# Using indirect measurement tasks to assess the self-concept of personality:

A systematic review and meta-analyses

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### Abstract

This systematic review presents the current state of research investigating the implicit self-concept of personality. First, we present results on meta-analyses estimating internal consistency, reliability coefficients, the implicit-explicit consistency and the single association predictive effect of implicit self-concept of personality measures. To do this, studies were aggregated over personality domains. Second, for each of the Five Factor personality domains, different aspects of construct validity and predictive validity are reviewed in a narrative way. Results show that implicit self-concept of personality measures are reliable, and there is evidence for the construct and predictive validity of these implicit measures, especially in the extraversion and agreeableness domains of personality. However, it must be kept in mind that clear evidence for publication bias was found for studies examining the single association predictive pattern. Finally, this systematic review identifies some achievable improvements that are needed in future research. Large cross-lab efforts are important in this respect. Moreover, the implicit self-concept of personality field must move from an "ad hoc" to a "validation" approach in developing new indirect measurement tasks. By adopting these research objectives, the information processing account of personality will increase its potential to become integrated into mainstream personality theory and research.

Key words: systematic review, meta-analysis, self-concept, personality, implicit measures

Human beings consider it important to gain insight into their person(ality). Unfortunately, research has demonstrated that we can have blind spots with respect to the behavioural manifestations of our selves (e.g., Hofmann, Gschwendner, & Schmitt, 2009; Hofmann & Wilson, 2010; Wilson, 2002; Wilson & Dunn, 2004). According to psychoanalytic tradition, humans lack self-knowledge because they are motivated to keep unpleasant and anxious thoughts/feelings outside awareness. The more contemporary view on the failure of self-knowledge holds that much of the information that people capture with their senses is processed outside awareness, simply because the amount of information is too large to be consciously processed. Several mental functions operate outside conscious awareness, including aspects of learning, attention, interpretation, emotions and goal-setting (Hofmann & Wilson, 2010; Wilson, 2002). Wilson (Wilson, 2002; Wilson & Dunn, 2004) calls these non-conscious processes the "adaptive unconscious", as they are vital for daily functioning. Several mental functions that are largely processed in the adaptive unconscious are part of - and are combined in - the construct of *personality*.

In personality psychology research, *direct self-report measures* are the standard measurement tasks for assessing individual differences in personality. People are directly asked about characteristics of their personality, based on introspection. These self-report measures provide *explicit* measures of personality traits, which are based on *conscious, controlled* processes. High face-validity, content validity, reliability and predictive validity are among the assets of these methods and make them indispensable in this field (Perugini & Banse, 2007).

Despite the advantages however, these measurement tasks also show some important limitations. First, personality questionnaires and interviews are based on the introspective capacity of the individual. The process of introspection, and answering questions based on introspective thought, often relies on building a coherent narrative of ourselves using mental processes that we are consciously aware of (McAdams, 1993; Wilson & Dunn, 2004). Consequently, the results of introspection often reflect *conscious* constructions, whereas the processes that drive our behaviour often operate automatically. Other disadvantages of direct self-report measures are their vulnerability to social desirability and self-presentational tendencies (Perugini & Banse, 2007). Therefore, to understand and predict personality related behaviours more completely, self-report measures must be complemented with other assessment methods (Back, Schmukle, & Egloff, 2009; Perugini, Connor, & O'Gorman, 2011).

Within social cognition research, new – *indirect* – measurement tasks were developed with the aim to assess psychological attributes that influence behaviour in an *automatic* manner. The crucial characteristic of indirect measurement tasks is that they assess psychological attributes without relying on a self-assessment of the to-be-measured attribute (De Houwer & Moors, 2010). Rather, attributes are inferred from behavioural responses such as key-presses in specifically developed reaction time procedures. The application of these response time procedures can provide *implicit measures* of attitudes, stereotypes, self-esteem, and the self-concept of personality. Implicit measures are based on *automatic* processes that operate in the relative absence of awareness, intention, cognitive resources or time (Bargh, 1994; Moors, Spruyt, & De Houwer, 2010). Therefore, such indirect assessments and tasks have the potential to provide measures that tap into aspects of the self that we cannot – or only partially - get access to through introspection.

In this paper, we provide a systematic review and meta-analysis of the literature on implicit measures of the self-concept of personality. The reliability and validity of these implicit measures in studies published before September 2016, are evaluated. Additionally, recommendations for future research are suggested, and the integration of the information processing accounts of personality into mainstream personality research will be discussed. But before reviewing the progress that has been made in the construction of psychometrically sound implicit measures of the self-concept of personality, some key concepts of this systematic review will be addressed. First, the self-concept of personality will be defined. Second, the differentiation between the explicit and implicit self-concept of personality will be discussed. Finally, the indirect measurement tasks that are used to assess the implicit self-concept of personality are presented.

## The self-concept of personality: A proxy to study personality through indirect measurement

## methods

Within the cognitive-psychological literature, *the self* and memory are traditionally viewed as two sides of the same coin. According to the semantic network models, long-term memory is represented as a network of interconnected nodes, in which each node symbolizes a specific concept (e.g., Collins & Loftus, 1975). Similarly, both in the research traditions of social cognition (e.g., Greenwald et al., 2002; Greenwald & Banaji, 1989) and of social-cognitive personality theories (e.g., McConnell, 2011; Robinson & Sedikides, 2009), the self is interpreted as a particularly rich social knowledge structure, organized within an associative memory network. According to Greenwald and colleagues (2002), a *self-concept* is "the association of the concept of self with one or more attribute concepts" (p. 5). Attribute concepts can include traits (e.g., indecisiveness), behaviours/activities (e.g., climbing), physical characteristics (e.g., elegant), social categories (e.g., soccer mum), objects (e.g. preferred brands), gender (masculinity/ femininity), ideals (e.g., braveness), goals, among others. This network of associations between the self and different attribute items constitutes the self-concept of a person. According to this view, the self-concept is characterized as a generalized representation of the self.

Subsequently, the *self-concept of personality* refers to a collection of (non-valence) attributes that describe relatively stable *personality traits*, associated with the concept of the self (e.g., McConnell, 2011; Schnabel & Asendorpf, 2010). Two of the major adaptive personality trait models are the Five-Factor Model (FFM; Costa & McCrae, 1992; McCrae & Costa, 2008) and the Big Six model (Ashton, Lee, & de Vries, 2014). More recently, in the build-up to the publication of the DSM-5, maladaptive personality trait models were also constructed, with Krueger and colleague's model being the most important (Krueger, Derringer, Markon, Watson, & Skodol, 2012). Additionally, it is also necessary to consider the Self-Determination Theory posited by Ryan and Deci (2000; SDT). In this theory, the need for achievement, affiliation and autonomy are not primarily conceptualized as individual difference variables. In contrast, within the SDT the concept known as causality orientations focuses on differences between people in global motivational orientations (Vansteenkiste, Niemiec, & Soenens, 2010). In this systematic review, we have included indirect measurement tasks that measure the association between the self and psychological attributes that are considered as part of these four models: the FFM, the Big Six, the maladaptive personality traits model of Krueger and the theory of causality orientations which is part of the SDT. Consequently, the ideal self and identity attributes such as moral identity, sexual identity, femininity/masculinity, and religiousness/spirituality are not necessarily stable over time, and are not included within these four models. Therefore, indirect measures assessing the association between the self and these attributes were not included in this systematic review.

Importantly, it must be kept in mind that the self-concept of personality serves as a *proxy* to study personality. The self-concept of personality does not cover the construct of personality entirely. First, some important research themes within the cognitive account of personality cannot be operationalized as self-knowledge or as a self-representation. For example, the ability of selfregulation/self-control refers to the way in which people differ in how they handle the dynamic interplay between themselves and the outside world (Corr & Matthews, 2009). The indirect measurement of this ability of self-regulation/self-control was not included in this review, as it is not part of the self-concept of personality. Second, other research traditions such as the socialpsychological accounts of personality (e.g., Jensen-Campbell, Knack, & Rex-Lear, 2009) and attachment theories (e.g., Shaver & Mikulincer, 2009) argue that personality cannot be conceived without considering the social situation. In social interactions, the beliefs/schemata about one's personality are expressed in behaviours towards others (Penke, 2011), and the reactions of the recipients of these behaviours (which are based on one's reputation) have, in turn, the potential to influence one's personality (Back et al., 2011). Because the interaction between personality and social situations cannot be conceptualized as part of the self-concept of personality, the indirect measurement of this interaction is not included in this systematic review. Third, some authors consider self-esteem as part of personality (e.g., Goldberg & Rosolack, 1994; Judge, Erez, Bono, & Thoresen, 2002). However, Greenwald and colleagues (2002) defined self-esteem as the association between the self and the *valence* attributes 'positive' and 'negative', or – put differently – as an *attitude* towards the self instead of a representation of the self. Therefore, the valence attributes 'positive' and 'negative' are not considered as part of the self-concept (Greenwald et al., 2002). Consequently, indirect measures of self-esteem are not investigated in this systematic review. This also holds true for indirect measures of approach and avoidance motivation. They too are not included in this review because approach and avoidance motivation are not conceptualized as part of the self-concept of personality.

Without denying the importance of these accounts and frameworks of personality, the choice was made here to systematically review research that has utilised indirect measurement tasks that focus on assessing the *self-concept of personality*. This choice reflects the dominant view of the research field which argues that the self-concept of personality serves as a good proxy to study personality. Moreover, within the domain of mainstream personality psychology, the personality questionnaires also assess the *self-concept* of personality, which is the self-knowledge/self-beliefs about one's own personality (Robinson & Sedikides, 2009). As such, the indirect measurement tasks that are reviewed here assess the self-concept of personality just as personality questionnaires do – the measurement method traditionally used in mainstream personality psychology.

## The implicit and explicit self-concept of personality

Some have argued that verbal manifestations of the self-concept of personality, such as scores on personality questionnaires, can be compared with the visible part of an iceberg (Greenwald & Banaji, 1989). This is because a large part of the network between the concept of the self and the personality trait attributes is not accessible through introspection, as they are activated automatically without a conscious intention to evaluate the relations within the network (Greenwald & Banaji, 1995). Relations between the self and personality trait attributes can be the result of either automatic/spontaneous information processes, or deliberate/controlled processes (e.g., Back et al., 2009; Gawronski & Bodenhausen, 2014; Strack & Deutch, 2004). First, according to the behavioural

process model of personality (Back et al., 2009), relations between the self and the trait attributes can be formed on the basis of repeated automatic activation of the concept of the self, together with (1) perceptual cues in the situation (e.g., a colleague asks which task you would like to do first), (2) an impulsive motivational tendency (e.g., avoiding), which results in (3) spontaneous behaviour (e.g., shrugging your shoulders), that subsequently activates the trait concept (e.g., indecisive). The more often this chain of relations is activated, the stronger the relation between the self and that trait concept becomes, and the more rapidly this network triggers the co-activation of "self" and "indecisive" whenever one or of both the concepts are activated through a situational or internal cue (Schnabel & Asendorpf, 2010). The personality-related self-representations that are activated in the automatic processing of information are assumed to correspond to the implicit self-concept of personality (e.g., Schnabel, Asendorpf, & Greenwald., 2008a). Second, differences between people in how they categorize situations, which actions they prefer, and how they deliberately behave according to these preferences, correspond to differences in the *explicit self-concept of personality* (e.g., Schnabel et al., 2008a). This network between the self and trait attributes is formed in the controlled/deliberate processing of information, and can be accepted as true or rejected as false by the person themselves. For instance, when completing a personality questionnaire during a job selection procedure, the person can modify his/her responses on the basis of factors such as selfpresentational concerns (e.g., "If I say that I make decisions easily, it will enhance my chances to get the job").

During the past three decades, two different kind of models were developed that focus on the nature of the implicit self-concept of personality and other implicit evaluations. *Associative accounts* argue that the implicit self-concept of personality depends on the automatic activation and formation of associations in memory. Associations are established in an impulsive system because of spatio-temporal contiguity and the frequency of experiencing this contiguity. One of the most typical features of associations in memory is that they are not characterized by a truth value (Strack & Deutsch, 2004). For example, a person might associate the concept of 'self' with the attribute 'indecisive', just because she often hears her mother say that it takes ages for her to make decisions. But this association does not imply that she intends to evaluate herself as indecisive. Individual differences in how people *automatically* process situational cues and which actions are *automatically* performed, are assumed to arise within the impulsive system, as the result of the activation of associations. The explicit self-concept of personality is built in the reflective system. Here, associations originating from the impulsive system are transformed into a relational format, that is, propositions (e.g., "I am a person who has difficulties to make decisions"), based on reasoning processes, which can be accepted as true or rejected as false (e.g., Gawronski & Bodenhausen, 2014; Strack & Deutch, 2004). Differences between people in how they categorize situations, which actions they prefer, and how they *deliberately* behave according to these preferences, are assumed to be based on these reflective processes.

It becomes clear from Greenwald's and his colleagues' (2002) definition of the term selfconcept (see previous section) that the research on implicit measures of the self-concept of personality is dominated by the associative accounts. This is not surprising because the first selfconcept of personality IATs were constructed during the time when the popularity of the associative and dual process models was at their peak. However, in the research tradition of implicit social cognition, a *propositional account* also arose explaining the mental mechanisms mediating implicit measures. Propositional account also arose explaining the mental mechanisms mediating might be the results of the automatic activation and formation of propositions (e.g., De Houwer, 2014; Hughes, Barnes-Holmes, & De Houwer, 2011; Mann & Ferguson, 2015). In contrast to associations, propositions contain information about the relation between concepts, and can result not only from repeated experiences of specific events, but also from a single instruction or inference with respect to these events. Propositional models and associative models might be difficult to differentiate on the empirical level. Nevertheless, the consideration of both information processing accounts of the self-concept of personality is important because it results in different interpretations of existing findings and in different predictions for future research (De Houwer, 2014). This point will be resumed in the discussion section.

#### Indirect measurement tasks directed at assessing the self-concept of personality

The methods used within the information processing account of personality consist most often of indirect measurement tasks. Reaction times and response accuracy are used to derive measures of basic cognitive processes, such as selective attention, interpretation and memory (Mathews, 2012). In the literature, the outcomes of these tasks are often called "implicit measures" assessing - among others - the implicit self-concept of personality. The concept *implicit* has received several meanings. In line with De Houwer and colleagues (De Houwer, 2006; De Houwer & Moors, 2007; Moors, et al., 2010; De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009), we equate the concept implicit with the concept *automatic*. Automaticity refers to the fact that *measurement processes* operate under suboptimal conditions, that is, in the relative absence of awareness, goals, resources, or time (Bargh, 1994; Gawronksi & Bodenhausen, 2014; Moors et al., 2010). Subsequently, an implicit measure is a *measurement outcome* of a measurment task that reflects the to-be-measured construct (in this case the self-concept of personality) through automatic processes. Most often, the self-concept of personality is inferred from behavioural reactions, triggered during *indirect measurement tasks* in which the respondents are instructed to work as fast as possible.

The Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) is the most widely used indirect measurement task for assessing the implicit self-concept of personality. This is in part due to its adequate psychometric properties in terms of internal consistency (αs around .80; test–retest coefficients around .55; Hofmann & Schmitt, 2008) and predictive validity (Perugini, Richetin, & Zogmaister, 2010). Moreover, the IAT is a quite flexible task in its application, a prerequisite to be able to measure the large diversity in personality traits. IAT effects (or IAT scores) reflect the difference in performance on two categorization tasks. During the IAT, words (appearing one by one in the middle of a computer screen) must be assigned to four categories - two attribute categories (e.g., extraversion vs. introversion) and two target categories (e.g., self vs. others) - by pressing one

of two indicated keys, as fast and accurately as possible. During the critical blocks, one response key is paired with one target and one attribute category (e.g., extraversion and self) and the other two categories (e.g., introversion and others) are assigned to the other response key. Which categories are assigned to the same key varies between blocks. The idea behind the IAT is that the task is easier, and therefore performance is faster, when the associations between the categories that are assigned to the same response key is stronger than the associations between the categories that are assigned to different response keys. The difference in performance between the two critical categorization tasks is reflected in a D-score (Greenwald, Nosek, & Banaji, 2003). In the calculation of this D-score, the reaction times of incorrect responses are replaced by the mean reaction time of the correct responses of that task plus an error penalty.

The measurement outcome of the IAT always includes a comparison. For instance, if respondents react faster when 'extraversion' and 'self' versus 'introversion' and 'others' are assigned to the two response keys, in comparison to the task in which 'extraversion' and 'others' versus 'introversion' and 'self' are assigned to the two keys, it is assumed that extraversion is more strongly associated with the self, compared to others (and that introversion is more strongly associated with others, compared to the self). A variant of the IAT that has also been used to study an aspect of the self-concept of personality is the Single Category IAT (e.g., De Cuyper, Pieters, Claes, Vandromme, & Hermans, 2013), in which only one attribute category is assessed. This measurement task is suitable for attribute categories that do not have a natural opposite concept.

Other indirect measurement tasks have also been developed, some of which have been used to measure the self-concept of personality: the Extrinsic Affective Simon Task (EAST; Teige, Schnabel, Banse, & Asendorpf, 2004), the Implicit Association Procedure (IAP; Schnabel, Banse, & Asendorpf, 2006b), the Go/No-Go Association Task (GNAT; Boldero, Rawlings, & Haslam, 2007), the Semantic Misattribution Procedure (SMP; Sava et al., 2012) and an Irrelevant Feature Task (IFT; Huntjens, Rijkeboer, Krakau, & de Jong, 2014, also see De Houwer, 2003). However, some studies showed that the EAST and the GNAT suffer from low reliability (Boldero et al., 2007; Schmukle & Egloff, 2006; Teige et al., 2004). Because these alternatives of the IAT also have psychometric limitations or do not approach the level of the IAT in their psychometric properties (Sava et al., 2012), at the moment, the IAT is considered to be the most practical indirect measurement task for assessing the self-concept of personality.

## Aims and overview

In the last decade, several personality researchers have begun to argue that other assessment procedures, in addition to self-report, are needed to better predict the complexity of human behaviour (e.g., Bluemke & Teige-Mocigemba, 2015; Ortner & van de Vijver, 2015). Consequently, not only attitudes and stereotypes, but also self-concepts, are now captured using indirect measurement procedures. The first aim of this review is to present the current state of research on the implicit self-concept of personality. Therefore, we present results on meta-analyses estimating internal consistency, reliability coefficients, the implicit-explicit consistency and the single association predictive effect of implicit self-concept of personality measures. To do this, studies were aggregated over personality domains. The relatively small number of studies examining implicit measures of specific personality traits does not warrant a meta-analytic review of the different aspects of construct and predictive validity for each personality domain separately. However, for each of the Five Factor personality domains (Costa & McCrae, 1992; McCrae & Costa, 2008), the different aspects of construct validity and predictive validity will be reviewed in a narrative way. The second aim of this review is the integration of implicit self-concept research and mainstream personality research, from which recommendations for future studies will follow. This issue will be targeted in the discussion section.

### Method

## Eligibility criteria for the studies and search process

Research papers which met the following criteria were included in the current review:

- 1) The research paper reports on one or more studies in which an aspect of the self-concept of personality was measured indirectly. First, the indirect measurement task must assess the relation between the concept of *the self* and *one* personality-related attribute, thereby assessing one clear aspect of the self-concept of personality. This implies that (a) *attitude* IATs which assess a personality trait (e.g., Perugini et al., 2011), and (b) indirect measurement tasks designed to measure a *conglomeration* of personality traits (e.g., Weertman, Arntz, de Jong, & Rinck, 2008) are not included in this review. Second, the personality attribute assessed by the implicit measures must be part of one of the four personality theories that are listed above.
- 2) The research paper reports data that allow for the evaluation of the construct validity of the implicit measure. Therefore, papers that met this specific criterion included the following:
  - a) a direct and/or a behavioural measure of the same personality construct is included in the study, prior to or without the introduction of a manipulation/treatment, OR
  - b) the indirect measurement task is administered in two groups which are known to differ with respect to a specific personality trait, OR
  - c) the indirect measurement task is part of an (semi-)experimental study that examines whether the manipulation of variables influencing the to-be-measured personality construct, causes differences in the measurement outcome (Borsboom, Mellenbergh, & van Heerden, 2004) OR
  - d) regarding studies investigating the construct validity of trait anxiety, depressiveness, or aggressiveness (i.e., traits that also have a state-counterpart): the indirect measurement task is part of an (semi-)experimental study that examines whether the induction of state anxiety/depression/aggression influences implicit trait anxiety/depressiveness/ aggressiveness.

When both the conventional algorithm (log-transformed score; Greenwald et al., 1998) and the D-algorithm (Greenwald et al., 2003) were used to compute the personality self-concept IAT- effect, only the results based on the D-measures were included into the review. Compared to the conventional algorithm, the use of the D-algorithm (1) requires smaller samples to reach the same statistical power, (2) reduces the influence of IAT experience (Greenwald et al., 2003), and (3) diminishes the task-switching cost present in the IAT procedure (Back, Schmukle, & Egloff, 2005; Greenwald et al., 2003; Mierke & Klauer, 2003). In four studies that were eligible for the review, the authors only presented the conventional scoring algorithm (Asendorpf, Banse, & Mücke, 2002; Egloff & Schmukle, 2002; Mierke & Klauer, 2003, Teige et al., 2004). Thus, results based on the conventional scoring algorithm were only included in this review with respect to these four studies.

Manuscripts were selected in the following manner. First, Web of Science and PsycINFO were searched at the end of August 2016, using the following search terms: (personality OR self-schema) AND (indirect OR implicit OR automatic) AND (attitude\* OR association\*). No restrictions were entered as to the publication year or the language. The research results were limited to the research domain of social sciences. Second, three - more restrictive - searches were executed with respect to the personality traits anxiousness, depressiveness and aggressiveness. These are the three personality traits (for which indirect measurement tasks have, up until now, been designed) that have an equivalent on the symptomatic level of an Axis-I disorder (anxiety disorder, affective disorder, conduct disorder or impulse control disorder). For this review, we included only those studies which reported results concerning these implicit measures as far as they reflected the psychometric properties of these implicit measures as trait measures, not as symptom or state measures. However, the trait versions of these indirect measurement tasks often use the same categories and stimuli as the state versions of these indirect tests. The studies which were set up by the authors to indirectly measure symptoms or states sometimes also contained results adding to the psychometric properties of the implicit measures, in that they assessed the trait equivalent of the investigated implicit state. We were concerned that these specific studies would not be selected using the research paper selection criteria as mentioned above, as these articles might not mention the term personality. Therefore, to be able to include those articles into the review, the following three extra searches were carried out in Web of Science without including the term personality:

- [anxi\* AND (automatic OR indirect OR implicit) AND (attitude\* OR \*associati\* OR \*schema OR \*view\*)] in Title
- [depressi\* AND (automatic OR indirect OR implicit) AND (attitude\* OR \*associati\* OR \*schema OR \*view\*)] in Title
- [aggressi\* AND (automatic OR indirect OR implicit) AND (attitude\* OR \*associati\* OR \*schema OR \*view\*)] in Title

Finally, the reference lists of the articles that were included in the review, and the reference lists of review papers and editorials that considered the indirect measurement of attitudes or of the self-concept, were inspected for other studies meeting the eligibility criteria. The electronic and hand searching, and the study selection, were executed by one researcher (KDC). Screening for eligibility was based on the title and the abstract. In case the content of the paper was not clear from the abstract, the paper itself was inspected. The details of the studies included in these reviews are presented in Appendix 1 of the data supplement that accompanies the online edition of this article, and can also be accessed by following the link <a href="https://osf.io/hpw3e/?view\_only="ht

79cd1a7e1d4b4be8b827a22b45b138b1.

Meta-analyses estimating internal consistency, reliability coefficients, the implicit-explicit consistency and the single association predictive effect of implicit self-concept of personality measures

First, across all personality domains, two meta-analyses based on independent samples<sup>1</sup> were performed to obtain an optimal estimation of (1) Cronbach's coefficient  $\alpha$  and (2) the reliability of the implicit measures. The last meta-analysis included studies in which the split-half reliability or the test-retest correlation of an implicit self-concept of personality measure was examined. In addition, across all personality domains, two meta-analyses were performed to obtain optimal estimates of (3)

<sup>&</sup>lt;sup>1</sup> The procedure that was used to reach independent samples is explained in Appendix A, added to this article.

the relation between implicit and self-reported explicit measures of the self-concept of personality, and (4) the single association predictive effect of the implicit measures. As argued by Rodriguez and Maeda (2006), we analyzed the studies using Cronbach's coefficient  $\alpha$  (CCA) as a measure of reliability separately as it has its own sampling distribution which can be used for precision weighting and other common meta-analytic procedures (see, Rodriguez & Maeda, 2006). Information on the effect sizes used for the meta-analyses can be found in Appendix B, added to this article.

Second, for the four meta-analyses, the homogeneity of the effect size distribution was examined using the Q-statistic (Lipsey & Wilson, 2001). When the Q-statistic is rejected, the effect size distribution is not homogeneous, implying that the variability in the effect sizes between studies is larger than can be expected based on sampling error (the error associated with the fact that the estimates in the individual studies are based on different samples of subjects). In this case, we performed a mixed random-effects model implying that the observed variance stems from three sources: 1) variance from subject-level sampling error, 2) variance from study characteristics that we could identify (e.g., the measurement procedure that was used to indirectly measure the personality trait), and 3) variance from other systematic random or unmeasured sources. In these analyses, several study characteristics were identified as moderators that may explain heterogeneity in effect sizes across studies. In all four meta-analyses, the moderating effect of the level of the personality characteristic under study, i.e., trait versus facet, was examined. The moderating effect of the measurement procedure - e.g., IAT versus SMP - that was used to indirectly assess the personality characteristic was computed in all meta-analyses, except for the meta-analysis estimating the single association predictive effect of implicit measures. This was because in 33 of the 37 studies included in this analysis, the IAT was used as the indirect measurement procedure. In two studies, an SMP was used, and in two studies a SC-IAT. In the meta-analysis estimating the reliability of the implicit measures, the moderating effects of the *method* used to estimate the reliability (split-half reliability versus test-retest correlation) and the amount of days between two administrations of the same task<sup>2</sup> were investigated. In the meta-analysis estimating the relation between the implicit and explicit measures of the same characteristic, the moderating effect of the *direct measurement procedure* - questionnaire versus attribute item ratings<sup>3</sup> - was studied. Finally, in the meta-analysis estimating the single association predictive effect of the implicit measures, whether the *type of criterion variable* – observed versus self-reported<sup>4</sup> – moderated the estimated results was examined.

To end, we created funnel plots for the four meta-analyses to examine publication bias.

# Narrative review of the construct validity of the implicit personality measures

To investigate the construct validity of the implicit personality measures, we reviewed the following for each personality domain:

1) the experimental validity, which is demonstrated when the manipulation of variables influencing the to-be-measured personality construct causes differences in the measurement outcome (Borsboom et al., 2004). Additionally, in some studies, it was investigated whether the induction of a state linked to the assessed personality trait, influences the implicit trait measures (e.g., Schnabel et al., 2006b). Because null findings are expected here, the results of these studies are a less clear-cut indicator of experimental validity. Furthermore, to demonstrate that a measure is implicit, it must be shown that the to-be-measured construct influences measurement outcomes in an automatic manner (De Houwer et al., 2009). With regard to self-concept of personality IATs, whether or not participants can control the outcome of the measurement task has most often been examined. More specifically, the difference in mean IAT-effects was examined in faking versus controlled conditions (between- or within-subject designs), or in participants who took part in a personnel assessment program versus volunteers (Vecchione, Dentale, Alessandri, & Barbaranelli,

<sup>&</sup>lt;sup>2</sup> For the split-half reliability coefficients, the time lag was set to zero.

<sup>&</sup>lt;sup>3</sup> For those studies in which both questionnaire measures and attribute item ratings were collected, the attribute item ratings were used in the analysis in order to achieve a better balance between the amount of questionnaire measures and the amount of attribute item measures used in the analysis.

<sup>&</sup>lt;sup>4</sup> In one study (Costantini et al., 2015), we had to choose between the self-reported criterion variable and observed behaviour criterion variable in order to achieve statistically independent samples. We chose for the self-reported variable because the analysis already included far more observed behaviour criterion variables compared to (self or other) reported criterion variables.

2014). In these studies, it is hypothesized that the differences in explicit measures between the faking condition/personnel assessment program versus the control condition/volunteers would be larger compared to the differences in implicit measures of personality between both conditions/groups.

- 2) whether implicit personality self-concept measures can differentiate between two groups by measuring an aspect of the self-concept which is known to differ between the groups. For example, we included studies in which the implicit self-concept of personality was compared (a) between a group *in remission* from an Axis-I disorder and a *control* group, or (b) between an Axis-II personality disorder group and a control group. Observing such differences would give evidence for the construct validity of the implicit measure.
- 3) the convergence of (a) implicit and explicit measures of the same personality trait, and of (b) the outcomes of different indirect measurement tasks assessing the same personality trait. The convergences between implicit and explicit measures of the same personality trait are inspected by looking at the inter-correlation between the outcomes of the two tests, and at other variables that correlate with both measures in a similar way (Greenwald & Nosek, 2009). The explicit measures are psychometrically validated trait questionnaire measures<sup>5</sup> and ratings of IAT attribute items. The instructions for these attribute item ratings are generally: "Please indicate the extent to which the following attributes apply to you (in general)." This implicit-explicit consistency was reviewed (a) in studies in which no experimental manipulation or specific treatment was included, and (b) in the control conditions/groups, or (c) in studies in which implicit-explicit consistency could be extracted from the baseline measures when the study did include a manipulation or treatment. For each personality domain, the weighted average correlations between the implicit and explicit measures of the same personality trait were computed using the Fisher's r to Z

<sup>&</sup>lt;sup>5</sup> The explicit bipolar self-ratings of the Asendorpf et al. article (2002) was not included into these analysis because this explicit self-rating is not a trait questionnaire that is validated against other trait questionnaires assessing shyness.

transformation function (Decoster & Iselin, 2005). Within each personality domain, the weighted average correlations were calculated for the trait questionnaire measures and the IAT attribute item ratings separately.

Nevertheless, it would be difficult to stipulate a cutting point from which the implicitexplicit correlations give evidence for the construct validity of the implicit self-concept of personality measure (Trochim, 2006). However, it follows from the information processing accounts that (a) in most cases, a valid implicit self-concept of personality measure correlates stronger with another valid and reliable implicit measure assessing the same personality trait but using another indirect measurement procedure, in comparison with an explicit measure of the same personality trait, that (b) the implicit-explicit consistency is significantly lower in a faking condition, and significantly higher in a elaboration condition, as both compared to a control condition (Egloff, Weck, & Schmukle, 2008; Schnabel et al., 2006b), and that (c) the implicit-explicit consistency is lower in an experimental group in which the assessment is part of a situation where participants have to make a good impression, compared to the control group (e.g., a personnel assessment program, Vecchione et al., 2014). The three indicators of construct validity will be considered in every personality domain in which it has been studied.

4) evidence for statistically different correlations between explicit and implicit measures of the same personality trait on the one hand, and a theoretically meaningful third variable at the other hand (Greenwald & Nosek, 2009), for example social desirability. These correlations were reviewed (a) in studies in which no experimental manipulation or specific treatment was included, and (b) in studies in which implicit-explicit consistency could be extracted from the baseline measures when the study did include a manipulation or treatment.

## Narrative review of the predictive validity of implicit personality measures

To evaluate the predictive validity of the implicit self-concept of personality measures, the empirical evidence for different predictive patterns in their ability to predict relevant variables are reviewed for each personality domain. Perugini and colleagues (Perugini et al., 2010) described five predictive

patterns: (1) the single association pattern in which the implicit self-concept of personality predicts the criterion variable, (2) the additive pattern in which the implicit self-concept of personality demonstrates incremental predictive value in the prediction of the criterion variables, over and above the explicit self-concept of personality, (3) the dissociation pattern in which only the implicit self-concept of personality predicts spontaneous self-concept related behaviour and only the explicit self-concept of personality predicts controlled self-concept related behaviour, (4) the moderated and mediated patterns in which a theoretical relevant variable moderates or mediates the predictive influence of the implicit self-concept of personality on the criterion variable, and (5) the multiplicative pattern in which the convergence of high (low) implicit and explicit self-concept of personality predicts the criterion variable.

One remark must be made in advance concerning the review of the predictive validity patterns. Predicting behaviour entails hypothesizing which behaviour will occur in the future. However, in many studies, direct and indirect measurement tasks "predicted" behaviour that occurred in the past. Because this is the case in many studies and because reports of past behaviour are often related to future behaviour, they were still included in our review.

#### Results

The first - broad - electronic search in WEB OF SCIENCE and PsycINFO resulted in 781 papers to be screened for eligibility. Papers were excluded following the procedure delineated in Figure 1, resulting in 54 papers considered eligible for this review.

The specific – more restrictive - electronic search with respect to anxiousness resulted in 34 articles. The papers were screened for eligibility according to the same procedure as delineated in Figure 1. This resulted in eight articles considered eligible for this review, of which three articles did not result from the first broad electronic search. The specific electronic search with respect to depressiveness resulted in 22 articles of which one article was considered eligible for this review, which also resulted from the first broad electronic search. The specific electronic search with respect to aggressiveness resulted in 20 articles, of which one was eligible for the review and did not result

from the other electronic searches. Finally, hand searching based on the reference lists of the articles which were included into this review, and on the reference lists of relevant review papers and editorials resulted in another 12 articles to be included into the review. The combined 4 search strategies resulted in 70 articles that met the criteria of this review.

Figure 1. Screening of the papers for eligibility.

These 70 articles describe the psychometric properties of indirect measurement tasks assessing 18 personality traits which we divided into the 5 personality domains according to the Five Factor Model (FFM) of Costa and McCrae (1992, McCrae & Costa, 2008), differentiating between traits and facets. Some facets are considered differently in other models, like the Big Six model (Ashton et al., 2014). However, this classification is made to simplify the presentation and the discussion of the results, and does not imply that the FFM model is considered as empirically or theoretically better than the Big Six model (Ashton & Lee, 2007). We distinguished (1) the Extraversion/shyness trait (resp. n = 27 and n = 6) with the facet risk propensity (n = 4), (2) the Neuroticism trait (n = 16) with the facets trait anxiety (n = 26), depressiveness (n = 2), shame proneness (n = 1), and dependency (n = 1), (3) the Agreeableness trait (n = 8) with the facets (lack of) angriness (n = 4), (lack of) aggressiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 19), humility (n = 4), altruism (n = 1) and forgiveness (n = 10), humility (n = 4), altruism (n = 1), and forgiveness (n = 10), humility (n = 4), altruism (n = 1), and forgiveness (n = 10), humility (n = 4), altruism (n = 1), and humility (n = 1), humility (n = 1)= 1), (4) the Conscientiousness trait (n = 18) with the facets impulse control (n = 1), orderliness (n = 1), industriousness (n = 1), responsibility (n = 1), self-control (n = 1) and aiming at perfection (n = 2), and (5) the Openness to experiences trait (n = 8) with the facets need for cognition (n = 2) and general causality orientation (n = 4). The indirect measurement tasks that were used in the studies were the IAT (n = 125), the Single Category IAT (SC-IAT; n = 6), the brief IAT (n = 5), the Go/No-Go Association Task (GNAT; n = 7), the Semantic Misattribution Procedure (SMP; n = 9), the Extrinsic Affective Simon Task (EAST; n = 5), the Implicit Association Procedure (IAP; n = 1), and an irrelevant feature task (IFT; n = 1).

Meta-analyses estimating internal consistency, reliability coefficients, the implicit-explicit consistency and the single association predictive effect of implicit self-concept of personality measures

Table 1 presents on overview of the results of the two meta-analyses computing the estimated weighted averaged (1) Cronbach's coefficient  $\alpha$  and (2) reliability of implicit self-concept of personality measures. The results of the two meta-analyses calculating the estimated weighted averaged (3) implicit-explicit correlation and (4) correlation between the implicit self-concept of personality measure and a criterion variable are summarized in Table 2.

## Table 1

Overview of the results of the meta-analyses computing the estimated weighted averaged Cronbach's coefficient  $\alpha$  and (retest)reliability of implicit self-concept of personality measures (with 95% confidence interval)

# Table 2

Overview of the results of the meta-analyses calculating the estimated weighted averaged implicitexplicit correlation and correlation between the implicit self-concept of personality measure and a criterion variable (with 95% confidence interval)

**Cronbach's coefficient**  $\alpha$  (**CCA**). Based on a meta-analysis involving 51 studies with 19719 unique participants and an average sample size of 387 participants<sup>6</sup> with a median of 89 participants, the estimated weighted CCA of the implicit self-concept of personality measures was .74. This result is in line with the reliability coefficients that are observed for implicit attitude measures (Hofmann, Gawronski, Le, & Schmitt, 2005; Nosek, Greenwald, & Banaji, 2007). The distribution of the estimated CCAs of each individual study, ordered from small to large, is presented in Figure 1 of Appendix 2 of

<sup>&</sup>lt;sup>6</sup> Whithout the large study of Vianello and colleagues (Vianello, Schnabel, Sriram, & Nosek, 2013), the average sample size was 107 participants.

the data supplement added to the online edition of this article, and can also be accessed by following the link <u>https://osf.io/hpw3e/?view only=79cd1a7e1d4b4be8b827a22b45b138b1</u>. The Qstatistic indicated that the distribution of the CCAs of the individual studies was not homogeneous, Q(50) = 2597.96, p < .001, which implies that the variability in the CCAs between studies is larger than can be expected on the basis of sampling error. Therefore, in a next step, we investigated the potential moderating effect of two study characteristics, i.e., the level of the personality characteristic under study - trait versus facet - and the measurement procedure that was used to indirectly assess the personality characteristic. Results indicated that only the indirect measurement procedure significantly explained part of the heterogeneity of the CCAs between the included studies, *F*(3, 49) = 4.76, p < .01. The estimated mean CCA was highest for the IAT effects, i.e., .82, 95% CI = .80 - .85. Moreover, this was significantly higher than the estimated mean CCAs of the SC-IAT effects and the brief IAT effects, being respectively .67 and .63, 95% CI respectively .53 - .78 and .34 - .82.

Finally, a funnel plot was created in Figure 2a to examine publication bias. Note that the raw statistic  $T_i$  instead of CCA was used in this figure<sup>7</sup> with lower (higher) values indicate better (worse) internal consistency (in contrast to the other results discussed for which we transformed  $T_i$  back to CCA). In this figure, one can see that the most of studies fell to the left of the vertical line, implying that most studies had a good internal consistency, whereas there are less, especially, smaller studies with a lower internal consistency (higher value of  $T_i$ ). Thus, there is some evidence for publication bias, which suggests that a number of small studies with lower internal consistency are not published.

*Figure 2.* Funnel plots for the four meta-analyses displaying the study-specific effect estimates in relation to the standard error

<sup>&</sup>lt;sup>7</sup> For an introduction to this statistic, see Appendix C.

(Retest) reliability. The split-half reliability coefficients of the EAST measures and a measure based on an irrelevant feature task (IFT) were not satisfactory (EASTs: on average .25, n = 5; IFT: -.27, n = 1). Therefore, the six studies using the EAST or an IFT were excluded from the review.

A meta-analysis was executed including 44 studies in which the split-half reliability or the test-retest correlation of an implicit self-concept of personality measure was examined. The metaanalysis included 6921 unique participants and the average sample size was 157 participants. The estimated weighted reliability amounted to .82, which demonstrates a good average reliability of the implicit self-concept of personality measures. The distribution of the estimated reliabilities of each individual study, ordered from small to large, is presented in Figure 2 of Appendix 2 of the data supplement added to the online edition of this article, and can also be accessed by following the link https://osf.io/hpw3e/?view only=79cd1a7e1d4b4be8b827a22b45b138b1. The Q-statistic indicated that the distribution of the reliabilities of the individual studies was not homogeneous, Q(44) = 442.44, p < .001, which implies that the variability in the reliabilities between studies is larger than can be expected on the basis of sampling error. Therefore, in a next step, we investigated the potential moderating effect of four study characteristics, i.e., (1) the level of the personality characteristic under study, (2) the measurement procedure that was used to indirectly assess the personality characteristic, (3) the method that was used to study the reliability, i.e., the split-half versus test-retest correlation, and (4) the amount of days between the two administrations of the indirect measurement task. Results indicated that only the indirect measurement procedure significantly explained part of the heterogeneity of the reliability coefficients between the included studies, F(2, 38.4) = 5.88, p < .01. The estimated mean reliability was highest for the IAT effects, i.e., .70, 95% CI = .46 - .85. This was significantly higher than the estimated mean reliability of the SMP effects, being .43, 95% CI .03 - .71.

Finally, to examine publication bias, a funnel plot was made as can be seen in Figure 2b. In this figure, all studies are scattered rather randomly around the vertical line, giving little evidence for publication bias.

Implicit-explicit consistency. Based on a meta-analysis involving 70 studies with 24029 unique participants and an average sample size of 343 participants<sup>8</sup> with a median of 95 participants, the estimated weighted implicit-explicit correlation of the implicit self-concept of personality measures was small, equalling .20. The distribution of the estimated implicit-explicit correlations of each individual study, ordered from small to large, is presented in Figure 3 of Appendix 2 of the data supplement added to the online edition of this article, and can also be accessed by following the link https://osf.io/hpw3e/?view only=79cd1a7e1d4b4be8b827a22b45b138b1. The Q-statistic indicated that the distribution of the implicit-explicit correlations of the individual studies was not homogeneous, Q(69) = 228.00, p < .001, which implies that the variability in the implicit-explicit correlations between studies is larger than can be expected on the basis of sampling error. Therefore, in a next step, we investigated the potential moderating effect of three study characteristics, i.e., (1) the level of the personality characteristic under study, (2) the measurement procedure that was used to indirectly assess the personality characteristic, and (3) the measurement method that was used to directly measure the personality trait, i.e., attribute item ratings versus a questionnaire. Results indicated that only the *direct* measurement method significantly explained part of the heterogeneity of the implicit-explicit correlations between the included studies, F(1, 70) =11.06, p < .01. The estimated mean implicit-explicit correlation was significantly higher for the attribute item ratings, i.e., .24, 95% CI = .16 - .33, than for the questionnaires, being .14, 95% CI .07 -.21.

With respect to publication bias, it can be seen in Figure 2c that almost all studies (maybe with the exception of two small studies that show larger effect sizes at the bottom right) are randomly distributed across the vertical line giving little evidence for publication bias.

Single association predictive effect of the implicit self-concept of personality measures. Based on a meta-analysis involving 37 studies with 4433 unique participants and an average sample size of 120 participants, the estimated weighted implicit-criterion correlation of the implicit self-

<sup>&</sup>lt;sup>8</sup> Whithout the large study of Vianello and colleagues (2013), the average sample size was 140 participants.

concept of personality measures was small, equating .19. The distribution of the estimated implicitcriterion correlations of each individual study, ordered from small to large, is presented in Figure 4 of Appendix 2 of the data supplement added to the online edition of this article, and can also be following the link accessed by https://osf.io/hpw3e/?view only=79cd1a7e1d4b4be8b827a22b45b138b1. The Q-statistic indicated that the distribution of the implicit-explicit correlations of the individual studies was not homogeneous, Q(36) = 60.90, p < .01, which implies that the variability in the implicit-criterion correlations between studies is larger than can be expected on the basis of sampling error. We further explored the potential moderating effect of two study characteristics in a fixed effects model (FEM): the level of the personality characteristic under study, and the type of criterion variable, i.e., observed versus self-reported. Results indicated that only the type of criterion variable moderates the distribution of implicit-criterion correlations of the individual studies, F(1, 13.3) = 7.98, p < .05. The estimated mean implicit-criterion correlation was higher for the observed criterion variables, i.e., .25, 95% CI = .20 - .29, than for the self-reported outcome variables, being .13, 95% CI .05 - .21.

However, the funnel plot in Figure 2d demonstrates clear evidence for publication bias. The figure shows a negative linear relation between the sample size and the effect size: the large studies result in a low implicit-criterion correlation and the smaller studies in a higher implicit-criterion correlation.

**Summary**. The results of these four meta-analyses, computed over all personality domains, show that the implicit self-concept of personality measures (1) have an acceptable to good reliability, (2) reveal a weak correlation with their explicit counterparts, and (3) have a small *single association* predictive effect on criterion variables. Moreover, the estimated average reliability coefficient was higher for IAT-effects compared to single-category and brief IAT scores, and compared to SMP effects. We also found that the implicit-explicit consistency was higher when attribute item ratings instead of questionnaires were used as direct measures of the personality traits. And finally, the single association predictive effect was higher for observed criterion variables compared to self-

reported criterion variables. However, with respect to this predictive effect of implicit self-concept of personality measures, publication bias should be taken into account.

# Narrative review of the construct and predictive validity of implicit measures of the self-concept of personality

In what follows, we successively discuss the construct validity and the predictive validity of implicit measures assessing an aspect of the self-concept of personality. The following personality domains will be considered: (1) the Extraversion/Shyness trait with the facet risk propensity, (2) the Neuroticism trait with the facets trait anxiety, depressiveness, shame proneness, and dependency, (3) the Agreeableness trait with the facets (lack of) angriness, (lack of) aggressiveness, humility, altruism and forgiveness, (4) the Conscientiousness trait with the facets impulse control, orderliness, industriousness, responsibility, and aiming at perfection, and (5) the Openness to Experiences trait with the facets need for cognition and general causality orientation.

Table 3 and 4 present a summary of the narrative systematic review results respectively with regard to the construct and the predictive validity of the implicit self-concept of personality measures, separately for the five personality domains. In both tables, for each executed (and reported) statistical analysis examining a validity indicator (see left column of the tables), a plus (+) was assigned when analysis gave evidence for the validity indicator, and a minus (-) was assigned when no evidence was observed for the validity indicator. These plusses and minuses were summed and are shown in the tables. In what follows, the construct and predictive validity results of the implicit self-concept of personality measures will be described for each personality domain separately.

# Table 3

Summary of the narrative systematic review results: Observed evidence for the construct validity of implicit self-concept of personality measures

## Table 4

Summary of the narrative systematic review results: Observed evidence for the predictive validity of implicit self-concept of personality measures

The validity of implicit extraversion/shyness measures and implicit facet measures assessing risk propensity. Extraversion is characterized by a predisposition towards sociability, talkativeness and assertiveness. A person high on extraversion seeks out social stimulation and likes to engage with others across different situations. Shyness constitutes the opposite end of extraversion. It refers to the predisposition of feeling awkward and not at ease when being in proximity to other people. Risk propensity is a facet of extraversion that is conceptually close to sensation seeking. It refers to the fact that people differ in their risk-taking behaviour.

In 2002, Asendorpf and colleagues published their seminal article on the double dissociation of the explicit and implicit self-concept of shyness (Asendorpf et al., 2002). This publication turned out to be the beginning of an interesting series of articles reporting studies on the assessment of the implicit self-concept of personality. Within the extraversion domain, most studies investigated implicit measures of the trait extraversion itself. On top of that, five studies on implicit shyness were published in which the same shyness IAT and the same ten shyness-descriptive adjectives pairs were administrated (Asendorpf et al., 2002, Studies 1 and 2; Briñol, Petty, & Wheeler, 2006, Study 1; Schnabel et al., 2006b; Teige et al., 2004). In addition to the shyness IAT, Schnabel and colleagues (2006b) developed a shyness Implicit Association Procedure (IAP), which is very similar to the shyness IAT (Schnabel et al., 2006b). The only difference lies in the way in which items are discriminated between the 'me' and 'not-me' categories. In the IAT procedure, left and right response keys are used; in the IAP, the participants must move a joystick towards or away from themselves. Regarding risk propensity, two IATs have each been studied twice (Dislich, Zinkernagel, Ortner, & Schmitt, 2015; Horcajo, Rubio, Aguado, Hernández, & Márquez, 2014).

Construct validity. First, in two between-subject designs, faking instructions influenced neither shyness IAP scores (Schnabel et al., 2006b), nor shyness IAT effects (Asendorph et al., 2002), as was expected. In contrast, in the studies of Schnabel and colleagues (Schnabel et al., 2006b) and McDaniel and colleagues (McDaniel, Beier, Perkins, Goggin, & Frankel, 2009), respectively shyness IAT effects and extraversion IAT scores were significantly lower in the faking condition compared to in the control condition. Nevertheless, this effect was much smaller for the shyness IAT (d = .23) and the extraversion IAT ( $\omega^2$  = .48), than for the direct measurement of respectively shyness (d = 2.00) and extraversion ( $\omega^2$  = .95). Similar results were observed in a within-subject design (Steffens, 2004, Study 2). Then, in line with the hypothesis, and in contrast with the explicit measures, no significant differences were observed in mean extraversion IAT effect between volunteers and either security guards or semiskilled workers who took part in a personnel assessment program (Vecchione et al., 2014). Moreover, the mean shyness IAT and IAP effect did not differ between participants that completed the shyness IAT before and after the shyness-inducing situation. Finally, participants who recalled extraversion-related memories or sought for explanations related to extraversion revealed significantly stronger associations between the self and extraversion on an IAT compared to participants who respectively recalled introversion-related memories or sought for explanations related to introversion, d = respectively .47 and .35 (Peters & Gawronski, 2011). These results give a considerable amount of evidence for the experimental validity of implicit measures of the extraversion domain.

Second, extraversion IAT effects differentiated significantly between a schizophrenia group and a non-clinical control group in the expected direction (Suslow, Lindner, Kugel, Egloff, & Schmukle, 2014).

Third, the weighted average correlation between the (SC-/brief) IATs and questionnaire measures of extraversion had overall a small effect size, equalling .24 (Grumm & von Collani, 2007, Study 1; Hirschmüller, Egloff, Nestler, & Back, 2013, Study 1; Hofmann, Gschwendner, et al., 2009, Studies 1 and 2; Günther, Matthes, Kersting, Egloff, & Suslow, 2016; McDaniel et al., 2009; Mierke &

Klauer, 2003, Study 3; Sava et al., 2012, Study 3; Schmukle, Back, & Egloff, 2008, Study 2; Siers & Christiaensen, 2013; Steffens, 2004, Study 2; Steffens & Schulze-König, 2006; Suslow et al., 2014; Vecchione et al., 2014; Vianello et al, 2013). The weighted average correlation between the IAT measures of extraversion and the IAT attribute item ratings observed had a medium size, equalling .35 (Back et al., 2009; Grumm & von Collani, 2007, Studies 1 and 2; Schmukle et al., 2008, Study 1; Schmukle & Egloff, 2005). Across four studies in which the same shyness IAT was implemented, implicit and explicit measures converged quite well. In the absence of faking instructions, the weighted average correlations between implicit and explicit shyness had a medium size, both when IAT attribute item ratings were used (.38; Asendorpf et al., 2002, Study 1; Teige et al., 2004) and the list of bipolar adjective pairs were used (.36; Asendorpf et al., 2002, Study 1; Briñol et al., 2006, Study 1; Schnabel et al., 2006b; Teige et al., 2004). As can be expected from the information processing accounts of implicit and explicit cognition (see above), the correlations between the shyness IAP and the explicit shyness measures were lower in the faking condition as compared to in the control condition. This was, however, not the case for the shyness IAT (Schnabel et al., 2006b). Also in line with the hypothesis, the correlation between implicit and explicit shyness was larger in a condition in which the participants thought more about information that was related to shyness compared to a condition in which the participant thought less about that subject (Briñol et al., 2006). In contradiction to the information processing accounts, however, extraversion IAT scores did not correlate significantly different with explicit extraversion in a volunteers group compared to a group of workers who took part in a personnel assessment program. Again, in line with the information processing accounts of implicit and explicit cognition, outcomes on another extraversion IAT were more strongly related with extraversion SMP scores, compared to explicit extraversion (Sava et al., 2012, Study 3). This significant difference between implicit-explicit consistency and implicit-implicitconsistency was, however, not observed for an extraversion SMP (Sava et al., 2012, Study 3), the shyness IAT and IAP (Schnabel et al., 2006b). It has to be concluded that, in the extraversion domain, the observed implicit-explicit consistency adds only to some extent to the construct validity of the implicit measures.

Fourth, if implicit trait measures correlate differently with social desirability compared to explicit trait measures, also this finding would add to the construct validity of both the implicit and explicit trait scores (Greenwald, Poehlman, Uhlmann, & Banaji, 2009). In the study of Schnabel et al. (2006b), the shyness IAT scores and the IAP effects did not correlate with social desirability, neither in the control, nor in the faking condition. Explicit shyness was, as expected, more strongly correlated with social desirability, but only in the faking condition in which participants were asked to act the least shy as possible. Concerning the implicit extraversion measures, neither extraversion IAT effects, nor extraversion SMP scores were differently associated with social desirability, compared to explicit extraversion (Sava et al., 2012, Study 3). Therefore, it must be concluded that the correlations between implicit and explicit measures of extraversion/shyness on the one hand, and social desirability on the other hand, only add – to some extent - to the construct validity of implicit shyness measures, but not implicit extraversion measures.

*Predictive validity.* Available evidence supports the single association predictive pattern and the incremental predictive validity of implicit extraversion/shyness, in the prediction of *observed* extraversion/shyness-related behaviour (Asendorpf et al., 2002; Study 1; Back et al., 2009; Hirschmüller et al., 2013; Hofmann et al., 2009, Studies 1 and 2; Horcajo et al., 2014, Study 1 and 2; Schnabel et al., 2006b; Steffens & Schulze-König, 2006), apart from one risk propensity IAT (Dislich et al., 2010; Horcajo et al., 2014, Study 2) and a shyness IAT (Schnabel et al., 2006b). Regarding the single association predictive pattern and the incremental validity pattern predicting *self-reported* extraversion-related behaviour and job performance rated by a manager, no significant results were observed (Rusu, Măirean, Hojbotă, Gherasim, & Gavriloaiei, 2015; Schmukle et al., 2008; Siers & Christiaensen, 2013; Steffens & Schulze-König, 2006). Two studies of Hofmann and colleagues (Hofmann, Gschwendner et al., 2009) confirmed that extraversion related behaviour was only predicted by implicit extraversion when the behaviour was rated by observers, but not when it was

scored by the participants themselves. These **mediated predictive pattern** results were replicated in two studies of Hirschmüller and colleagues (2013). In these studies, the participants completed an extraversion IAT and an extraversion questionnaire. Their videotaped performance was only rated by neutral observers (in contrast to the study of Hofmann, Gschwendner, et al., 2009), and became the basis for the observers' extraversion inferences. Interestingly, in these studies, ten independent expert judges also rated the degree of controllability versus automaticity of the behavioural cues observed on the videotape. It turned out that the more the behavioural cues were judged as controllable, the more the extraversion inferences based on these controllable cues were related to the participants' explicit extraversion, and less to the participants' implicit extraversion. The more the behavioural cues were judged as automatically processed, the more the reverse pattern was observed. These results are in line with the **double dissociation pattern** of explicit and implicit measures including that explicit measures rather predict controllable behaviour and implicit measures rather spontaneous behaviour.

The predictive validity of shyness IAT effects, in relation to explicit shyness, was examined in only two studies (Asendorpf et al., 2002, Study 1; Schnabel et al., 2006b, control condition). In the study of Asendorpf and colleagues (2002), the strong version of the **dissociation model** was confirmed, with the shyness IAT only predicting spontaneous shy behaviour and self-reported shyness only predicting controlled shy behaviour. In the study of Schnabel and colleagues (2006b), however, the shyness IAT was not significantly correlated with observed shy behaviour (control condition), in contrast to the shyness IAP and explicit shyness. The authors also explored the associations between the explicit and implicit shyness measures on the one hand, and spontaneous versus controlled shy behaviour on the other hand, but no significant results were observed. These results imply that a replication of the results of the seminal work of Asendorpf and colleagues (2002) concerning the strong dissociation predictive pattern of implicit and explicit shyness, has not yet been observed. According to Schnabel and colleagues (2006b), this might be due to the fact that, in their own study, the shyness-related behaviour was observed in the framework of a role-play. In

contrast, in the study of Asendorpf et al. (2002), shy behaviour was observed in a naturalistic interaction situation. The meaning of the observed behaviour might have been different in a roleplay versus a naturalistic situation. Another difference between both studies is the position of the shyness-related behaviour in the research design. In Asendorpf et al. (2002), the observation of the behaviour took place before the completion of the measurement tasks, whereas in the study of Schnabel et al. (2006b), in half of the participants, the role-play was positioned after the administration of the assessment tasks. More studies are needed to investigate whether the double dissociation pattern of implicit and explicit shyness will be replicated when the shyness-related behaviour is observed in a naturalistic situation and examined consistently *after* the completion of the direct and indirect assessment of shyness.

Finally, with regard to the risk propensity self-concept, Dislich and colleagues (2015) tested the double dissociation predictive model. Indirect measures of implicit risk propensity were expected to predict risk taking behaviour in a task that gratifies impulsive and punishes reflective tendencies. Direct measures of explicit shyness were hypothesized to predict risk taking behaviour in a task in which the reward and punishment procedure was designed the other way around. A *risk attitude* IAT as well as a *risk propensity self-concept* IAT were tested. However, the double dissociation predictive model was only confirmed for the risk attitude IAT.

The validity of implicit neuroticism measures and implicit facet measures assessing trait anxiety, depressiveness, shame proneness and dependency. Neuroticism is characterized by the predisposition to experience several negative affective states like anxiety, guilt, shame and depressive mood. Therefore, it is not surprising that different descriptors have been used to label this personality trait in indirect neuroticism measurement tasks ('calmness' versus 'nervousness', 'high neuroticism' versus 'low neuroticism', 'emotional stable versus emotional labile). This variety of category labels reflects the difficulty to capture the meaning of this broad personality trait in one, commonly used word, which is, however, a prerequisite for constructing IATs and other implicit measures of neuroticism. Consequently, several facets of implicit neuroticism have also been investigated, i.e. trait anxiety, depressiveness, shame proneness, and dependency. Depressiveness describes the trait counterpart of the state depression, and shame-proneness the trait counterpart of the state shame. Dependency describes the dispositional tendency to rely on others to be able to experience a sense of well-being. Within the neuroticism domain, the psychometric properties of implicit trait anxiety measures have most often been studied until now.

Some remarks have to be made in advance. The evidence for the validity of *implicit anxiety* measures will be reviewed here as far as this evidence adds to the validity of these measures as an indication of implicit *trait* anxiety, not *state* anxiety. Moreover, in seven studies, a so-called *neuroticism* IAT was administered in which, however, the same attribute categories were used as is the case for *anxiety* IATs, consisting of the same or similar items (Back et al., 2009; Donges, Jachmann, Kersting, Egloff, & Suslow, 2015; Schmukle et al., 2008, study 1 and 2; Suslow et al., 2014; Vecchione et al., 2014; Vianello et al., 2013). Therefore, these so-called neuroticism IATs will be reviewed here together with the trait anxiety IATs.

**Construct validity.** First, in between-subject designs, non-specific faking instructions did not influence the results of two anxiety IATs and the outcomes of an anxiety SC-IAT and a calmness SC-IAT (Egloff & Schmukle, 2002, Study 2; Stieger, Göritz, Hergovich, & Voracek, 2011). However, in the faking condition with specific instructions (Stieger et al., 2011), faking attempts significantly affected scores on the anxiety IAT, the anxiety SC–IAT and the calmness SC-IAT compared to the control group (Scheffé post hoc test: p = respectively .14, .29., and .27, all p < .05). No explicit trait anxiety measures were administrated in this study. As hypothesized, no significant differences were observed in mean anxiety IAT effect between volunteers and either security guards or semiskilled workers who took part in a personnel assessment program, in contrast to the explicit measures of trait anxiety. Additionally, it has been examined whether anxiety IAT effects are robust to the manipulation of *state* anxiety induction. The two studies in which the presence/absence of state anxiety induction was manipulated across two conditions showed that this was the case (Schmukle &

Egloff, 2004, Study 1 and 2). Because it is not possible to experimentally induce trait anxiety, the fact that the induction of state anxiety did not influence implicit trait anxiety in a between-subject and a within-subject design, adds to the experimental validity of *trait* anxiety IAT effects. However, these results must be complemented with the findings of Schmukle and Egloff (2005), and Sato and Kawahara (2012). Schmukle and Egloff (2005) observed in their latent state-trait analysis of implicit and explicit anxiety and extraversion that anxiety IAT scores captured more state variance compared to extraversion IAT effects. Sato and Kawahara (2012) found that the anxiety IAT effects did significantly differ between a high-stress versus a low-stress induction condition.

Second, to demonstrate whether trait anxiety IAT effects can differentiate between groups of which it is known that they differ with respect to explicit trait anxiety, remitted anxiety disorder (AD) patients can be compared with controls without a history of AD. One can expect that these two groups differ especially with respect to trait anxiety, and much less (or not) with respect to state anxiety. Comparing current AD patients with remitted AD patients or non-clinical controls is only informative with respect to the validity of anxiety IAT effects as implicit state measures. The same holds for comparisons between groups with another diagnosis in which state anxiety is a central symptom, and a remitted or non-clinical group (e.g., schizophrenia, Suslow et al., 2014). In two out of three studies published until now, remitted AD patients showed higher implicit anxiety on an anxiety IAT, compared to non-clinical controls (Glashouwer & de Jong, 2010; Glashouwer, de Jong, & Penninx, 2011; van Harmelen et al., 2010). Additionally, anxiety IAT effects differentiated between a high trait anxiety group and a low trait anxiety group (Huang, Yang, Miao, Lu, & Zhu, 2012). With regard to depressiveness, depressiveness IAT scores significantly differentiated between participants with remitted depression and a non-clinical control group. However, when these samples were divided into the participants with versus without a history of abuse, the latter result turned out to be only significant in the subgroup without a history of abuse (van Harmelen et al., 2010). Finally, the outcome of an IAT assessing shame proneness versus anxiety differentiated between women with a BPS and women with social phobia/healthy women (Rüsch et al., 2007). Importantly, it should be noted that - in all these studies - it was never examined whether the group effect remained after controlling for state anxiety/depressiveness/shame. More research is needed in which state/mood (induction) is taken into account. Nevertheless, it can be concluded that these results add to the known group effects of implicit measures of facets of the neuroticism domain.

Third, the weighted average correlation between the neuroticism implicit measures, the anxiety (SC-/brief) IAT effects, and the dependency SC-IAT effects on the one hand, and the guestionnaire measures of the respective traits at the other hand, were all small<sup>9</sup> (respectively .17, .16, and .08; Cogswell, Alloy, Karpinski, & Grant, 2010; Egloff & Schmukle, 2002, Studies 1, 3 and 4; Egloff & Schmukle, 2003, Study 1; Egloff & Schmukle, 2004, Study 1; Grumm & von Collani, 2007, Study 1; Gschwendner, Hofmann, & Schmitt, 2008a; Huang et al., 2012; Osinsky et al., 2010; Schmukle & Egloff, 2006, Study 2; Schnabel, Banse, & Asendorpf, 2006a; Siers & Christiaensen, 2013; Steffens & Schulze-König, 2006; Vianello et al., 2013). In contrast, the weighted average correlation between neuroticism, anxiety, and depressiveness IAT effects on the one hand, and the IAT attribute item ratings of the respective traits on the other hand, had a medium size (respectively .31, .32, .38, and .39; Back et al., 2005, Study 4; Back et al., 2009; Egloff & Schmukle, 2002, Study 3; Egloff et al., 2008; Schmukle et al., 2008, Study 1; Glashouwer & de Jong, 2010; Grumm & von Collani, 2007, Studies 1 and 2; Sava et al., 2012, Study 1; Schmukle & Egloff, 2005; Schmukle & Egloff, 2006, Studies 1 and 2; Schnabel et al., 2006a). These results cannot be compared with the correlation between two different implicit measurement tasks assessing aspects of the neuroticism domain, because this has not been examined yet. Nonetheless, the study of Egloff and colleagues (Egloff et al., 2008) shows that the correlation between an anxiety IAT and IAT attribute item ratings is significantly higher in an elaboration condition compared to a control condition. However, in the study of Vecchione and colleagues (Vecchione et al., 2014), the correlation between an anxiety IAT and explicit trait anxiety did not differ between a group of volunteers and a group of workers who took part in a personnel assessment program, which was in contradiction to the hypothesis. So, the study of Egloff and

<sup>&</sup>lt;sup>9</sup> By Cohen's convention, *d* effect sizes of .10, .30, and .50 are interpreted as respectively small, medium and large (Cohen, 1988).
colleagues (2008) is the only study of which the observed implicit-explicit consistency adds to the construct validity of anxiety IAT effects.

Fourth, the differential correlation between implicit and explicit trait measures on the one hand, and social desirability on the other hand was studied in the implicit neuroticism domain (i.e., implicit neuroticism, trait anxiety, and depressiveness). In only 1 of the 4 studies, significant differences were observed between the way in which the implicit and explicit measures correlated with (all aspects of) social desirability (Egloff & Schmukle, 2002, Study 3<sup>10</sup>; Egloff & Schmukle, 2003, Study 1; Sava et al., 2012, Studies 1 and 2; Schnabel et al., 2006a). In line with these results, irrespective of whether implicit and explicit anxiety differed in their relation with (aspects of) social desirability, the latter did not moderate the relationship between implicit and explicit trait anxiety (Egloff & Schmukle, 2003, Study 1 and 2). These results suggest that the lack of association between implicit and explicit trait measures in the neuroticism domain is not due to a self-presentational bias of the self-report measures.

*Predictive validity.* First, a single association predictive pattern was observed for several aspects of the neuroticism domain. In four studies, the single association prediction pattern of implicit neuroticism measures was investigated and perceived for (1) neuroticism GNAT scores in the prediction of the mean reaction time during the trials of the GNATs that were administered (Boldero et al., 2007, Study 2), for (2) neuroticism SMP scores in the prediction of self-reported career adaptabilities (Rusu et al., 2015), and for (3) neuroticism IAT effects and (4) anxiety IAT effects both predicting observed neuroticism-related behaviour (respectively Steffens & Schulze-König, 2006 and Back et al., 2009). Only in the study of Siers and Christiaensen (2013) did neuroticism IAT scores not predict employees' performance reported by the manager. Subsequently, dependency SC-IAT effects - when entered in two regression analyses as an independent variable, together with three dependency related questionnaires - were uniquely associated with major depression disorder criterion A and B symptomatology (*R*<sup>2</sup>s not reported; Cogswell et al., 2010). Moreover, of these four

<sup>&</sup>lt;sup>10</sup> Egloff & Schmukle, 2002, Study 3 and Egloff & Schmukle, 2003, Study 2 are the same studies.

dependency measures, only the SC-IAT scores differentiated significantly between the presence and absence of past major depressive disorder. Subsequently, with respect to implicit trait anxiety measures, the predictive validity results were equivocal. In two studies, a single association prediction pattern of anxiety IAT effects in the prediction of AD was examined. Glashouwer and colleagues (Glashouwer et al., 2011) observed that anxiety IAT scores predicted the onset of AD in a period of 2 years follow-up in the group with remitted AD, but not in the control group. Significant prediction of the onset of AD based on the anxiety IAT effects was also observed in the group with depressed participants with a history of AD, but not in the depressed group without a history of AD. The study of Cogswell and colleagues showed that dependency IAT effects "predicted" depressive symptomatology and the diagnosis of a major depressive disorder in the past (Cogswell et al., 2010). In three studies, a single association prediction pattern of anxiety IAT effects in the prediction of observed performance on a task (giving a speech, concentration task) was investigated (Egloff & Schmukle, 2002, Studies 3 and 4; Gschwendner et al., 2008a). Only three of the ten executed analyses were significant. In the only study examining the predictive effect of anxiety IAT effects on self-reported behaviour, both executed analyses were not significant (Schmukle et al., 2008, Study 2).

Second, studies investigating the **additive predictive pattern** in the neuroticism domain showed mixed results. In five studies, the predictive validity of implicit neuroticism measures was examined, over and above explicit neuroticism, (Cogswell et al., 2010; Rusu et al., 2015; Sava et al., 2012, Study 1; Siers & Christiaensen, 2013; Steffens & Schulze-König, 2006). Significant results were only observed in the study of Steffens and colleagues (2006) and in de study of Cogswell and colleagues (Cogswell et al., 2010). Neuroticism IAT scores predicted observed stress-related behaviour and self-reported stress, over and above explicit neuroticism ( $R^2$  not reported; Steffens et al., 2006). Dependency SC-IAT effects were associated with major depression disorder criterion A and B symptomatology over and above three dependency related questionnaires ( $R^2$ s not reported; Cogswell et al., 2010). Moreover, of these four dependency measures, only the SC-IAT scores differentiated significantly between the presence and absence of past major depressive disorder. Subsequently, with respect to implicit trait anxiety measures, the predictive validity results were equivocal. Subsequently, anxiety IAT scores and depressiveness IAT effects predicted respectively self-reported anxiety and depressiveness symptoms, over and above respectively anxiousness and depressiveness item ratings, across participants with current MDD/AD/both, remitted MDD/AD/both or without a history of MDD and AD (Glashouwer & de Jong, 2010). It is important to note, however, that the prediction of *symptoms* does not add to the incremental predictive validity of anxiety IAT effects, in the capacity of *trait* measure of anxiety. Regarding the incremental predictive value of anxiety IATs for observed behaviour, five of the eight hierarchical regression analyses were significant in the hypothesized direction (Back et al., 2009; Egloff & Schmukle, 2002, Studies 3 and 4; Schnabel et al., 2006a). The significant results were also observed after controlling for the valence of the attribute items of an anxiety IAT (Back et al., 2009) or for social desirability (Egloff & Schmukle, 2002, Study 3 and 4). No evidence was observed for the incremental predictive validity of an anxiety IAT over and above the neuroticism subscale of the NEO-FFI, and in the prediction of self-reported neuroticism related behaviour (Schmukle et al., 2008, Study 2).

In the study of van Harmelen and colleagues (2010), the **mediating effect** of anxiety IAT scores and depressiveness IAT effects between retrospectively reported childhood emotional maltreatment (CEM) and respectively self-reported anxiety and depressive symptoms were examined. By adding anxiety/depressiveness IAT effects as a mediator, the association between CEM and respectively anxiety and depressive symptoms reduced significantly, although not entirely. Interestingly, the mediating effect of the anxiety/depressiveness IAT effects remained after adding respectively the anxiety and depressiveness IAT attribute item ratings as another mediator in the model.

Finally, only in one study of Sava and colleagues (Sava et al., 2012, Study 1) and in the study of Cogswell and colleagues (Cogswell et al., 2010), the **interaction** of implicit and explicit neuroticism effects was examined, in the prediction of respectively negative word bias on a memory task and depressive symptomatology and disorder. No significant results were observed.

The validity of implicit agreeableness measures and implicit facet measures assessing (lack of) angriness and aggressiveness, humility, altruism, and forgiveness. Agreeableness reflects individual differences in cooperation, altruism, compliance and modesty. Indirect measures of the facets altruism, humility, and forgiveness have also been studied. Altruism is characterized by the concern for the welfare of others. A person high on altruism benefits others without the expectation of reciprocity, possibly at the cost of the self. Humility refers to the predisposition of lowering oneself in relation to others. Note that within the Big Six model, Humility is considered as a separate factor rather than a facet of Agreeableness, based also on substantial cross-cultural evidence (Ashton et al., 2004). Its inclusion here as a facet of Agreeableness is exclusively a matter of presentational convenience. Actually, there is strong evidence supporting the idea that Humility and Honesty should be considered as an independent sixth factor (Ashton et al., 2014). Forgiveness is a characteristic that is close to altruism and humility. It is the trait counterpart of the action of forgiving an offender, and has been indirectly measured in only one study until now. Finally, we decided to classify the implicit measures of (lack of) angriness and aggressiveness in the agreeableness domain. Aggressiveness is the trait counterpart of state aggression. Of all the factors of the FFM (Costa & McCrae, 1995), aggressive behaviour correlates with most of the Agreeableness facets (Jones, Miller, & Lynam, 2011). Angriness describes the trait counterpart of state anger. It is situated between the Agreeableness and the Neuroticism factor (e.g., Sanz, Garcia-Vera, & Magan, 2010). But because it is most often a prosecutor of aggressive behaviour, angriness is also classified in the agreeableness domain.

In the agreeableness domain, the indirect measures of aggressiveness has most often been investigated. In most of the aggressiveness IATs, 'aggressive' versus 'peaceful' were used as attribute categories. Some authors selected only verbs for these categories, instead of adjectives (Banse, Messer, & Fischer, 2015; Bluemke, Friedrich, & Zumbach, 2010; Bluemke & Friese, 2012, Study 3; Grumm, Hein, & Fingerle, 2011; Richetin, Richardson, & Mason, 2010; Schmitt, Hofmann, Gschwendner, Gerstenberg, & Zinkernagel, 2015). Because aggressive people are often not selfcritical about their level of aggressiveness, they may have developed a strong association between the categories 'me' and 'fighting' without qualifying themselves as 'aggressive' (Banse et al., 2015). Therefore, it is expected that behaviour versions of aggressiveness IATs better predict aggressive behaviour, compared to trait/adjective versions of these IATs. Comparing behaviour versions of the aggressiveness (SC-)IATs with trait/adjective versions of these IATs, the mean coefficients of equivalence do not differ between these two groups of IATs, being respectively .76 and .74.

*Construct validity.* First, as hypothesized, no significant differences were observed in a mean agreeableness IAT effect between volunteers and either security guards or semiskilled workers who took part in a personnel assessment program, in contrast to the explicit measures (Vecchione et al., 2014).

Second, by analogy with the indirect measurement of trait anxiety, also for implicit measures of aggressiveness, it is important to examine whether (trait) aggressiveness IAT effects are robust to the manipulation of state aggression. In four studies, the level of state aggression was experimentally induced in a between-subject design by manipulating the level of aggression of a videogame that participants played at the start of the session (Banse et al., 2015; Bluemke et al., 2010; Uhlmann & Swanson, 2004; Zumbach, Seitz, & Bluemke, 2015). Unfortunately, these studies did not allow to test the robustness of the aggressiveness IATs to aggression induction. In one study, state aggression was not measured (Bluemke et al., 2010), and in the other three studies, the directly assessed state aggression did not differ between the different conditions (Banse et al., 2015, Study 4; Uhlmann & Swanson, 2004; Zumbach et al., 2015). More studies are warranted here, especially in view of the results of a latent-state trait analysis that has been executed on an aggressiveness IAT (behaviour version) in children between 10 and 14 years old (Lemmer, Gollwitzer, & Banse, 2015). Twenty to thirty percent of the variance in the children's IAT scores was situation-unspecific, whereas 36 to 50% was situation-specific. These results are not as encouraging as the results of latent-state trait analyses of an extraversion and an anxiety IAT (Schmukle & Egloff, 2005). However, it must be considered that the four measurement occasions in Lemmer and colleague's (2015) study were spread over more than one year, whereas the two measurement occasions in Schmukle & Egloff's (2005) study were situated within one week. Consequently, the study of Lemmer and colleagues (2015) is a very conservative test of the extent to which the aggressiveness IAT measures trait aggressiveness variance.

Third, only for one of the five implicit measures for which known group differences were examined, positive results were observed. Aggressiveness IAT scores differed significantly between a group of butchers/hunters and men with other professions, with the former group showing scores indicating more aggressiveness (Voracek et al., 2010, Study 2). However, the scores on another – personalized - aggressiveness IAT did not differentiate between men and women in two examined samples (Voracek & Stieger, 2009). Moreover, both an aggressiveness IAT and a transgression IAT did not differentiate between offenders and a community sample (Suter, Pihet, de Ridder, Zimmermann, & Stephan, 2014), and two other aggressiveness IATs – a behaviour version and a trait version - did not differentiate between a group of ice hockey players and a group of volleyball players (Banse et al., 2015, Study 1). These results do not add to the known groups effects of implicit measures of the aggreeableness domain.

Fourth, the weighted average correlation between the agreeableness (SC-/brief) IAT scores, the aggressiveness IAT effects, and the angriness IAT effects on the one hand, and the questionnaire measures of the respective traits on the other hand, were all small <sup>11</sup> (respectively .13, .11, and .19; Banse et al., 2015. Studies 1-3; Bluemke, et al., 2010; Bluemke & Friese, 2012, Study 3; Gollwizer, Banse, Eisenbach, Naumann, 2007; Grumm & von Collani, 2007, Study 1; Grumm, et al. 2011; Schnabel et al., 2006a; Schmukle et al., 2008, Study 2; Steffens & Schulze-König, 2006; Teige et al., 2004; Teubel, Asendorpf, Banse, & Schnabel, 2011; Vianello et al., 2013; Veccchione et al., 2014; Voracek et al., 2010, Study 2). The weighted average correlation between agreeableness (SC-/brief) IAT effects and attribute item ratings of the IATs approached zero (.03; Back et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2008, Study 1). Apart from these low implicit-explicit

<sup>&</sup>lt;sup>11</sup> By Cohen's convention, *d* effect sizes of .10, .30, and .50 are interpreted as respectively small, medium and large (Cohen, 1988).

correlations, in two of three studies, the correlation between two aggressiveness IATs was significantly stronger compared to the correlations between the two aggressiveness IATs on the one hand, and explicit aggressiveness on the other hand (Banse et al., 2015, Studies 1 and 2; Bluemke & Friese, 2012, Study 3). Moreover, the correlation between implicit and explicit agreeableness was significantly stronger in a group of volunteers compared to a group of workers and security guards who took part in a personnel assessment program (Vecchione et al., 2014). The implicit-explicit consistency indicators observed in these three studies provide evidence for the construct validity of aggressiveness and agreeableness IAT effects.

Fifth, in the agreeableness domain, as much evidence is observed in favour of (Banse et al., 2015, Studies 1 and 3) as against (Banse et al., 2015, study 2; Schnabel et al., 2006a) the expected differential correlation of implicit and explicit measures with social desirability. In none of the four studies, a differential correlation was found with impression management (Banse et al., 2015, study 3; LaBouff, Rowatt, Johnson, Tsang, & McCullough Willerton, 2012, Study 3; Rowatt et al., 2006, Study 1; Fatfouta, Schöder-Abé, & Merkl, 2014).

Finally, the results from one study which found significant changes in implicit aggressiveness perceived between the post-test and the follow-up-test after the Vienna Social Competence training, need replication (Gollwizer, Banse, Eisenbach, & Naumann, 2007). This is also the case for the discrepancy that was observed between the implicit and explicit self-concepts towards aggression and transgression in an offender sample, while a community sample was characterized by a consistency between these implicit and explicit self-concepts (Suter et al., 2014).

*Predictive validity.* First, with exception of one analysis considering the multiplicative predictive pattern (Bluemke & Friese, 2012, Study 3), all tests examining the predictive validity of *behaviour* versions of an aggressiveness IAT were significant in the expected direction. It concerns the investigation of (1) the single association predictive pattern predicting observed behaviour (Banse et al., 2015, Studies 1 and 2) or other-reported behaviour (Banse et al., 2015, Study 3), (2) the additive predictive pattern predicting observed behaviour (Banse et al., 2015, Studies 1 and 2);

Grumm et al., 2011) or other-reported behaviour (Banse et al., 2015, Study 3), (3) the double dissociative predictive pattern (Schmidt, Zimmermann, Banse, Imhoff, 2015), and (4) the multiplicative predictive pattern predicting observed behaviour (Bluemke & Friese, 2012, Study 3; Richetin et al., 2010). The results concerning the single association and additive predictive patterns of a *trait* or *mixed*<sup>12</sup> version of an aggressiveness IAT were equivocal (Banse et al., 2015, Studies 1 and 2; Teubel et al., 2011). These results give a substantial amount of evidence for the predictive validity of the behaviour versions of aggressiveness IATs.

Second, in three studies, the single association and additive predictive validity patterns of agreeableness IAT effects were investigated. Although evidence for the single association and incremental predictive validity of agreeableness IAT scores was observed in the prediction of observed unjust accusation (Steffens & Schulze-König, 2006), this was not the case for observed helpful behaviour (Back et al., 2009) and for three of the four self-reported agreeableness criterion variables (Schmukle et al., 2008, Study 2).

Third, a humility IAT predicted two indicators of exam performance later in the semester (obtained from the university; Rowatt et al., 2006, Study 2). Another humility IAT predicted – over and above explicit humility - the amount of help that the participants *reported* to give, but only in the low pressure condition.

Fourth, the study of Perugini and colleagues (Perugini et al., 2011) confirmed the expected double dissociation pattern for spontaneous helping and general volunteering, but only for the altruism *attitude* IAT effects, not for the altruism *self-concept* IAT. As the authors commented, the absence of results with respect to the self-concept altruism IAT should be interpreted with caution because this IAT was always completed after the attitude altruism IAT. This might have adversely impacted on the validity of the self-concept altruism IAT.

Finally, a pattern of equivocal results was observed for implicit angriness (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, M., 2008, Study 3; Schnabel et al., 2006a) and forgiveness

<sup>&</sup>lt;sup>12</sup> One aggressiveness IAT included verb and adjective items (Teubel et al., 2011).

measures (Fatfouta et al., 2014). Interestingly, Hofmann and colleagues examined the moderating role of working memory capacity in the prediction of provoked aggressiveness behaviour based on an angriness IAT (Hofmann et al., 2008, Study 3). The results of this study demonstrated that the predictive influence of the angriness IAT on negative social feedback - but not on performance feedback - got weaker as the working memory capacity increased. A forgiveness IAT only predicted the time a participant needed to rate his feelings of revenge (not avoidance and benevolence; Fatfouta et al., 2014). This predictive relation was still observed when the directly measured tendency to forgive was controlled for. The fact that the predictive relation was only significant for the feelings of revenge - not avoidance and benevolence - might be because the attribute concepts of the IAT were 'forgiving' versus 'vengeful'.

The validity of implicit conscientiousness measures and implicit facet measures assessing impulse control, orderliness, industriousness, responsibility, and aiming at perfection. Conscientiousness comprises the "socially prescribed impulse control that facilitates task- and goal-directed behaviour, such as thinking before acting, delaying gratification, following norms and rules, and planning, organizing and prioritizing tasks" (John & Srivastava, 1999, p. 121). Four lower-level facets of this trait were consistently identified: impulse control, orderliness, industriousness, and responsibility (e.g., Roberts, Lejuez, Krueger, Richards, & Hill, 2014). Each of these lower-level facets – together with the characteristic of aiming at perfection - have been measured by one IAT until now (Costantini et al., 2015; De Cuyper et al., 2013). The other indirect measurement tasks, discussed here, aimed to assess the construct conscientiousness as a whole.

*Construct validity.* First, in a between-subjects design, conscientiousness IAT effects did not differ between baseline and after faking instructions, neither in the conscientiousness condition, nor in the non-conscientiousness condition (Steffens, 2004, Study 1). Moreover, as hypothesized, no significant differences were observed in mean conscientiousness IAT effect between volunteers and either security guards or semiskilled workers who took part in a personnel assessment program, in

contrast to the explicit measures (Vecchione et al., 2014). Both studies give evidence for the experimental validity of conscientiousness IAT effects.

Second, the weighted average correlation between (SC-/brief) IATs and explicit measures of conscientiousness had a small effect size, both when the IAT attribute items ratings were used (.18; six samples; Back et al., 2009; Grumm & von Collani, 2007, Study 1; Sava et al., 2012, Study 1; Schmukle et al., 2008, Study 1; Vianello, Robusto, & Anselmi, 2010, Studies 1 and 2), and when the questionnaire measures of conscientiousness were used (.15; 13 samples; Grumm & von Collani, 2007, Study 1; McDaniel et al., 2009; Sava et al., 2012, Studies 1, 2 and 3; Schmukle et al., 2008, Study 2; Siers & Christiaensen, 2013; Steffens, 2004, Study 1; Steffens & Schulze-König, 2006; Vecchione et al., 2014; Vianello et al., 2010, Studies 1 and 2; Vianello et al., 2013). Moreover, in contradiction to the hypothesis, the correlation between a conscientiousness IAT and explicit conscientiousness did not differ between a group of volunteers and a group of semiskilled workers and security guards who took part in a personnel assessment program (Vecchione et al., 2014).

Regarding the four IATs that measured each one of the lower-level facets of conscientiousness (i.e., impulse control, orderliness, industriousness, and responsibility; Costantini et al., 2015), the correlations with the IAT attribute item ratings had also a small effect size, and did not significantly differ from the weighted average correlation between conscientiousness IATs and the corresponding IAT attribute item ratings (Z = respectively -.90, -.22, -.33, and -.33, ns). The average correlations between the lower-level facets IATs and the questionnaire measures of those facets showed a low to medium effect size. Only the average correlation between the impulse control IAT and impulse control questionnaires was significantly stronger than the weighted average correlation between the conscientiousness IATs and questionnaire measures of conscientiousness (.10; Z = -2.35, p < .05; regarding the other facets Z = respectively -1.27, -1.03, and .23, ns).

Finally, the differential correlation of implicit and explicit conscientiousness with social desirability was investigated and observed in three studies, both for a conscientiousness SMP and IAT

(Sava et al., 2012, Studies 1, 2, and 3). These results add to the construct validity of implicit consciousness measures.

*Predictive validity.* Regarding the single association predictive pattern, implicit measures of conscientiousness, aiming at perfection and orderliness predicted respectively *observed* task persistence, exam performance, and working memory capacity (Costantini et al., 2015; De Cuyper et al., 2013; Sava et al., 2012, Study 2; Steffens et al., 2004, Study 1; Steffens & Schulze-König, 2006; Vianello et al., 2010, Study 2), with one exception (Back et al., 2009). Implicit measures of other facets of conscientiousness - impulse control, industriousness, and responsibility - did not predict observed criterion variables according to the single association pattern (Costantini et al., 2015). Of the four studies in which the incremental predictive effect of implicit conscientiousness measures was examined in the prediction of observed criterion variables, only Steffens and Schulze-König (2006) found (consistent) results in line with the hypothesis (Back et al., 2009; Sava et al., 2012, Study 2; Steffens & Schulze-König, 2006; Vianello et al., 2010, Study 2).

In the prediction of *reported* outcome variables, no criterion was consistently predicted by an implicit measure from the conscientiousness domain in accordance with the single association or additive predictive pattern (Costantini et al., 2015; Rusu et al., 2015; Schmukle et al., 2008, Study 2; Siers & Christiaensen, 2013; Vianello et al., 2010, Study 1). The implicit measure with the best predictive results was the orderliness IAT that predicted a composite score of ten daily orderliness-related behaviours and the self-reported ability to initiate desirable behaviour, but not the self-reported ability to obstruct undesirable behaviour (Costantini et al., 2015).

Finally, the *single* dissociative and the multiplicative predictive patterns have each been examined in the conscientiousness domain. The interaction between conscientiousness SMP scores and explicit conscientiousness did not predict observed task persistence (Sava et al., 2012, Study 2). On the contrary, conscientiousness IAT effects predicted an automatic aspect of conscientiousness, i.e., the number of errors in a concentration task, but not a controlled aspect of conscientiousness, i.e., returning the concentration test to the experimenter in time (Steffens, 2004, Study 1). The opposite predictive pattern was not significant for explicit conscientiousness.

The validity of implicit openness to experiences measures and an implicit facet measures assessing general causality orientation and need for cognition. Openness to experiences is a personality trait that includes several aspects: active imagination, aesthetic sensitivity, attentiveness to inner feelings, preference for variety and/or intellectual curiosity across different situations. The characteristics general causality orientation and need for cognition were therefore categorized as facets of this personality domain. General causality orientation refers to the tendency to be generally motivated by more autonomous than controlled reasons to engage in behaviour. People scoring high on dispositional *autonomy* motivation often experience their engagement in activities as their own choice, based on their interest in the activities and the satisfaction and pleasure they derive from it. People scoring high on dispositional *controlled* motivation often feel obliged to perform activities, or feel a sense of control or pressure coming from external events. Need for cognition refers to dispositional differences in enjoying and feeling satisfied by cognitive efforts.

*Construct validity.* First, as was expected, no significant differences were observed in mean openness to experiences IAT effect between volunteers and either security guards or semiskilled workers who took part in a personnel assessment program, in contrast to the explicit measures (Vecchione et al., 2014). However, in contradiction to the hypothesis, the correlation between implicit and explicit openness to experiences did not differ between the group of volunteers and the group of security guards and semiskilled workers. Second, a small – and even slightly negative - correlation was observed between (SC-/brief) IATs and questionnaire measures of respectively openness to experiences and general causality orientation (respectively .18 and -.05; Grumm & von Collani, 2007, Study 1; Keatley, Clarke, & Hagger, 2013, Studies 1 and 2; Levesque & Brown, 2007, Studies 1 and 2; Schmukle et al., 2008, Study 2; Steffens & Schulze-König, 2006; Veccchione et al., 2014; Vianello et al., 2013). No convergence at all was observed between the openness IATs and the IAT attribute item ratings (.00; Back et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukle et al., 2009; Grumm & von Collani, 2007, Study 1; Schmukl

al., 2008, Study 1). Finally, self-deceptive enhancement correlated significantly different with implicit and explicit causality orientation, although this was not the case for impression management (Levesque & Brown, 2007, Study 1). It has to be concluded that for the openness to experiences domain, evidence was only observed for the experimental validity of the implicit measures.

*Predictive validity*. First, in five studies, the single association and/or incremental predictive validity of openness IAT effects were investigated. Two studies examined the prediction of observed openness-related behaviour (Back et al., 2009; Fleischhauer et al., 2013, Study 2), and three studies investigated the prediction of self-reported openness-related behaviour (Levesque & Brown, 2007, Study 2; Schmukle et al., 2008; Study 2; Steffens & Schulze-König, 2006). The single association and incremental predictive pattern was only significant for observed recall of peripheral test information (Fleischhauer et al., 2013, Study 2) and self-reported reading classic literature (Schmukle et al., 2008; Study 2). In contrast, across the two studies of Keatley and colleagues (Keatley et al., 2013), causality orientation IAT scores demonstrated both single association predictive validity and incremental predictive validity in the prediction of observed task persistence, both in an unsolvable and in a solvable task, over and above explicit causality orientation (Keatley et al., 2013). However, in contrast to their hypothesis, implicit and explicit causality orientation did not interact with each other in predicting task persistence.

Second, Levesque and Brown (2007, Study 2) investigated the motivational reasons for engaging in five domains of activities during the two weeks after completion of the causality orientation measures. Two measurement methods were implemented. First, using an experiencesampling method, during those two weeks three times a day, participants were asked for their motivational reasons to engage in the activity of that moment. Second, after the two weeks, participants completed the General Causality Orientations Scale based on the experiences of the past two weeks. The first measurement method was hypothesized to imply more automatic processes compared to the second method. Levesque and Brown (2007, study 2) did not find evidence for the double dissociation pattern in the prediction of experience-sampled versus questionnaire based motivational outcome, which contradicted their hypothesis. Both outcome variables were predicted by explicit, but not by implicit causality orientation. However, Fleischhauer and colleagues (Fleischhauer, Strobel, Enge, & Strobel, 2013) examining implicit need for cognition, observed evidence for the double dissociation model in the prediction of reflective versus automatic aspects of need for cognition related behaviour. Moreover, the overall model fit of the double dissociation model was better, compared to the multiplicative predictive model, which also fitted the data well.

Interestingly, and revisiting the second study of Levesque and Brown (2007), the relation between causality orientation IAT scores and the motivational outcome as assessed by the experience sampling method, was moderated by dispositional mindfulness. Dispositional mindfulness reflects the tendency to persevere in mindful states across situations, independent of meditation practice. The causality orientation IAT predicted the experience sampled motivational outcome in participants low on dispositional mindfulness, but not in participants with high dispositional mindfulness. It is interesting to compare these results with the study of Hofmann et al. (2008, Study 3) who showed that the influence of an angriness IAT on negative social feedback diminished with increasing working memory capacity. It has been suggested that working memory is one of the underlying cognitive mechanisms of trait mindfulness (Ruocco & Direkoglu, 2013). Consequently, the results of those two studies converge to put working memory capacity and trait mindfulness to the front as important moderators in the prediction of criterion behaviour. More specifically, the influence of the implicit self-concept of personality on outcome variables diminishes when working memory capacity increases.

#### Discussion

## Psychometric properties of implicit measures assessing the self-concept of personality

**Reliability of implicit self-concept of personality measures.** The meta-analyses revealed an acceptable to good average Cronbach's coefficient  $\alpha$  and split-half reliability of implicit self-concept of personality IATs, respectively equating .82 and .73. These results are in line with the results of meta-analyses in which IATs, mainly assessing attitudes, were included (e.g., Hofmann, Gawronski,

Le, & Schmitt, 2005; Nosek, Greenwald, & Banaji, 2007). The estimated average test-retest correlation of the self-concept of personality IAT effects was somewhat lower compared to the attitude IAT effects, equating .41.

Because the temporal stability of implicit measures is a necessary precondition to be able to assess individual differences in a valid manner, it is important to understand the causes of the gap between the coefficients of equivalence and the test-retest correlations of implicit measures (Hofmann & Schmitt, 2008). In the literature, three factors have been investigated that can cause a decrease in the temporal stability of implicit self-concept measures: (1) situation-specific, (2) personspecific and (3) method-specific factors. First, the latent state-trait analysis of Schmukle and Egloff (2005) indicated that implicit anxiety and extraversion measures do not just capture stable interindividual differences, but are also sensitive to situation-specific effects. Moreover, this was true to a greater degree for the implicit measures, than for the questionnaires. Gschwendner and colleagues observed that the test-retest reliability of anxiety IAT scores was higher when anxiety-related background pictures were used in the IAT, instead of neutral background pictures (Gschwendner, Hofmann, & Schmitt, 2008b). These results of Gschwendner and colleagues (2008b) show that constraining the contextual influences on the implicit measure by using context-specific indirect measurement tasks, increases the temporal stability of – at least – anxiety IAT effects. The authors argue that the activation of the to-be-measured concept in the measurement task itself leads to a more consistent activation of the concept-relevant memories across time points. Therefore, they conclude that IATs in which relevant background pictures are used are more suitable for the assessment of traits, while decontextualized IAT versions might be more appropriate for measuring states.

Second, regarding the person-specific factors, Gschwendner and colleagues investigated whether the chronic accessibility of the to-be-measured personality trait influences the test-retest correlation of the implicit measure (Gschwendner et al., 2008b). Chronic accessibility is thought to be a function of stable individual differences. However, Gschwendner and colleagues (2008b) did not observe such an interaction effect on the test-retest correlation in the domain of implicit anxiety, in contrast to their findings in the domain of attitudes towards Turks. Importantly, in the study examining implicit anxiety, the chronic accessibility of anxiety was measured by means of the time the participants needed to answer the items of a self-description task. The test-retest correlation of this measure was low (.39). We therefore recommend to use other measures of the chronic accessibility of personality traits, such as well-validated questionnaires that were developed for the assessment of – in this case – trait anxiety.

Third, Schnabel and Asendorpf (2010) argued that method-specific variance of the IAT might also diminish the test-retest reliability. IAT effect sizes attenuate from the first administration to subsequent administrations. The block order that results in the largest IAT-effects – i.e., first the compatible block, then the incompatible block (see next paragraph: task-switching costs in the IAT) – produces systematically less robust scores in the IAT retest. This observation has been linked to the fact that, at the retest, the participants had already had the opportunity to exercise the categorization assignment of the incompatible task during the first administration of the IAT. In line with this hypothesis, Schnabel and Asendorpf (2010) suggest that the new variants of the IAT that eliminate order effects (e.g. the single-block IAT; Teige-Mocigemba, Klauer, & Rothermund, 2008; Rothermund, Teige-Mocigemba, Gast, & Wentura, 2009) might have a higher test-retest reliability. Until now however, we are not aware of indirect measurement tasks assessing the implicit self-concept of personality in which a single block procedure was used. A lot of work is still outstanding to provide more progress in this area.

A final consideration relates to the much higher test-retest correlation of (trait) questionnaires compared to the test-retest correlation of the implicit self-concept of personality measures. Gawronski and colleagues (Gawronski, Morrison, Phills, & Galdi, in press) observed a test-retest correlation of .63 for an extraversion IAT and of .83 for a conceptually equivalent direct measure of extraversion, both measures showing similar internal consistencies. This implies a higher amount of state or other situation-specific variance that is captured by implicit measures compared

to questionnaires (Lemmer et al., 2015; Schmukle & Egloff, 2005). Additionally, changes in test-taking strategies between the two test administrations might affect reaction time tasks more heavily than questionnaires (Egloff, Schwerdtfeger, & Schmukle, 2005). In contrast to this finding, it is remarkable that the test-retest correlation decreases less over time for implicit measures as compared to direct assessment methods. Egloff and colleagues (2005) demonstrated that the test-retest correlation of an anxiety IAT hovered around .55, irrespective of whether the retest administration occurred after 1 week, 1 month, or even 1 year. Both findings – the higher test-retest correlation of questionnaires and the higher stability of implicit measures over a long period of time – might be explained by the associative-propositional evaluation (APE) model (Gawronski & Bodenhausen, 2006, 2011). According to this model, the associative processes that underlie the implicit measures are based on similarity and spatio-temporal contiguity which make the implicit measures susceptible to situation-specific fluctuations. In contrast, the propositional processes that underpin the explicit measures involve validation processes based on cognitive consistency which are more consistent over time and across contexts, as compared to the associative processes, resulting in a higher test-retest correlation (Gawronski et al., in press). However, there is no reason - theoretically - to assume that the situational fluctuations affecting the implicit measures would increase with every measurement occasion. In contrast, the validation processes may result in different direct measurement outcomes over time (i.e., 1 week, 1 month, 1 year) because they build on the learning histories of people (e.g., trait maturation). This could explain why test-retest correlations appear to be less affected over time for implicit relative to explicit measures. To conclude, more studies are needed to examine the merits of these theoretical explanations as well as whether they apply also in other personality domains.

**Construct validity of implicit self-concept of personality measures.** First, the results of the narrative review allow us to conclude that evidence was observed for the strongest indicator of construct validity, being the experimental validity of the implicit self-concept of personality measures; and this in all five personality domains. Second, evidence for the known groups effects – also a strong

indicator of construct validity – was found for implicit measures from the extraversion and neuroticism domain, but not for implicit measures from the agreeableness domain. The known groups effects were not examined in the two other personality domains until now. Third, the differential correlation of implicit and explicit measures with social desirability only gives evidence for the construct validity of implicit measures in the conscientiousness domain, but not in the extraversion, neuroticism or agreeableness domains. Fourth, as was expected based on the implicit social cognition literature (Greenwald et al., 2009; Hofmann, Gschwendner, Nosek, & Schmitt, 2005; Hofmann, Gschwendner, & Schmitt, M., 2005), the meta-analytically integrated estimated average implicit-explicit consistency was low, amounting to .20. These results imply that the evidence observed for the construct validity of implicit self-concept of personality measures can at least be called meaningful, especially for the extraversion and the agreeableness domain, and for the facets of the neuroticism domain.

It is crucial to note here that the low implicit-explicit consistency cannot be interpreted as a lack of construct validity of the implicit measures. After all, a cutting point from which the implicit-explicit correlations give evidence for the construct validity of implicit measures is difficult to stipulate. It is (a) the comparison between the implicit-explicit consistency in different experimental conditions or groups, or (b) the comparison between the implicit-explicit consistency and the correlation between two different indirect measurement tasks assessing the same personality trait (called implicit-implicit consistency) that can give evidence for the construct validity of implicit measures. The results of studies using these experimental designs need consideration here.

First, in two studies, the comparison between the implicit-explicit consistency in different experimental conditions showed that the *strength* of the assessed trait moderates the implicitexplicit convergence in the domains of trait anxiety and shyness. In the study of Egloff and colleagues (Egloff et al., 2008), a significant positive relation was found between the implicit and explicit trait anxiety measures in the condition in which the participants elaborated on *anxiety*-arousing situations before completing the questionnaires and the IAT. In contrast, no correlation was observed in the control condition in which participants elaborated on *extraversion*-arousing situations before the administration of the measurement tools. Because the two conditions did not differ with respect to state anxiety, this moderation effect could not be mediated by a difference in state anxiety resulting from the manipulation of the elaboration instruction between the two conditions. In the study of Briñol and colleagues (2006), the strength of the assessed trait shyness was manipulated by varying the extent to which participants were asked to think about the trait (Briñol et al., 2006). The correlation between implicit and explicit shyness was larger in a condition in which the participants thought more about information that was related to shyness, compared to a condition in which the participant thought less about that subject. Both studies suggest that a better self-perception or awareness with respect to a specific personality domain increases the implicit-explicit consistency in that domain (Egloff et al., 2008; see also Perugini, Richetin, & Zogmaister, 2014). To further test this hypothesis in future studies, self-perception of the personality trait under study might also be manipulated in other ways than by activating information concerning the personality trait. For example, it would be expected that doing mindfulness exercises focused on the personality trait under study would increase the implicit-explicit consistency.

Second, the comparison between the implicit-explicit consistency in different experimental conditions (faking versus control) or groups (workers taking part in a personnel assessment versus volunteers) showed a moderating effect of a self-presentational bias on implicit-explicit consistency only for a shyness IAP (Schnabel et al., 2006b). In contrast, the moderating effect was not observed for five of the six IATs measuring an aspect of the self-concept included in the the Big Five (Schnabel et al., 2006b; Vecchione et al., 2010). Evidence for the moderating effect of self-presentational bias on implicit-explicit convergence in the self-concept of personality domain is, at present, lacking.

Third, in only 5 of the 10 tests examining the implicit-implicit consistency versus the implicit-explicit convergence, the implicit-implicit correlation was significantly higher than the implicit-explicit correlation (Banse et al., 2015, Studies 1 and 2; Bluemke & Friese, 2012, Study 3; Sava et al., 2012, Study 3; Schnabel et al., 2006b). This poor result can be due to two reasons: (1) explicit measures can

also capture automatic processes (e.g., if people rely on gut feelings to make ratings) which increases the implicit-explicit correlation, and (2) one or both implicit measures are unreliable which decreases the implicit-implicit correlation (Gawronski & Bodenhausen, 2014). The lack of reliability of implicit measures could be due to the method-specific variance that is captured by the implicit measures. Mierke and Klauer (2001) demonstrated in attitude IATs that switching between the categorization of attribute and target items produces more costs (i.e., more time) in the incompatible blocks than in the compatible blocks. This result was expected based on the idea that, in the compatible blocks, merely addressing the attribute-related information is typically enough to classify both attribute and target items fast and accurately. In the incompatible blocks, however, the target related information also needs to be processed, to be able to categorize all items correctly. When the IAT is used to measure individual differences in, for instance, extraversion, but individuals also differ in task switching abilities, the IAT-effect might not only reflect differences in extraversion, but also in task switching ability. In the domain of the implicit self-concept of personality, Mierke and Klauer (2003), Back and colleagues (2005) and Fleischhauer and colleagues (2013, Study 1 and 2) investigated the correlation between an IAT purely measuring task switching abilities and the absolute D-scores of respectively an anxiety IAT, an extraversion IAT and a need for cognition IAT. Task-switching abilities were expected to influence the IAT-effect only in the incompatible blocks. Whether a combined block is an incompatible block is function of the participant, not of an IAT itself. Consequently, low task switching abilities always lead to more extreme IAT-effects. The correlations between the task switching IAT effects and the self-concept of personality IAT D-scores were significant in only one of the four studies (Back et al., 2005), and the effect sizes ranged from zero in one study (Fleischhauer et al, 2013, Study 2) to small in the three other studies. These results show that the IAT D-scores assess task switching abilities to a small extent in the domain of the self-concept of personality. Therefore, the search for new variants of indirect measurement procedures that eliminate order effects of compatible and incompatible blocks (see also paragraph on temporal stability) might increase the implicit-implicit consistency of implicit self-concept of personality measures.

Consequently, studies on this issue will also be needed to get a clearer image of the implicit-implicit consistency of measures of the self-concept of personality.

Finally, our meta-analysis showed that the direct measurement method is also a moderating factor of the implicit-explicit consistency. In line with the hypothesis, the implicit-explicit consistency was higher when attribute item ratings (.24) instead of questionnaires (.14) were used to directly assess the personality characteristic. This result was expected because the attribute item ratings only differ from the implicit measures with respect to the measurement operation. In contrast, the questionnaires not only differ from the implicit measures with respect to the format and the content of the questions/items. Unfortunately, the correlation between implicit self-concept of personality measures and attribute item ratings only provides a small amount of evidence for the construct validity of the implicit measures because the item ratings were not validated as trait measures, in contrast to the trait questionnaires.

**Predictive validity of implicit self-concept of personality measures.** The results of the meta-analysis show that the estimated single association predictive effect of implicit self-concept of personality measures is small. The type of criterion variable – reported by the participant or observed by others – has been shown to be a moderating factor. The single association predictive effect was higher for observed criterion variables compared to self-reported criterion variables. Importantly, publication bias must be taken into account here. Greenwald and colleagues (2009) did not find a moderating effect of the type of criterion variable on the predictive effect of attitude IAT effects. However, in their meta-analysis, publication bias was not assessed using funnel plots.

The systematic narrative review results regarding the predictive validity of implicit measures of the five personality domains complement the findings of the meta-analysis. First, the single association and additive predictive patterns were found to be often significant for *observed* criterion variables in the extraversion domain, but not at all for *self-reported* outcome variables in that domain. For the *behaviour* versions of the aggressiveness IAT (Banse et al., 2015; Studies 1, 2, and 3; Bluemke & Friese, 2012, Study 3; Grumm et al., 2011; Richetin et al., 2010; Schmidt et al., 2015) and for a general causality orientation IAT (Keatley et al., 2013, Studies 1 and 2), both predictive patterns were also consistently significant in the prediction of observed behaviour. The prediction of selfreported criterion variables was not examined for these two facets. For the implicit measures of the other traits and facets, such a clear difference between the prediction of observed versus selfreported outcome variables was not observed. Interestingly, however, these observations in the extraversion domain and for the facets aggressiveness and general causality orientation are all confirmed by moderated predictive validity results found in several studies in the extraversion domain. Extraversion-related criterion behaviour was only predicted by implicit extraversion when the criterion behaviour was observed by the experimenter, but not when the behaviour was reported by the participants themselves (Hirschmüller et al., 2013; Hofmann, Gschwendner, et al., 2009). In our opinion, this issue needs further consideration in new studies, as well as in the other personality domains. This is especially the case because our meta-analytically integrated results showed that the study of the *single association* predictive pattern shows publication bias.

Second, the double dissociative predictive pattern results were not convincing. Significant results were observed for a shyness IAT (Asendorpf et al., 2002, Study 1), a behaviour version of an aggressiveness IAT (Schmidt et al., 2015), and for a need for cognition IAT (Fleischhouwer et al., 2013, Study 2). However, the predictive results of the shyness IAT effects were not replicated in another study (Schnabel et al., 2006b). Also for shyness IAP scores, risk propensity IAT effects, altruism IAT scores and general causality IAT effects, a double dissociative predictive pattern was examined, but not found. Future studies are needed to further investigate on which boundary conditions - and their interactions - the relation between implicit personality attributes and criterion measures depend. These boundary conditions include person-related variables, situational variables and characteristics of the indirect measurement tasks (Friese, Hofmann, & Schmitt, 2008; Gerstenberg et al., 2013; Gschwendner et al., 2008a; Gschwendner, Hofmann, & Schmitt , 2006; Schmidt et al., 2015). We agree with Gerstenberg and her colleagues (Gerstenberg et al., 2013) that "unless the relations

between implicit constructs (and their measures) with these boundary conditions (and their interactions) are included in a data model, the predictive potential of implicit constructs and the validity of their measures will be underestimated and misjudged" (p. 253-254). Our narrative review revealed some interesting studies in this respect, in the domain of implicit aggressiveness and angriness.

First, Richetin and colleagues investigated the predictive validity of aggressiveness IAT effects in a between-subjects design (Richetin et al., 2010). Aggressiveness IAT effects predicted the valence of the participants' evaluation of the experimenter, but only after the experimenter insulted the participant, in contrast to in the control condition in which the experimenter did not insult the participants. Second, Bluemke and Friese (2012, Study 3) observed that aggressiveness related behaviour, elicited from the participants without provocation, was predicted by aggressiveness IAT effects (using idiographic – and not generic – stimuli), but only when the participants showed high – in contrast to low - explicit aggressiveness. Third, Hofmann and colleagues perceived that the predictive influence of an angriness IAT on negative social feedback (but not on performance feedback) got weaker as the working memory capacity increased (Hofmann et al., 2008, Study 3). It is thought that the central executive function of working memory capacity – a prerequisite to achieving self-control - weakens the extent to which automatically processed angriness influences selfregulatory agressive behaviour (Friese, Hofmann & Wiers, 2011). In a fourth study, a double dissociation pattern was observed in the prediction of reactive aggression in a mock competitive game that took place within the lab (Schmidt et al., 2015). An aggressiveness IAT predicted the level of reactive aggression in a high ego depletion condition (participants have low self-regulatory resources), but not in a low ego depletion condition (participants have high self-regulatory resources). In the low ego depletion condition, a questionnaire measure of reactive aggression predicted the level of reactive aggression that was displayed by the participants during the competitive game, which was not the case in the high ego depletion condition. These four studies show that the relation between implicit aggressiveness/angriness and behavioural measures does indeed depends on the following boundary conditions: the provocation of aggressive behaviour (Richetin et al., 2010), high explicit aggressiveness (Bluemke & Friese, 2012), low working memory capacity (Hofmann et al., 2008), and lack of other self-regulatory resources (Schmidt et al., 2015). The search for the boundary conditions of the construct and predictive validity of implicit selfconcept of personality measures has also started (and begun to be reported) in the extraversion and openness to experiences domains (Hofmann, Gschwendner, et al., 2009, Studies 1 and 2; Levesque & Brown, 2007), but not yet in the neuroticism and conscientiousness domains. More studies investigating moderating and mediating predictive patterns are needed to further clarify how and why implicit self-concept of personality measures predict specific categories of criterion variables. This work will also be necessary to explain why all but one study examining *multiplicative* predictive patterns found insignificant results. We first conclude that clear evidence for the predictive validity of implicit self-concept of personality measures was found particularly in the extraversion and agreeableness domains – the latter mostly for the facets aggressiveness and angriness. In the other personality domains, more studies will be needed and must be reported, even when null findings were observed. Moreover, as is also the case in the implicit attitude research field, large cross-lab efforts are needed when it comes to the prediction of real-life personality-related behaviour.

Finally, we want to warn that – at present - it is premature to use indirect measurement tasks, like the IAT, as a diagnostic tool within applied (personality) psychology (e.g., Ortner & van de Vijver, 2015). Two important reasons for this are considered in this discussion-section. First, the test-retest correlations are, so far, too moderate to pass judgement on the personality of a specific person based on the outcome of self-concept of personality IATs. Second, more research is needed to investigate whether the predictive validity of the implicit self-concept of personality measures with respect to personality related behaviour can be enhanced by (i) a more thorough selection of the IAT attribute items (see below), (ii) a better understanding of the variables moderating/mediating the link between implicit self-concept of personality measures and criterion behaviours and/or (iii) the application of other indirect measurement tasks.

### Implications and future research

The construction of self-concept of personality IATs. The construction of self-concept of personality IATs needs consideration as the categories and stimuli used in these IATs might influence the validity of the tasks. First, the level of specificity at which a self-concept of personality is measured is of importance here (Perugini, Costantini, Richetin, & Zogmaister, 2015), especially when using indirect measurement tasks to capture broad personality traits like the Big Five, which consist of different facets. To appreciate the importance of these procedural elements, one must realize that these facets need to be sufficiently *correlated*, otherwise they would not be part of the same broad factor. But they also need to be sufficiently distinctive, otherwise there would be no reasons for distinguishing them. An ideal measure of a broad personality trait should therefore tap into the different facets. While this can be more easily accomplished with validated self-reported questionnaires, it is less straightforward with an IAT. Nonetheless, stimuli can be carefully selected with a dedicated study aimed at empirically identifying the best markers for each facet to be used subsequently in the IAT. A recent study of Costantini and colleagues is a good example of this approach (Costantini et al., 2015). However, the items of an indirect measurement task assessing a self-concept of personality are not often scientifically identified. Consequently, it should be considered that two indirect measures that are nominally the same might in fact reflect different aspects of the same trait. This issue, of course, has implications not only for implicit-explicit correspondence but also for predictive validity, where the correspondence between specific features of the to-be measured trait and the criteria to be predicted is paramount. Consequently, it is recommended for future studies to establish predictive validity by developing IATs at a facet level and considering criteria specific for that level.

Second, personality characteristics not only differ in their content, but also in their level of egosyntonicity (e.g., Paris, 2015). In personality domains that are characterized by high levels of egosyntonicity - for example aggressiveness or aiming at perfection - the process of self-deception is often active, and perhaps especially active in certain populations (respectively offenders and eating disorder patients; Banse et al., 2015). Implicit measures are less susceptible to self-deception, impression management and other aspects of social desirability compared to questionnaire measures. However, they are not immune to these tendencies (Perugini & Banse, 2007). Consequently, the validity of implicit measures in these personality domains and/or populations might also be limited. Banse and colleagues (Banse et al., 2015) suggest – and our narrative review confirms - that the use of verbs instead of adjectives/traits as IAT attribute item stimuli might increase the validity of these implicit measures. Linking, for example, the self with aggressive behaviour needs less of a self-critical attitude than linking the trait word 'aggressive' with the self. More research is needed to get a better insight into how the use of verb stimuli can increase the validity of implicit self-concept measures. Until now, the psychometric properties of *behaviour* versions of IATs have only been investigated for the facet aggressiveness, which had led to good results (Banse et al., 2015; Bluemke et al., 2010; Bluemke & Friese, 2012, Study 3; Grumm et al., 2011; Richetin et al., 2010; Schmidt et al., 2015).

**Information processing accounts of the personality self-concept.** At present, many researchers agree that implicit measures of the self-concept of personality mostly assess personality-related *associative* representations, whereas explicit measures of the self-concept of personality mostly assess personality-related *propositional* representations (e.g., Back et al., 2009; Schnabel & Asendorpf, 2010; Strack & Deutsch, 2004). In line with these dual process models, the results of direct measurement tasks (e.g., questionnaires, interviews) are often interpreted as measures of the subjective truth value of personality-related propositions, whereas effects in indirect measurement tasks are assumed to reflect the momentary activations of personality-related *associations*, regardless of whether they are acknowledged as accurate by the person them self.

However, as explained in the beginning of this article, several authors have recently defended the idea that implicit social cognitions might be the result of the automatic activation and formation of *propositions* (e.g., De Houwer, 2014; Hughes et al., 2011; Mann & Ferguson, 2015). According to the propositional model of implicit evaluation, "a stimulus can evoke an evaluative

response automatically only after a proposition about the evaluative properties of the stimulus has been formed or activated automatically" (De Houwer, 2014, p. 345; Hughes et al., 2011). De Houwer (2014) summarizes the evidence demonstrating that propositions can be activated automatically from memory. According to this model, the interpretation of the outcome of an IAT is a perilous undertaking. Take for example an IAT in which a positive score suggests a stronger association between "me" and the attribute concept "achievement oriented" as compared to the association between "others" and the attribute concept "achievement oriented" (De Cuyper et al., 2013). From a propositional perspective, a positive score on this Single Category IAT can reflect the proposition "I *am* more achievement oriented than others" or the proposition "I *want to be* more achievement oriented than others". Because IATs do not restrict the ways in which concepts are related, IAT scores cannot clearly reflect the exact nature of the propositions that might underlie these scores.

Building on this line of reasoning, this propositional model can, for example, shed a new light on the equivocal findings concerning the ability of IAT measures to differentiate between clinical and non-clinical groups - especially in the agreeableness domain. Recent studies by Remue and colleagues (Remue, De Houwer, Barnes-Holmes, Vanderhasselt & De Raedt, 2013; Remue, Hughes, De Houwer, & De Raedt, 2014) and Heider and colleagues (Heider, Spruyt, and De Houwer, 2015) investigate this issue in the domain of respectively self-esteem and body dissatisfaction by using an implicit measurement procedure that can capture different propositions (i.e., the Implicit Relational Assessment Procedure; IRAP; Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010). The results of Remue and colleagues (2013, 2014), for example, suggest that dysphoric people have a higher ideal self-esteem, and a lower actual self-esteem IAT (De Raedt, Schacht, Franck, & De Houwer, 2006; Franck, De Raedt, & De Houwer, 2007; Franck, De Raedt, & De Houwer, 2008; Ritter, Ertel, Beil, Steffens, & Stangier, 2013) – which does not restrict the way in which the concepts are related measured different propositions in the different populations (i.e., high ideal self-esteem in dysphorics and high actual self-esteem in controls), thus failing to detect the differences in the various types of self-esteem. Also in the domain of the self-concept of personality, it might be worthwhile to use the IRAP to investigate not only how clinical versus non-clinical groups differ from each other with respect to personality traits at an automatic level, but also to examine other aspects of construct and predictive validity. If it would indeed be the case that IATs measure propositions instead of associations, it might be that participants belonging to the same sample can have different propositions automatically activated during the task despite the stimuli being identical. Of course, this would have large repercussions for the hypothesis testing in these studies using indirect measurement tasks that are assumed to assess associations.

Towards an integration of the information processing account of personality into mainstream personality theory and research. During the last three decades, implicit social cognition and selfconcept research has demonstrated that *direct* assessment methods must be complemented with indirect measurement tools to assess psychological attributes that are prone to blind spots, social desirability, faking and/or impression management tendencies. Because implicit measures are based on automatic processes that operate in the relative absence of awareness, intention, cognitive resources or time (Bargh, 1994; Moors et al., 2010), indirect assessment tasks have the potential to provide measures that tap into aspects of the self that we cannot - or do not want to - get access to through introspection. These advantages of indirect assessment tasks are of value in several domains in which mainstream personality psychology is prominently present, for example, in clinical, forensic, and human resources settings. Despite these observations and arguments, however, the indirect assessment of the personality self-concept is not commonly integrated - neither pragmatically nor theoretically - within current practice in the mainstream personality field. This contrasts with the attitude domain, where it has become quite common to conduct studies measuring both implicit and explicit attitudes. Moreover, in the attitude research field, there are a number of theoretical models and contributions focused on the formation, functioning, and interplay of implicit and explicit attitudes (e.g., Gawronski & Bodenhausen, 2014; Strack & Deutch, 2004). One may wonder why the implicit self-concept of personality field is still situated in an earlier phase of integration with mainstream personality research, and what could be done to improve this situation.

First, there are some practical reasons that make integration less common than desirable. An indirect self-concept measure implies the use of a PC for each participant whereas a standard personality questionnaire is often collected in a paper-and-pencil format. This implies greater direct or indirect costs for the former. Another practical obstacle is that whereas one can collect a standard personality questionnaire measuring several constructs at once, within reasonable limits, this is trickier or not recommended for indirect measurement tasks (Nosek et al., 2007). This can make the study of the research question regarding personality functioning far more complex. Second, the skills and expertise required to develop and use an indirect measurement task overlap only partly with those that are acquired within a typical academic training path in personality. This matters also because there are little - if any - indirect self-concept of personality measures that are validated in the same sense and with similar psychometric standards as used for personality questionnaires. Hence, quite often indirect measurement tasks need to be constructed ad hoc for a specific study. This may hamper cumulative progress as well as reduce the attractiveness of using an indirect selfconcept measurement task for personality-oriented researchers. Until recently, this situation resulted in the construction of personality models in which little integration has been made with information processing accounts of personality (e.g., DeYoung, 2015).

Fortunately, there are two important exceptions to this evolution. First, the behavioural process model of personality of Back and colleagues (Back et al., 2009) is a personality-oriented adaptation of the reflective-impulsive model of Strack and Deutch (2004). It integrates a trait approach (FFM; Costa & McCrae, 1992; McCrae & Costa, 2008), an information processing approach (RIM; Strack & Deutch, 2004), and a motivational approach to personality (approach and avoidance temperaments in personality; Elliot & Trash, 2002). According to this model, the impulsive operating system - where associations between the self and (Big Five) traits are established – is influenced by approach and avoidance motivational tendencies. In interaction with the automatic perception of

situational cues, these motivational orientations drive behavioural activation towards approach or avoidance behaviour. Back and colleagues (Back et al., 2009) suggested that their implicit extraversion and neuroticism measures – in contrast to the other implicit Big Five measures - showed significant predictive validity because both traits "have been closely linked to basic affective dimensions and approach–avoidance tendencies ..., which foster the automatic execution of behavior" (Back et al., 2009, p. 542). Moreover, they demonstrated – together with Schnabel and colleagues (Schnabel, Asendorpf, & Greenwald, 2008b) - that the predictive validity results of their study did not change after controlling for valence. Consequently, the fact that approach and avoidance orientations differ as a function of valence does not explain the predictive validity results of Back and colleagues (Back et al., 2009). As such, this model of personality shows that individual differences in personality traits that are closely linked to approach and avoidance motivational tendencies result in personality-related behaviour – among others - through the operation of the impulsive system where the implicit self-concept of personality is established. This insight might prompt motivational personality researchers to include implicit measures of personality characteristics into their studies (e.g., Churchill & Jessop, 2011; Fishbach & Shah, 2006).

Second, the model of Hofmann and his colleagues also adopts the dual system view, in this case to study impulse and self-control (Hofmann, Friese, & Strack, 2009). Hofmann and colleagues (2009) proposed that self-control outcome variables are preceded by both impulsive and reflective precursors. Additionally, according to the model, both situational (i.e., depletion of self-regulatory resources) and dispositional moderators (i.e., working memory capacity) determine which of both precursors have the largest impact on self-control outcome variables in a specific situation. Our review included four studies that support this dual system model of self-control. In one study, angriness IAT effects predicted control over anger (= giving less negative social feedback about someone), but only if the working memory capacity of the participant was low (Hofmann et al., 2008, Study 3). In this study, the self-concept of angriness IATs examined in the studies of Bluemke and

Friese (2012, Study 3) and Richetin and colleagues (Richetin et al., 2010), were also shown to be impulsive precursors of aggressive behaviour. Also in these two studies, a situational (provocation of aggressive behaviour) and a dispositional moderator (explicit aggressiveness) of the impact of aggressiveness IAT scores on aggressive-related behaviour were identified. A fourth study showed that an irrelevant feature task assessing the self-concept of self-control predicted spontaneous self-control behaviours, in contrast to the explicit measures of trait self-control (Huntjens et al., 2014). These four studies also show that implicit measures of the self-concept of self-control need to be considered – in addition to the direct measures - to reach a full understanding of how the *self-concept* of self-control is related to the *ability* of self-control, i.e., accomplishing self-regulatory behaviour.

The behavioural process model of personality (Back et al., 2009) and the dual-systems perspective on impulse and self-control (Hofmann, Friese, et al., 2009) illustrate how the integration of information processing accounts into mainstream theories of personality can offer new hypotheses on the structure and dynamics of personality. We propose that the implicit self-concept of personality research field can breathe new life into the development of integrative models of personality by rigorously adopting a validation approach. The study of the implicit self-concept of personality must start from a careful empirical based selection of stimuli (which is conceptually equivalent to the selection of items when constructing a personality questionnaire), followed by a validation study. Only after these steps have been taken can the newly constructed self-concept of the implicit self-concept of personality measure be used in a substantial study (Costantini et al., 2015). This systematic review of the implicit self-concept of personality measures as they have been constructed and used until now, aimed at presenting the current state of the research field, in order to give all chances to this validation approach within the implicit self-concept research field.

# Conclusion

This systematic review shows that implicit self-concept of personality measures are reliable, and that first evidence is observed for the construct and predictive validity of these measures, especially in

the extraversion and agreeableness domains of personality. However, this only forms a starting point from which the implicit self-concept of personality field needs to move forward. Our review identified some improvements that are achievable and needed in the near future. To reach a realistic estimation of the construct and predictive validity of implicit self-concept of personality measures, future studies are needed to further investigate on which boundary conditions - and their interactions - the relation between implicit personality attributes and criterion measures depend on. Large cross-lab efforts are important in this respect. Furthermore, other or new variants of indirect measurement tasks need to be tested to focus on our "real self" instead of on our "ideal self", or a mix of both. Finally, and perhaps most importantly, the implicit self-concept of personality field must move from an "ad hoc" to a "validation" approach in developing new indirect measurement tasks, as is usually done for standard personality will increase its potential to become integrated into the mainstream personality field. Only by integrating different theoretical frameworks into personality theory and research, will the personality research field make significant steps forward in the prediction and explanation of real-life behaviour.

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\*= article is included in the review

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#### Appendices

#### Appendix A: Reaching independent samples to enter in the four meta-analyses

First, when the same indirect measurement task was administrated twice in the same study, the coefficient of equivalence of the first administration was only included into the review. When a control condition was compared with (an) experimental condition(s), only the coefficient of equivalence obtained in the control condition was included into the review. Test-retest reliability was inspected in studies in which the same indirect measurement task was administrated twice, without a specific treatment in between or before the first administration of the indirect measurement task.

Second, to compute the meta-analytically integrated average reliability coefficients, the samples are separated into statistically independent samples (Lipsey & Wilson, 2001, p. 112). Therefore, the following steps were taken in this order: (1) the reliability coefficients of two or more indirect measurement tasks assessing the same personality trait using the same measurement procedure in the same sample were averaged (Bluemke & Friese, 2012; Boldero et al., 2007, Study 1; Costantini et al., 2015; Horcajo et al., 2014, Study 2; Stieger, Goritz, et al., 2011, SC-IAT condition; Suter et al., 2014), unless the authors hypothesized that one of both tasks would have a more reliable and valid outcome (Banse, Mesner, & Fischer, 2015, Study 1 and 2; Sava et al., 2012, Study 3), (2) when two different measurement procedures were used to assess the same personality trait in the same sample, the reliability coefficient(s) of the indirect measurement task with the procedure the least used in the whole array of studies reviewed here, was omitted from the analyses (Bluemke, Friedrich, et al., 2010; Schnabel et al., 2006b), (3) the reliability coefficients of indirect measurement tasks assessing different Big Five traits using the same procedure in the same sample were averaged (Back et al., 2009; Boldero et al., 2007, Study 2; Glashouwer & de Jong, 2010; Grumm & von Collani, 2007, Study 1 and 2; McDaniel et al., 2009; Osinsky et al., 2010; Rusu et al., 2005; Sava et al., 2012, Studies 1, 2, and 3; Schmukle, Back, & Egloff, 2008; Study 1 and 2; Siers & Christiaensen, 2013; Steffens & Schulze-Konig, 2006; Suslow et al., 2014; Vecchione et al., 2014; Vianello et al., 2013). When two or more traits were assessed in the same sample that are not all part of the Big Five, the reliability coefficient of the task measuring the personality trait that was least studied in the whole array of studies reviewed here, was omitted from the analyses (Glashouwer & de Jong, 2010; Teige et al., 2004).

Third, for the meta-analysis estimating the relation between implicit and self-reported explicit measures of the self-concept of personality, the same procedure was followed to reach statistically independent samples.

Fourth, for the meta-analysis estimating the single association predictive pattern results, two categories of studies were not included in the analysis: (1) studies with two conditions in which the single association predictive validity results were not reported per condition (LaBouff et al., 2012, Study 3; Richetin et al., 2010; Schmidt et al., 2015), and (2) studies in which the criterion variable was an aggregated variable consisting of both self-reported and observed variables (Sava et al., 2012, Studies 1, 2 and 3). Subsequently, regarding the studies that tested the (single or double) dissociation predictive pattern, only the correlation between the implicit measure and the spontaneously processed behaviour – and not the behaviour processed in a controlled way - was considered in the meta-analysis (Asendorpf et al., 2002, Study 1; Dislich et al., 2010; Fleischhauer et al., 2013, Study 2; Levesque & Brown, 2007, Study 2; Perugini et al., 2011, Study 1; Steffens, 2004, Study 1). To end, the three steps taken to reach statistically independent samples that are explained above, were applied in the same way as for the three other meta-analyses.

#### Appendix B: Effect sizes used for the meta-analyses

The effect size used for the meta-analysis performed to obtain an optimal estimation of Cronbach's coefficient  $\alpha$  (CCA) is the transformed sample coefficient alpha:  $T_i=(1-CCA_i)^{1/3}$  with CCA<sub>i</sub> referring to CCA of Study i. As is common in meta-analytic studies (Lipsey & Wilson, 2001), the inverse of the variance is used for precision weighting with the variance of study i being  $[18J_i(n_i-1)(1-CCA_i)^{2/3}] / [J_i-1)(9n_i - 11)^2]$  (with J<sub>i</sub> the number of items used in the measure in Study i). Note that while discussing the results, all T<sub>i</sub>'s, the weighted mean effect size and confidence intervals are all converted back in the metric of CCA.

For the three other meta-analyses - obtaining an optimal estimation of the reliability, the implicit-explicit consistency and the single association predictive effect - the correlation coefficient was used as effect size. However, as noted by Lipsey and Wilson (2001), as the product-moment correlation coefficient has some undesirable statistical problems including a problematic standard error formulation (needed for precision weighting), all correlations were transformed using Fisher's  $Z_r$  -transformation:  $ES_{Zr} = 0.5 \log_e[(1-r_i)/(1+r_i)]$  with  $r_i$  being the correlation of Study i. For precision weighting the inverse of the variance of  $ES_{Zr}$  results in a weight  $w_i$  of study i with  $w_i$ = n-3. For ease of interpretation, all  $Z_r$ -transformed correlations, the weighted mean effect size, and all confidence intervals are also back transformed into standard correlational form.

For the funnel plots, we used untransformed effect sizes; note that the interpretation of  $T_i$  – the effect size for CCA –, is in reverse direction with lower (higher) values of  $T_i$  implying higher (lower) internal consistency (or reliability).

# Appendix C: Use of the statistic $T_i$ in the funnel plot of the meta-analysis of Cronbach Coefficient $\alpha$ 's (CCA)

As documented by Rodriguez and Maeda (2006), and mentioned in the method section and Appendix B, the transformed sample coefficient alpha T<sub>i</sub> is the appropriate effect size for CCA.  $T_i=(1-CCA_i)^{1/3}$  with CCA<sub>i</sub> being CCA of Study i with the variance of study i being  $[18J_i(n_i-1)(1-CCA_i)^{2/3}] / [J_{i}-1)(9n_i - 11)^2]$  (with J<sub>i</sub> the number of items used in the measure in Study i). As a result, CCA has its own sampling distribution and variance – that differs from the split-half and test-retest reliability – which can be used for precision weighting and other common meta-analytic procedures (see, Rodriguez & Maeda, 2006 and Appendix B for more information).

#### Tables

## Table 1

Overview of the results of the meta-analyses computing the estimated weighted averaged Cronbach's coefficient α and (retest)reliability of implicit self-

concept of personality measures (with 95% confidence interval)

	Cro	nbach's coefficient $\alpha$	F	Reliability coefficient		
		k = 51		k = 44		
		N = 19719 <sup>a</sup>		N = 6921		
Fixed Effect Model		.74 [.7475]		.82 [.8182]		
Q-statistic		2597.96***	442.44***			
Moderators (REM): F-statistic and estim	ated effect for	each category				
a. Trait vs. facet	.00	Trait: .71 [.6278]	1.52	Trait: .56 [.2477]		
		Facet: .71 [.6178]		Facet: .62 [.3381]		
b. Indirect measurement procedure	4.76**	IAT: .82 [.8085]	5.88**	IAT: .70 [.4685]		
		SMP: .68 [.4085]		GNAT: .61 [.2383]		
		SC-IAT: .67 [.5378]		SMP: .43 [.0371]		
		Brief IAT: .63 [.3482]				
c. Method: split-half vs. retest	n.a.		1.07	Split-half: .73 [.6480]		
				Retest: .41 [4086]		
d. Days time lag	n.a.		.02	n.a.		

*Note.* k = the amount of samples included in the meta-anlysis. REM: random-effects model. N.a. = not applicable.

<sup>a</sup> The same results were observed when the large study of Vianello et al. (2013; n = 14348) was excluded from the meta-analysis.

\*\* *p* < .01; \*\*\* *p* < .001

## Table 2

Overview of the results of the meta-analyses calculating the estimated weighted averaged implicit-explicit correlation and correlation between the implicit

	Relation between implicit and explicit		Single asso	ciation predictive effect of implicit		
		measures		measures		
		k = 70		k = 37		
		$N = 24029^{a}$		N = 4433		
Averaged weighted effect size (FEM)		.20 [.1921]		.19 [.1622]		
Q-statistic		228.00***	60.90**		228.00*** 60.90**	
Moderators (SEM): F-statistic and estima	ted effect for	r each category				
a. Trait vs. facet	3.72	Trait: .22 [.1430]	.43	Trait: .20 [.14 – .27]		
		Facet: .16 [.0824]		Facet: .18 [.1223]		
b. Indirect measurement procedure	.67	Brief IAT: .28 [.1241]	n.a.			
		SMP: .21 [.1032]				
		IAT: .20 [.1623]				
		SC-IAT: .17 [0739]				
		GNAT: .10 [0928]				
c. Item ratings <sup>b</sup> vs. questionnaire	11.06**	Item ratings : .24 [.1633]	n.a.			
		Questionnaire : .14 [.0721]				
d. Type of criterion variable	n.a.		7.98*	Observed: .25 [.2029] Self-reported: .13 [.0521]		

self-concept of personality measure and a criterion variable (with 95% confidence interval)

*Note.* k = the amount of samples included in the meta-anlysis; FEM = fixed effects model; SEM = random-effects model. N.a. = not applicable.

<sup>a</sup> The same results were observed when the large study of Vianello et al. (2013; n = 14348) was excluded from the meta-analysis. <sup>b</sup> The items coming from the implicit measure are rated on a Likert scale.

## Table 3

	Extraversion/ shyness	Neuroticism	Agreeableness	Conscientiousness	Openness to experiences	Over all domains
Experimental validity	10 +	8 +	2 +	4 +	2 +	26 +
	2 -	4 -	0 -	0 -	0 -	6 -
Known groups effects	1+	13 +	1 +	no data available	no data available	15 +
	0 -	3 -	4 -			7 -
I-E consistency vs. I-I	1+	no data available	4 +	no data available	no data available	5 +
consistency	3 -		2 -			5 -
I-E consistency in a between-	2 +	1+	1 +	0 +	0 +	4 +
groups design	2 -	1 -	0 -	1 -	1 -	5 -
Differential correlation of I	0 +	3 +	4 +	5 +	1+	13 +
and E measure with SD	4 -	6 -	8 -	0 -	1 -	19 -

Summary of the narrative systematic review results: Observed evidence for the construct validity of implicit self-concept of personality measures

*Note*: For each executed (and reported) statistical analysis examining a validity indicator (see left column), a plus (+) was assigned when the analysis gave evidence for the validity indicator, and a minus (-) was assigned when no evidence was observed for the validity indicator. These plusses and minuses were summed and are shown in the table.

Extraversion = implicit extraversion and risk propensity measures; Neuroticism = implicit neuroticism, trait anxiety, depressiveness, shame proneness and dependency measures; Agreeableness = implicit agreeableness, angriness, aggressiveness, humility, altruism and forgiveness measures; Conscientiousness = implicit conscientiousness and aiming at perfection measures; Openness to experiences = implicit openness to experiences, general causality orientation and need for cognition measures. I-E = implicit-explicit; I-I = implicit-implicit; SD = social desirability

## Table 4

	Extraversion/ shyness	Neuroticism	Agreeableness	Conscientiousness	Openness to experiences	Over all domains
Single association pattern						
Behaviour criterion	15 +	12 +	14 +	9 +	3 +	53 +
variables*	12 -	14 -	13 -	7 -	1 -	47 -
Reported criterion variables*	0 +	8 +	3 +	5 +	1+	17 +
	7 -	6 -	4 -	15 -	3 -	35 -
Additive pattern						
Behaviour criterion	4 +	6 +	7 +	2 +	2 +	21 +
variables*	0 -	4 -	7 -	3 -	1 -	15 -
Reported criterion variables*	0 +	6 +	3 +	1+	1+	11 +
	7 -	3 -	4 -	4 -	2 -	20 -
Single or double dissociation	1 +	no data available	1 +	1+	1 +	4 +
between behaviour and self- reported criterion variables	3 -		1 -	0 -	2 -	6 -
Moderated and mediated pattern						
Behaviour criterion	4 +	no data available	2 +	no data available	no data available	6 +
variables*	0 -		1 -			1 -
Reported criterion variables*	no data available	no data available	no data available	no data available	3 +	3 +
					5 -	5 -

Summary of the narrative systematic review results: Observed evidence for the predictive validity of implicit self-concept of personality measures

Multiplicative pattern						
Behaviour criterion	no data available	0 +	1 +	0 +	0 +	1+
variables*		1 -	1 -	1 -	2 -	5 -
Reported criterion variables*	no data available	0 +	no data available	no data available	no data available	0 +
		3 -				3 -

*Note*: For each executed (and reported) statistical analysis examining a validity indicator (see left column), a plus (+) was assigned when the analysis gave evidence for the validity indicator, and a minus (-) was assigned when no evidence was observed for the validity indicator. These plusses and minuses were summed and are shown in the table.

Extraversion = implicit extraversion and risk propensity measures; Neuroticism = implicit neuroticism, trait anxiety, depressiveness, shame proneness and dependency measures; Agreeableness = implicit agreeableness, angriness, aggressiveness, humility, altruism and forgiveness measures; Conscientiousness = implicit conscientiousness and aiming at perfection measures; Openness to experiences = implicit openness to experiences, general causality orientation and need for cognition measures.

\* When the criterion variable consisted of a composite score of observed and reported behaviour, the analyses were not included in this table (see Sava et al., 2012)