IAT Procedures

IAT procedures aim to assess automatic associations between a bipolar target (e.g., *me* vs. *others*) and a bipolar attribute (e.g., *shy* vs. *sociable*) concept through a series of sorting tasks that require quick responses. Quicker responses are expected when highly associated concept poles are mapped onto identical instead of different response keys. For instance, a shyness IAT starts by training participants to press the left response key when a *me* word appears on the screen and the right response key when an *others* word appears on the screen. In the following block, participants are trained to press left for *shy* words and right for *sociable* words. The next block combines both discrimination tasks, and participants are instructed to press left for *me* or *shy* and right for *others* or *sociable*. The following block is again a single discrimination task and reverses the target discrimination such that *others* words are assigned to the left and *me* words are assigned to the right response key. The final block again combines the attribute and the previously reversed target discrimination, and participants press left for *others* or *shy* words, and right for *me* or *sociable* words. The order of the combined blocks may be counterbalanced across participants such that, for instance, either the categories *me* + *shy* and *others* + *sociable* or the categories *me* + *sociable* and *others* + *shy* are paired first. Counterbalancing block order is recommended in order to control for the effect that IAT scores tend to show stronger associations for the categories that are paired first (Greenwald et al., 1998; for a more detailed discussion concerning the experimental variation of procedural variables, see Schnabel, Asendorpf, & Greenwald, 2008).

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Only the combined tasks are used for the calculation of IAT scores (IAT effects). Scores are calculated as the difference in mean response latencies of the second minus the first combined task. For instance, if participants are faster in combining *me* + *shy* and *others* + *sociable* relative to the reverse combined task, they show small latencies in the first and long latencies in the second combined task. Overall, this results in a positive IAT score. According to the IAT's logic (Greenwald et al., 1998), positive scores in this example reflect stronger associations for *me* + *shy* and *others* + *sociable* relative to *me* + *sociable* and *others* + *shy*. As a modification of this raw score, Greenwald, Nosek, and Banaji (2003) presented an improved scoring algorithm for computing an interrelated set of D measures. D measures are individually calibrated by each participant's standard deviation of response latencies (see Lane, Banaji, Nosek, & Greenwald, 2007, or Schnabel et al., 2008, for a more detailed description) and were shown to enhance internal consistencies, correlations with self-report measures, and resistance to extraneous factors (e.g., general response speed). Internal consistency is usually estimated as split-half reliability over difference scores that are calculated separately for different test-halves.

## Accounts for the IAT Effect

The degree to which target and attribute categories share similar features plays a key role in many accounts of the IAT effect. The basis of similarity can be associations as well as other aspects such as stimulus familiarity or word length. These alternative sources of similarity need to be controlled for if one aims to assess associations. Similarity between categories is assumed to facilitate combined IAT tasks that require the identical response key for two categories (De Houwer, Geldof, & De Bruycker, 2005). De Houwer (2003a) attributed this facilitation effect to a *stimulus-response compatibility* mechanism and claimed that target and attribute information elicit synergistic response tendencies if similar categories are mapped on the same response key. In contrast, if dissimilar categories are mapped on the same response key then response tendencies for target and attribute categories are antagonistic to each other.

In a similar vein, the *task-switching* account by Mierke and Klauer (2001, 2003) states that the pairing of dissimilar categories requires participants to switch between target and attribute discrimination. In contrast, participants only need to consider attribute-related information if associated categories are paired with each other. Several studies have shown that task-switching costs (greater costs, i.e., slower responses, in tasks pairing categories that are not well associated) represent an important component of the IAT effect (Mierke & Klauer, 2001, 2003). Additionally, individual differences in task-switching ability were shown to represent a small portion of method-specific IAT variance that was independent of the associations being measured (Back, Schmukle, & Egloff, 2005; Teige-Mocigemba, Klauer, Rothermund, 2008).

Other well-replicated accounts point out that features of both the category labels and the individual stimuli contribute to the overall IAT effect (e.g., Steffens & Plewe, 2001; for a more detailed review on different accounts, see Schnabel et al., 2008). More recent efforts use the latency and/or error data of IAT responses to estimate different process components of implicit task performance through mathematical models. The quad model (Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005) hypothesizes four distinct components and refers to an automatic process (association activation), two rather effortful processes (ability to discriminate the stimuli and ability to overcome automatic associations), and a general guessing bias. The IAT diffusion model analysis (Klauer, Voss, Schmitz, & Teige-Mocigemba, 2007) separates three distinct components. The first component compares ease and speed of information accumulation between the two combined IAT tasks. This component is significantly related to explicit attitude ratings. The second component compares speed-accuracy settings and is strongly related to method variance caused by differential task-switching abilities. The third component refers to the nondecision components of processing (e.g., response execution) that contribute to the IAT effect. Although the first component did not show incremental validity over the IAT D measures, the diffusion model analysis provides a theory-based means to partial out construct-irrelevant variance in IAT effects. In order to estimate the usefulness of the quad-process and the diffusion models, further studies are needed to show the reliability of the different process components.

# Psychometric Properties of IATs

Judging the suitability of IATs for assessment purposes means evaluating whether IATs meet relevant psychometric criteria and contribute significantly to the prediction of behavior. In this section, we review psychometric properties of IAT measures and refer particularly to the question of whether IATs show incremental validity over and above direct self-report measures.

## Reliability

IAT measures typically show internal consistency estimates between .70 and .90 (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005; Nosek, Greenwald, & Banaji, 2006). Such scores are psychometrically satisfactory and much higher than those found for other latency-based measures (e.g., Bosson, Swann, & Pennebaker, 2000). In contrast, the test-retest reliabilities of IATs were less satisfactory, and showed a median of .56 across different studies (Nosek et al., 2006). Retest reliabilities

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seem to be rather unaffected by whether the retest is completed immediately or after a time span of up to 1 year (Egloff, Schwerdtfeger, & Schmukle, 2005). The discrepancy between satisfactory internal consistencies and smaller retest reliabilities indicates that IATs capture both stable and occasion-specific variance. Currently, the sources of the systematic occasion-specific variance remain unclear.

## Fakability

Several studies have shown that IATs are fakable, although much less so than explicit self-reports (e.g., Fiedler & Bluemke, 2005; Schnabel, Banse, & Asendorpf, 2006a; Steffens, 2004). If participants are informed beforehand about how to fake, fakability increases (Kim, 2003). Faking also appears when participants are asked to pretend to have attitudes toward fictitious target objects that they did not know previously (De Houwer, Beckers, & Moors, 2007). However, faking is a threat to the validity of IATs only if different individuals fake to a different degree. Differential faking effects alter the rank order of participants' IAT scores and affect their correlations with external validation criteria that are resistant to faking attempts. Schnabel et al. (2006a) explored differential faking effects on implicit and explicit shyness measures using observer judgments of shyness as validation criterion. Faking instructions significantly reduced the predictive validity of explicit but not of implicit shyness measures. In sum, IATs were shown to be more robust against faking instructions than explicit self-report measures with regard to both mean and differential faking effects. The slight fakability of IATs suggests that they do not solely assess the strength of automatic associations. This is in line with results for the quad-process component model that showed that IATs are also influenced by controlled efforts to reduce automatic biases (Conrey et al., 2005). Future studies should aim at improving the IATs' resistance to faking attempts or develop algorithms that allow to empirically separate honest and faked IAT performance.

## Validity

### Convergent and Discriminant Validity with Implicit Measures

Correlations between IATs and other implicit measures are typically weak (e.g., Bosson et al., 2000). This can be attributed to the unsatisfactory reliabilities of other implicit measures such as priming procedures (Banse, 1999), the Go/No-go Association Task (GNAT; Nosek & Banaji, 2001), and the Extrinsic Affective Simon Task (EAST; De Houwer & De Bruycker, 2007; Teige, Schnabel, Banse, & Asendorpf, 2004). For a different implicit measure, the Implicit Association Procedure (IAP), correlations with an IAT were considerably higher (up to .50) and in the range of the IAT's and the IAP's retest reliability (Schnabel et al., 2006a). Like the IAT, the IAP measures relative association strengths and compares the latencies of two combined discrimination tasks. In contrast to the IAT, the IAP requires joystick movements toward or away from the participant instead of pressing two response keys. Because of the methodological similarities between IAP and IAT, their correlation of approximately .50 may represent an upper bound to the construct validity, suggesting substantial method variance in IATs and related measures. A recent study by Steffens, Kirschbaum, and Glados (in press) revealed a correlation of .29 between a response-window priming task and an IAT variant that used the concept categories as stimuli. In order to establish the convergent validity of IATs with other implicit measures at a level that is satisfactory for individual assessment purposes, higher implicit-implicit correlations still need to be shown.

### Convergent and Discriminant Validity with Explicit Self-Report Measures

Two meta-analyses over various content domains (including self-concept, attitude, and stereotype IATs) revealed average correlations between IATs and explicit self-reports of .24 (Hofmann, Gawronski et al., 2005) and .37 (Nosek, 2005). The somewhat higher correlations in Nosek's meta-analysis may stem from the fact that these data refer to attitude domains that show higher implicit-explicit consistency. Additionally, Nosek used only relative feeling thermometers as explicit measures, which may better correspond with the IAT as they tap more directly into an affective component. In order to organize moderators of implicit-explicit consistency, Hofmann, Gschwendner, Nosek, and Schmitt (2005) developed a process model with five primary factors. The *translation factor* deals with implicit-explicit correspondence at the representational level and refers to aspects like representational strength, dimensionality, social distinctiveness, and awareness. Higher implicit-explicit consistency is associated with representations that are strong and subjectively important, bipolar rather than unipolar, distinct from other individuals, and introspectively accessible (see Nosek, 2005). According to the factor *additional information integration*, implicit-explicit consistency is higher if explicit self-reports are generated spontaneously and with minimal use of cognitive resources. The factors *implicit assessment* and *explicit assessment* deal with reliability and method-specific variance (e.g., fakability) of implicit and explicit measures. Finally, *design factors*, such as lack of conceptual correspondence between implicit and explicit measures and variance restriction because of sampling biases, are associated with low implicit-explicit consistency.

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### Predictive Validity for Behavioral Measures

A recent meta-analysis (Greenwald, Poehlman, Uhlmann, & Banaji, in press) found compelling evidence for the predictive validity of IATs (and explicit measures) across various behavioral domains. Differently from IAT measures, the predictive validity of explicit measures was reduced in socially sensitive domains such that IATs showed better predictive validity than explicit measures in studies dealing with stereotypes and prejudice. In contrast, predictive validity was smaller for IATs than for explicit measures in studies that explored brand preferences or political attitudes.

In order to organize different models of predictive validity for implicit and explicit measures, Perugini (2005) distinguished between three different types: the additive, the multiplicative, and the double-dissociation model. All three models postulate that implicit measures show incremental validity and increase the prediction of behavior. According to the additive model, implicit and explicit measures explain separate portions of variance of a relevant criterion (e.g., Schnabel et al., 2006a; Schnabel, Banse, & Asendorpf, 2006b). According to the multiplicative model, implicit and explicit measures interact in predicting relevant behavioral criteria (e.g., Schröder-Abé, Rudolph, Wiesner, & Schütz, 2007a, 2007b). According to the double-dissociation model, implicit measures predict spontaneous behavior whereas explicit measures predict controlled behavior (e.g., Egloff & Schmukle, 2002; McConnell & Liebold, 2001; see also Friese, Hofmann, & Wänke, in press).

Using shyness as an example, Asendorpf, Banse, and Mücke (2002) confirmed a full and strong double-dissociation model. Explicit self-reports uniquely predicted indicators of controlled but not spontaneous shy behavior, whereas the IAT uniquely predicted indicators of spontaneous but not controlled shy behavior. The double-dissociation model is an excellent way to show the unique validity of the IAT for the prediction of spontaneous behavior because double-dissociation patterns can rule out invalidity of the corresponding explicit measure.

It should be noted that many studies explored the predictive validity of IATs with attribute concepts that are confounded with positive and negative valence (e.g., anxious vs. calm, shy vs. nonshy). Therefore, it is currently unclear to what extent responses in these IATs are based on the specific semantic meaning or on the general positive and negative valence of the attribute categories (see Schnabel et al., 2006b). In an attempt to disentangle both influences, Amodio and Devine (2006) successfully separated stereotyping and evaluation effects in implicit race biases. They used both evaluative (pleasant vs. unpleasant) and stereotyping (mental vs. physical) race IATs and showed discriminant behavioral validity for both IATs. In a similar vein, Perkins and Forehand (2006) separated influences of valence and semantic meaning in self-concept IATs and showed independent effects for both the semantic meaning of personality describing attributes and their positive or negative valence. Future studies should continue to disentangle valence from semantic influences in IATs.

## Alternative Implicit Procedures

Research on the assessment of implicit attitudes, stereotypes, and self-representations was largely stimulated by the development of priming procedures (for a review, see Fazio & Olson, 2003), such as the affective priming task (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Interest in IAT measures was promoted by their relatively large effect sizes (Greenwald et al., 1998) and satisfactory internal consistencies (see above). Alternatives to IAT measures were developed mainly because of two specific features of the original IAT procedure. First, IATs require two bipolar concepts with two categories for each concept. Second, IATs are restricted to the assessment of relative association strengths. For instance, a positive score in the standard flower-insect IAT does not reflect positive attitudes to flowers and negative attitudes to insects but rather more positive attitudes to flowers relative to insects.

It should be noted that many social objects do have natural counterparts (e.g., males vs. females, me vs. others), and that questionnaires, especially personality questionnaires, typically imply comparisons with a referential group or referential objects. Additionally, recent studies by Olson, Goffin, and Haynes (2007) indicated that relative explicit attitudes that involved a comparison with other people showed higher predictive validity than absolute attitude measures. Nevertheless, there are cases where associations with unipolar concepts are the matter of interest. Single Category IATs (SC-IATs; Karpinski & Steinman, 2006; Nosek & Banaji, 2001; Penke, Eichstaedt, & Asendorpf, 2006) use one unipolar (e.g., "Coke") and one bipolar concept (e.g., *positive* vs. *negative*) and were developed for the assessment of associations with concepts that do not have a natural complement (e.g., brands, partners). Several SC-IATs showed satisfactory internal consistencies and significant or even higher implicit-explicit correlations as compared to corresponding conventional IAT procedures (Boldero, Rawlings, & Haslam, 2007; Karpinski & Steinman, 2006; Penke et al., 2006). However, some SC-IAT procedures also failed to show satisfactory psychometric properties (Nosek & Banaji, 2001), which may be explained by the fact that SC-IAT tasks can be facilitated by concentrating on the single category. Remember that in SC-IAT tasks one response key is assigned to the joint category (e.g., *Black* + *positive*) whereas the other key is assigned to the single category (e.g., *negative*). If participants ignore the joint category and base their responses on the single category alone, the SC-IAT no longer assesses associations between the joint categories but rather speed of identification of the single category. Thus, a lot of questions need to

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be answered before SC-IATs may be judged superior to the standard IAT procedure.

As a measure of associations between two unipolar categories, Blanton, Jaccard, Gonzales, and Christie (2006) developed the Single Association Test (SAT). In the SAT tasks, one target (e.g., *Black*) and one attribute category (e.g., *pleasant*) is contrasted to two neutral control categories (e.g., *furniture* and *middle*). Decomposing concept associations of a race IAT, Blanton and colleagues assessed association strengths between the concept categories separately in different tasks. Results showed that only response latencies of the *Black + negative* task but not of the other three tasks (i.e., *Black + positive*, *White + negative*, and *White + positive*) were significantly related to explicit racism. Unfortunately, Blanton and colleagues did not directly compare the SAT results with results from an IAT, nor did the authors report reliabilities for the SAT scores. Therefore, further evidence is necessary to show the suitability of the SAT method (see Nosek & Sriram, 2007). In a similar way as for SC-IATs, the validity of SATs may be threatened by participants concentrating on the nonrelevant categories (e.g., *furniture* and *middle* instead of *Black + negative*).

The extrinsic affective Simon task (EAST) was presented by De Houwer (2003b). Like the IAT, the EAST requires the categorization of two concepts but in the EAST only one concept is categorized according to its relevant feature (e.g., *positive* vs. *negative*) whereas the second concept (e.g., *female* vs. *male*) is categorized according to a nonrelevant feature (e.g., *green* vs. *red*). Depending on the nonrelevant feature, categories of the second concept mutually share response keys with one category of the first concept. The EAST score reflects which of the two pairings is completed quicker or with less mistakes. In theory, the EAST also allows single or even multiple categories for the second concept. However, with few exceptions (Ellwart, Becker, & Rinck, 2005; Huijding & de Jong, 2005), internal consistencies of the EAST have proven to be rather unsatisfactory (De Houwer, 2003b; De Houwer & De Bruycker, 2007; Teige et al., 2004).

Better psychometric properties were shown for the Affect Misattribution Procedure (AMP; Payne, Cheng, Govorun, & Steward, 2005) that represents a variant of the affective priming task. The AMP requires participants to judge the visual pleasantness of neutral Chinese characters. The characters are preceded by ostensibly irrelevant primes (positive, negative, or neutral stimuli). Results revealed that pleasantness judgments of the Chinese characters were nevertheless influenced by the valence of the primes (misattribution effect) in an internally consistent way and that the judgments correlated with self-reported attitudes to the prime. The AMP seems to be quite flexible in terms of its adaptability to unipolar or multiple-target concepts. However, the procedure seems to be quite susceptible to faking attempts because the dependent variable is calculated from explicit pleasantness judgments rather than response latencies. Also, the AMP appears to be confined to the assessment of valence associations. Additional research is necessary to show the validity of the AMP for the prediction of behavior.

Recently, two IAT variants were proposed that aim to reduce the number of necessary trials while preserving satisfactory psychometric properties. First, Multifactor Trait IATs (MFT-IATs; Greenwald, 2005; for a brief description see Banse & Greenwald, 2007) allow for the assessment of multiple constructs such as the Big Five. The Big Five MFT-IAT uses *me* vs. *others* as target categories and one Big Five dimension (e.g., Agreeableness) vs. a joint category of the remaining Big Five dimensions (Emotional Stability, Extraversion, Openness, Conscientiousness) as attribute categories. This brings the important benefits that (a) valence confounded attribute concepts like *agreeable* vs. *disagreeable* are avoided and (b) only 5 out of 10 possible category contrasts need to be realized. Second, Brief IATs (Sriram & Greenwald, 2007) abbreviate the number of trials by the two strategies of (a) omitting the single-task practice blocks and (b) in the combined blocks, instructing respondents to focus on just two relevant categories (e.g., *me* and male) by pressing the match key and to give a mismatch response with a different key to the remaining categories (e.g., *others* and female). The second combined block uses different focal (e.g., *me* and female) and mismatch categories (e.g., *others* vs. male). Thus, Brief IATs concentrate the procedure on the relevant associations (e.g., associations with *me* instead of with *others*) and reach satisfactory reliability and validity with fewer trials.

## New Prospects for the Prediction of Behavior

IATs add incremental validity over and above explicit questionnaire measures, especially in domains where the validity of explicit assessments is limited. These are socially sensitive domains like prejudice and stereotyping (Greenwald et al., in press) as well as domains that refer to automatic or spontaneous behavior (e.g., Asendorpf et al., 2002). IATs offered new prospects for the prediction of behavior and immediately became a fascinating and widely used research tool. Nevertheless, it is still premature to approve the use of IATs as tools in personnel selection and other areas of individual diagnosis, partly because of the moderate retest reliability of IATs and partly because of the likelihood that training may permit controlled processes to suppress the effects of automatic associations on behavior.

Current approaches deal with individual and situational factors that moderate the validity of implicit and explicit measures. For instance, cognitive control resources (working memory capacity) as an individual differences factor were shown to moderate the predictive validity of implicit and explicit alcohol-related cognitions (Thush et al., in press). Implicit alcohol-related cognitions predicted drinking behavior in participants with lower levels of working

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memory capacity, whereas explicit alcohol-related cognitions predicted drinking behavior in participants with higher levels of working memory capacity. An example for the influence of situational factors is a study by Perugini and Prestwich (2007) showing that IATs predicted relevant behavior only if the attitudes measured by the IATs were activated before the behavior was assessed. Other examples of situational moderators are self-regulatory resources that were made available or unavailable by experimental manipulations and consequently decreased or increased the predictive validity of implicit measures (Friese et al., in press; Hofmann, Rauch, & Gawronski, 2007). Together with many other studies that are cited in this review, these results make evident that meaningful dissociations between implicit and explicit measures can be found in various fields.

IATs provide access to individual differences in implicit cognition that are not captured by explicit measures. A large international internet project (http://implicit.harvard.edu) offers opportunities to complete IATs in a variety of languages (presently 15), and provides further evidence for the pervasiveness of implicit preferences and stereotypes (Nosek et al., 2007). The forthcoming "teenage years" of IATs promise to be just as exciting as their early years in many ways.

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