

# Single-Attribute Implicit Association Tests (SA-IAT) for the Assessment of Unipolar Constructs

## The Case of Sociosexuality

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**Abstract.** A major problem with Implicit Association Tests (IATs) is that they require bipolar attributes (e.g., good–bad). Thus, IAT effects for an attribute category can be interpreted only relative to an opposite category. Problems arise if there is no clear opposite category; in this case, a neutral category can be used, although it induces systematic error variance and thus reduces validity. The present study suggests that this problem can be solved using single-attribute IATs (SA-IATs). Sociosexuality (the tendency to engage in uncommitted sex) was expected to be related at the implicit level to stronger stranger–sex associations relative to partner–sex associations. An IAT was constructed that used conversation as a neutral attribute; it showed satisfactory reliability but only low correlations with explicit sociosexuality. An alternative SA-IAT with sex as the only attribute showed a similar reliability but higher correlations with explicit sociosexuality.

**Keywords:** implicit association, single-attribute IAT, sociosexuality

Current dual-system models in social cognition research take into account that there are deliberate, reflective determinants as well as spontaneous, impulsive determinants of behavior. Some models, such as the one by Strack and Deutsch (2004), assume that information processing giving rise to spontaneous behavior involves implicit mental representations of objects and their attributes in the form of associative networks. The association strength between the mental representations reflects the likelihood that the represented entities co-occur in reality or imagination. Thus, in principle it should be possible to use this information about implicit associations in order to assess individual evaluations and behavioral tendencies, without explicitly asking the respondents to report them.

In recent years, methods such as the Implicit Association Tests (IAT; Greenwald, McGhee, & Schwartz, 1998) have been developed for this purpose. Frequently, these procedures were designed to study implicit attitudes, including implicit self-esteem, by assessing associations between target objects and attributes along a good–bad dimension (see Fazio & Olson, 2003, and Spence, 2005, for reviews). Other studies explored associations between the self as a target concept and behavioral attributes such as shy–nonshy or angry–self-controlled (e.g., Asendorpf, Banse, & Mücke, 2002; Egloff & Schmukle, 2002; Schnabel, Banse, & Asendorpf, in press). The underlying assumption of these IAT versions is that they predict spontaneous behavior particularly well because they provide direct access to

associations between the self and representations of such behaviors.

Evolutionary psychology assumes that many impulsive determinants of human social behavior are based on domain-specific evolved psychological mechanisms that were shaped by selection pressures in our evolutionary past and that continue to operate in all humans, or are sex-specific (e.g., Buss, 2003; Tooby & Cosmides, 1990). More recently, attempts have been made by evolutionary psychologists to explain not only sex differences but also systematic interindividual differences within sex by principles of evolution, such as frequency-dependent selection, environmentally contingent strategies, or environment-contingent development (e.g., Buss & Greiling, 1999). The present study combines the social cognition and the evolutionary approaches in an attempt to study impulsive determinants of interindividual differences in sociosexuality.

## Sociosexuality

Individuals differ in their tendency to engage in uncommitted sexual activity, a disposition that Kinsey (Kinsey, Pomeroy, & Martin, 1948; Kinsey, Pomeroy, Martin, & Gebhard, 1953) termed *sociosexual orientation* or *sociosexuality*. Sociosexuality is conceptualized as a personality dimension, with the poles labeled “restricted” (monogamous) sociosexuality and “unrestricted” (promiscuous) so-

ciosexuality. On the basis of the observation that sociosexual behaviors, attitudes, and fantasies tend to correlate, Simpson and Gangestad (1991) developed the Sociosexual Orientation Inventory (SOI), a seven-item self-report questionnaire that combines measures of sociosexual attitudes, behaviors, and fantasies to an overall score. The SOI has been applied in over 40 published studies (reviewed in Simpson, Wilson, & Winterheld, 2004), including a large-scale intercultural study that confirmed its reliability and validity across 48 nations (Schmitt, 2005). The latter study also showed that men universally have a more unrestricted sociosexual orientation than women (an overall effect size of  $d = 0.74$ ), a sex difference that is expected from evolutionary theorizing (Buss & Schmitt, 1993; Trivers, 1972).

The heterogeneity of the SOI due to the inclusion of both sociosexual attitudes and behaviors has sometimes been criticized (e.g., Townsend, Kline, & Wasserman, 1995). We therefore first examined the factorial structure of sociosexuality in an extended version of the SOI, the Sociosexuality Scale (SS) by Bailey, Kirk, Zhu, Dunne, and Martin (2000).

Sociosexuality is distinct from general sex drive or libido (Ostovich & Sabini, 2004) and unrelated to the interest to engage in sexual activity with a committed relationship partner (Simpson & Gangestad, 1991). Indeed, sexual motivation toward strangers appears to serve completely different functions than sexual motivation in committed relationships (Buss & Schmitt, 1993; Klusmann, 2002).

## Assessment of Implicit Sociosexuality

If interindividual differences in sociosexuality are primarily based on evolved mechanisms at the level of impulsive information processing, they are a prime candidate for the application of social cognition methods such as Implicit Association Tests. However, we are not aware of any such study in the literature. Our attempt to study implicit sociosexuality was guided by four assumptions. First, the evolved mechanism underlying sociosexuality is the desire for sexual variety, a motive to quickly engage in sexual activity with members of the preferred sex, even if they are totally unacquainted (Buss & Schmitt, 1993; Schmitt, Shackelford, Duntley, Tooke, & Buss, 2001; Schmitt et al., 2003). Second, therefore, sociosexuality is characterized at the level of impulsive information processing (Strack & Deutsch, 2004) by the strength of the association between *stranger* and *sex*. That is, when unrestricted males and females meet strangers, they associate sexual thoughts and feelings with them more easily than do restricted males and females.

Third, because of the theoretically expected higher sociosexuality of males that has been strongly confirmed at the explicit level (Schmitt, 2005; Schmitt et al., 2003), males should show, on average, stronger stranger–sex associations than females. And fourth, the correlation between measured explicit sociosexuality and the measured association strength between *stranger* and *sex* should be moderately positive because both measures relate to the same construct but show method-specific variance in the

explicit measures (e.g., tendencies to admit or to exaggerate sexual motives) and in the implicit measures.

Thus, the key task was to construct a test that assesses the individual strength of the association between *stranger* and *sex*. Because of the notoriously low reliability of affective or semantic priming as a method for the assessment of interindividual differences (see, e.g., Spence, 2005), we initially attempted to construct an Implicit Association Test (IAT; Greenwald et al., 1998) that contrasts the association strength between *stranger* and *sex* with the association strength between *sex* and a control category that was generally linked with sex but not specifically linked with sex in unrestricted individuals. We chose *partner* as such a control target category because partner–sex is an ubiquitous association and because we did not expect a stronger partner–sex association for unrestricted individuals because explicit sociosexuality is unrelated to sexual interest in committed relationships (Simpson & Gangestad, 1991).

Another requirement for IATs is an opposite or at least neutral attribute category (in the present case, for sex). We used *conversation* as such an attribute because it can be easily associated with both strangers and partners and because we assumed that *conversation* is sexually neutral and therefore unrelated to sociosexuality. Thus, our sociosexuality IAT used categories that referred to social interaction: (a) the bipolar target categories stranger–partner that primarily differ with regard to the unfamiliarity of the social-interaction partner, and (b) the attribute categories sex–conversation that primarily differ with regard to the sexual nature of the social interaction.

## Study 1: IAT

A sociosexuality IAT aimed at assessing the association strength between *stranger* and *sex* relative to the association strength between *partner* and *sex* was developed in a laboratory experiment and subsequently was tested on the Internet. *Conversation* was chosen as a sexually neutral control category. Explicit ratings of the association of *sex* and *conversation* with an opposite-sex stranger in a hypothetical situation and the Sociosexuality Scale by Bailey et al. (2000) that includes the Sociosexual Orientation Inventory by Simpson and Gangestad (1991) served as validation criteria.

## Method: Laboratory IAT Study

Adult males and females were invited to participate in a laboratory study on sexuality through advertisements in local magazines or personal contacts. Most participants were students (less than 10% psychology students). Participants received either course credits or coupons for a local movie theater, or they participated in a lottery with attractive prizes. The present study refers only to those participants who (a) were 18–39 years of age, (b) were heterosexual and sexually experienced according to self-report, and (c) had an overall error rate not above 15% in the sociosexuality IAT (see below). These criteria were met by 50

males and 44 females; mean age was 24.0 years ( $SD = 4.3$ ).

Participants answered a few questions concerning personal information such as age, sex, sexual orientation, and relationship status, completed the sociosexuality IAT, and subsequently answered various questionnaires including a sociosexuality situation rating and the Sociosexuality Scale, in this sequence. Thus, the implicit sociosexuality measure was assessed before the two explicit sociosexuality measures. All items were answered on a computer.

### Sociosexuality IAT

This IAT was constructed closely following the procedure outlined by Greenwald et al. (1998). The target-concept discrimination was *partner-stranger*, and attributes were *sex-conversation*. In a first step, participants discriminated *partner-stranger* and then *sex-conversation*. In the initial combined task, they discriminated *partner-sex* from *stranger-conversation*. Subsequently, they discriminated *partner-stranger* in reversed order and finally *stranger-sex* from *partner-conversation* (reversed combined task; see Table 1). The 80 test trials in each combined condition were preceded by 40 training trials. The IAT effect was computed by subtracting the mean reaction time in the test trials of the reversed combined task from the mean reaction time in the test trials of the combined task; thus, positive IAT effects indicate faster associations between *stranger* and *sex* than between *partner* and *sex*, assuming that *conversation* is equally associated with strangers and partners.

Participants used the letter A on the left side of the keyboard and the number 5 on the right-side numeric keypad for discrimination. The target or attribute category names were presented in the left and right upper corners of the computer screen throughout each task. The stimuli (category exemplars; see Table 2) were presented in the center of the screen until the participant responded. In the two combined tasks, the stimuli alternated between target and attribute. Target and attribute categories were randomized in order within six blocks of 20 trials. Interstimulus interval was 250 ms; after an incorrect response, the word *FEHLER* (German for *error*) immediately replaced the stimulus for 300 ms. Because this study focuses on interindividual differences, all participants received the blocks and the stimuli in the same order to minimize interindividual variance due to order effects. Thus, the IAT means are confounded with block order and can be interpreted only with regard to interindividual and group differences, not absolutely.

Participants were instructed to respond as quickly and

accurately as possible. Their responses were recorded using experimental run-time system software (Beringer, 1994). In keeping with Greenwald et al. (1998), the first two responses in the combined tasks were not analyzed, response latencies below 300 ms were recoded as 300 ms, and latencies above 3,000 ms were recoded as 3,000 ms; incorrect responses were treated as missing values. The raw latencies were used only for descriptive purposes. All other statistical analyses were based on log-transformed latencies to correct for the skewed latency distribution.

### Sociosexuality Situation Rating

Participants were asked to imagine a situation in which they are alone in a train compartment with an attractive stranger of the opposite sex and to rate the extent to which they would associate this situation with 20 items on a 5-point scale (not at all–very much). Of the 20 items, 10 were the attribute stimuli for *conversation* and *sex* in the sociosexuality IAT (see Table 2), which were randomly mixed with 10 distractor items (e.g., window, smoking). The 5 conversation ratings ( $\alpha = .94$ ) and the 5 sex ratings ( $\alpha = .94$ ) were aggregated, serving as explicit measures of the tendency to associate conversation, or sex, with the stranger situation.

### Sociosexuality Scale

The 20-item Sociosexuality Scale (SS) by Bailey et al. (2000) was translated into German. It consists of the items of the Sociosexual Orientation Inventory (SOI; Simpson & Gangestad, 1991), 12 items in a yes/no format from Eysenck (1976) that assess sociosexual attitudes, and a further open question about the lifetime number of sexual partners. A factor analysis with varimax rotation identified, according to the scree plot, two orthogonal factors that could be clearly interpreted as sociosexuality attitude (highest-loading item *Sex without love is ok* explained variance 18.9%) and sociosexual behavior (highest-loading item *During your entire life, how many partners of the opposite sex have you had sexual contact with?* explained variance 14.6%).

Therefore, we constructed from the z-standardized items that loaded above .50 on one factor and below .30 on the other factor two short subscales of the SS, the sociosexual attitude scale (items no. 3, 9–12, and 14 of the original SS) and the sociosexual behavior scale (items no. 16–19 of the original SS). Because the items of the sociosexual behavior scale were strongly skewed and included zero responses,

Table 1. Implicit Association Test for sociosexuality: Task sequence

Block	No. of trials	Task	Response key assignment	
			Left key	Right key
1	40	Target discrimination	Stranger	Partner
2	40	Attribute discrimination	Conversation	Sex
3	40 + 80	Initial combined task	Stranger, conversation	Partner, sex
4	40	Reversed target discrimination	Partner	Stranger
5	40 + 80	Reversed combined task	Partner, conversation	Stranger, sex

Table 2. Implicit Association Test for sociosexuality: Stimuli (original German stimuli in parentheses)

Partner	Stranger	Sex	Conversation
Partner (Partner/in)	Stranger (Fremde/r)	Sex (Sex)	Talk (Gespräch)
Steady partner (Feste/r Partner/in)	Unknown person (Unbekannte/r)	Seduce (Verführen)	Conversation (Unterhaltung)
Lifetime companion (Lebenspartner/in)	Unfamiliar person (Unvertraute/r)	Lust (Lust)	Chat (Geplauder)
Steady relationship (Feste Beziehung)	New acquaintance (Neue/r Bekannte/r)	Erotic (Erotik)	Talking (Reden)
Lifemate (Lebensgefährte/in)	New man/woman (Neue/r Mann/Frau)	Arousal (Erregung)	Speaking (Sprechen)

they were submitted to a  $\log + 1$ -transformation. The resulting scales showed sufficient reliability despite their shortness:  $\alpha = .79$  for attitude,  $\alpha = .72$  for behavior. The two subscales correlated significantly but not highly,  $r = .34$ ,  $p < .001$ . To compare our findings with other studies, we also report results for the SOI score ( $\alpha = .69$ ).

### Method: Internet IAT Study

A similar study was conducted online on <http://www.psytests.de>, the online portal for Internet studies of the Institute of Psychology, Humboldt University. The Web site was also linked with multiple German Web sites specializing in psychological experiments and tests. Despite former preconceptions, evidence is accumulating that online studies can provide valid data for research on implicit associations (Nosek, Banaji, & Greenwald, 2002), personality (Gosling, Vazire, Srivastava, & John, 2004), and sexuality (Mustanski, 2001). The study was implemented in line with the guidelines on Internet research proposed by Michalak and Szabo (1998) and the recommendations given by Kraut, Olson, Banaji, Bruckman, Cohen, and Couper (2004).

After basic demographic questions, the sociosexuality IAT was given, followed by, among other measures, the Sociosexuality Scale. Both the implicit and explicit measures were analyzed exactly as in the laboratory study. The explicit ratings were programmed in HTML and php. The IAT was programmed as a JAVA applet, which was embedded in the Web page that the participants loaded into their browsers. When the IAT was successfully finished, the results were uploaded to the Web site. The JAVA applet used an inaccurate-timing filter (Eichstaedt, 2001) such that response time biases due to, for example, the parallel execution of other programs were minimal. Participants were prompted to reduce any sources of environmental disturbances during the study and asked to participate only if they had enough time and privacy.

During 17 days, 187 Web site visitors completed all parts of the study. Selected for the final sample were all sexually experienced heterosexuals age 18–39 years (47 males, 89 females); mean age was 23.7 years ( $SD = 5.2$ ). The sample did not differ significantly from the laboratory sample with regard to age and the number of lifetime sexual partners (all  $p$  values  $> .10$ ).

### Results

Four participants (4.3%) in the laboratory IAT, and three participants (2.2%) in the Internet IAT showed more than 15% incorrect responses during the combined blocks; they were excluded from further analysis. As Table 3 indicates, the laboratory and the Internet IAT showed similar means, SDs, error rates, and internal consistencies  $\alpha$ ;  $t$  tests confirmed this for the mean IAT effect and the error rate,  $t < 1$ , in both cases. Also, the correlations with the explicit sociosexuality scales were not significantly different as confirmed by  $z$  tests for differences between correlations. Thus, the Internet method yielded results virtually identical to the laboratory method's results.

Concerning the validity of the IAT, the results were disappointing because the correlations with the explicit sociosexuality scales (SOI and the behavioral and attitudinal subscales of the SS) were not significant in all six cases (the mean correlation was .04). Also, the sex difference was not even marginally significant for both the laboratory IAT and the Internet IAT ( $p > .10$  in both cases). This result suggested that there was perhaps a problem with the conversation category. If conversation is positively related to implicit sociosexuality, this would at least partly explain the low correlation between the IAT and the sociosexuality scales.

In order to test this a posteriori hypothesis, the stranger situation ratings in the laboratory study were analyzed (situation ratings were not assessed in the Internet study). The conversation ratings correlated clearly positively with the sex ratings,  $r = .41$ ,  $p < .001$ . Thus, participants who more strongly associated sex with the stranger situation also tended to more strongly associate conversation with it, and vice versa. However, the SOI scores were only associated with the sex ratings. They correlated significantly,  $r = .26$ ,  $p < .05$ , with the sex ratings, not at all with the conversation ratings,  $r = .00$ , and significantly with the sex–conversation difference score,  $r = .26$ ,  $p < .05$ . Thus, as expected, explicit sociosexuality was related to the explicit tendency to associate sex with this situation, but not conversation. In other words, conversation was a neutral category, not an opposite category, with regard to explicit sociosexuality. As Table 3 indicates, the sociosexuality IAT replicated this pattern. It correlated  $r = .19$ ,  $p = .07$ , with the sex rating, and  $r = -.03$ , ns, with the conversation

rating; the correlation with the difference score sex–conversation was  $r = .21, p < .05$ .

Together, these results for the stranger-situation ratings suggest that conversation is a neutral category with regard to sociosexuality at both the explicit and the implicit level. The rather high correlation of .41 between the ratings of conversation and sex seems to be due to shared method variance that is independent of sociosexuality, particularly situation-specific tendencies to engage in any activity with strangers.

## Discussion

This study has replicated for a laboratory version and an Internet version descriptive indices of a sociosexuality IAT that aims at assessing the association between *stranger–sex* relative to *partner–sex*, with *conversation* serving as a neutral category. For young adult samples, the mean, the standard deviation, and a satisfactory error rate and reliability were replicated. However, at the same time this study also replicated that this IAT failed to show any significant correlations with three explicit sociosexuality scales. Weak evidence for the IAT's validity was only found for the ratings of a potential interaction with an opposite-sex stranger; the IAT was significantly related to *sex* minus *conversation* ratings that used the IAT stimuli for these categories as items. Together, these results point to a weak validity of the IAT that was only revealed for an explicit measure that was more closely matched to the IAT procedure than the traditional sociosexuality scales. These situation ratings also confirmed that conversation is a neutral category with regard to both implicit and explicit sociosexuality because both explicit sociosexuality and the IAT correlated virtually zero with the conversation ratings while showing at least marginally positive correlations with the sex ratings.

These results suggested to us that the validity of the sociosexuality IAT was suppressed by individual differences in the tendency to associate conversation more with strangers than with partner, individual differences that were irrelevant for sociosexuality but confounded with the IAT scores. Therefore we constructed a sociosexuality single-attribute IAT (SA-IAT) that relied solely on the attribute category *sex* but was otherwise as much comparable with the sociosexuality IAT as possible.

Table 3. Results for the sociosexuality IAT: Effect, error rate, reliability, and external correlates

	N	Effect (ms)		Error rate <sup>a</sup>		Reliability	Correlation $r$ with				
		M	SD	M	SD	a <sup>b</sup>	SOI	SS <sub>att</sub>	SS <sub>beh</sub>	Conv	Sex
Laboratory	94	–156.2	148.3	5.3%	3.3%	.81	.13	.20#	.07	–.03	.19#
Internet	133	–126.6	141.8	5.4%	3.6%	.75	–.06	.02	–.13	–	–

SOI = sociosexual orientation inventory sum score, based on the  $z$ -transformed items of the SOI

SS<sub>att</sub> = sociosexual attitude subscale of the Sociosexuality Scale (SS); SS<sub>beh</sub> = sociosexual behavior subscale of the SS

Conv = situation rating conversation; Sex = situation rating sex

<sup>a</sup> Percentage of incorrect responses in the combined tasks.

<sup>b</sup> Reliability was evaluated with regard to the four 20-trial blocks in the test trials of the combined tasks.

#  $p < .10$ .

## Study 2: SA-IAT

### Method

For this study, the sociosexuality IAT was modified to a single-attribute IAT. Target concepts were again *partner* and *stranger*, but only *sex* served as the (unipolar) attribute; for these three categories, the same stimuli were used as in the sociosexuality IAT. The testing and analysis procedures were the same as for the sociosexuality IAT except that (a) the attribute discrimination and the reverse attribute discrimination were dropped, and (b) only sex-related stimuli were presented in the attribute conditions (thus, each of the five stimuli of the target category that was presented without accompanied attribute stimuli in the combined blocks occurred twice as often as in the sociosexuality IAT). Table 4 presents the SA-IAT task; it is structurally highly similar to the single-target IAT (ST-IAT) by Wigboldus, Holland, and van Knippenberg (2005), except that the asymmetry in this variant of the IAT refers to attributes rather than targets.

Because we were initially concerned that participants would become bored during the many trials of this simplified procedure, and because Wigboldus et al. (2005) used only 40 trials in the combined blocks of their ST-IAT, we first implemented a short version of the SA-IAT with only 20 trials in the target discrimination task and only 60 trials in the combined tasks. Because of reliability problems, we subsequently used the full procedure. In the following par-

Table 4. Single-attribute IAT for sociosexuality: Task sequence

Block	No. of trials <sup>a</sup>	Task	Response key assignment	
			Left key	Right key
1	40	Target discrimination	Stranger	Partner
2	40 + 80	Initial combined task	Stranger	Partner, sex
3	40 + 80	Reversed combined task	Stranger, sex	Partner

<sup>a</sup> Half as many trials in each condition for the short version.

agraphs we refer to these two versions as the short version and the full version.

The short version was tested over the course of 17 days immediately preceding the Internet IAT study—thus, on as many days as the Internet IAT, resulting in 236 completed tests. The full version was tested during a whole year, starting after the IAT testing, because it was found to be advantageous to the short version as shown in the result section. To provide a fair comparison between short and full version, only the tests of the full version completed on the first 17 days of testing are considered here (171 tests). The final sample consisted of 315 sexually experienced heterosexuals age 18–39 years (in the short version, 56 males and 117 females, mean age 23.9 years,  $SD = 5.4$ ; in the full version, 54 males and 89 females, mean age 24.3 years,  $SD = 5.9$ ). The Internet samples in studies 1 and 2 (IAT, short SA-IAT, full SA-IAT) did not differ significantly with regard to sex composition, age, highest achieved educational level, and number of lifetime sexual partners.

## Results

Because of error rates above 15% in the SA-IAT, nine participants (5.2%) were excluded for the short SA-IAT, and four participants (2.9%) for the full SA-IAT. Table 5 presents the results for these two SA-IAT versions that can also be directly compared with the results for the two IAT versions in Table 3. Table 5 indicates that the short and the long versions had a mean close to zero and similar standard deviations and error rates. However, the long version was more reliable, which can be attributed to the double number of trials in each combined task. Indeed, the Spearman-Brown formula predicts a reliability of .81 for the full version on the basis of the .68 reliability for the short version. An inspection of the corrected block–total correlations for the six 20-trial blocks to which the reliability of the full version refers indicated that these correlations were similarly high; in particular, they did not decrease toward the end of the test trials. Because of the higher reliability of the full version, it is not surprising that the correlations with the sociosexuality scales were somewhat higher for the full version.

When the SA-IAT findings for the full version were compared with the Internet IAT results (to avoid methodological differences with the laboratory IAT), the SA-IAT showed a similar error rate and reliability, significantly higher correlations with the SOI scale,  $z = 2.48$ ,  $p < .05$  and the behavioral SS subscale,  $z = 2.46$ ,  $p < .05$ , but not with the attitudinal SS subscale,  $z = 1.57$ , *ns*. The SA-IAT also showed a significantly more positive mean,  $t(270) = 9.09$ ,  $p < .001$ , and a smaller standard deviation,  $F(1, 270) = 10.93$ ,  $p < .001$ ; the interindividual variance was reduced to 60% of the IAT variance. Finally, a comparison of the mean reaction times for the 80 test trials between the Internet IAT and the full SA-IAT revealed significantly faster reactions in the SA-IAT (for the first combined block: IAT,  $M = 795.2$  ms,  $SD = 165.7$ , SA-IAT,  $M = 750.4$  ms,  $SD = 240.3$ ,  $t(270) = 2.90$ ,  $p < .005$ ,  $d = 0.35$ ; for the reversed combined block: IAT,  $M = 921.8$  ms,  $SD = 197.6$ , SA-IAT,  $M = 741.2$  ms,  $SD = 228.8$ ,  $t(270) = 8.87$ ,  $p < .001$ ,  $d = 1.08$ ). The faster responses particularly for the reversed combined block can be attributed to the easier SA-IAT task, particularly regarding the reversal of a single attribute in the SA-IAT versus two targets in the IAT (see Tables 1 and 4).

An analysis of the sex differences in the two SA-IAT versions was consistent with the hypothesis that the full version showed a higher validity than the short version. Whereas the sex difference for the short version was not significant,  $p > .10$ , which was consistent with the IAT, the full SA-IAT showed the expected sex difference. Males had significantly higher implicit sociosexuality scores than females (for males,  $M = 21.4$  ms,  $SD = 128.0$ ; for females,  $M = -13.0$  ms,  $SD = 97.6$ ;  $t(137) = 2.01$ ,  $p < .05$ ,  $d = 0.34$ ), which was slightly smaller than the effect at the explicit level for Germany of  $d = 0.48$  (Schmitt, 2005). Thus, only the full SA-IAT version showed a significant, moderate sex difference.

To test whether this sex difference was only due to the correlation of the SA-IAT with explicit sociosexuality, an analysis of covariance was conducted, with sex as the independent factor and the SOI score as the covariate. The sex effect for the SA-IAT remained nearly unchanged,  $F(1, 136) = 3.46$ ,  $p = .06$ ,  $d = 0.32$ . Thus, it cannot be attributed to a mediation through explicit sociosexuality.<sup>1</sup>

Table 5. Results for the sociosexuality SA-IAT: Effect, error rate, reliability, and external correlates

SA-IAT	N	Effect (ms)		Error rate <sup>a</sup>		Reliability	Correlation <i>r</i> with		
		M	SD	M	SD	a	SOI	SS <sub>att</sub>	SS <sub>beh</sub>
Short	163	-1.95	101.1	5.7%	3.8%	.68 <sup>b</sup>	.20*	.14	.14
Full	139	-0.64	110.3	4.5%	2.6%	.82 <sup>c</sup>	.21*	.19*	.14

SOI = sociosexual orientation index, based on the *z*-transformed items of the SOI;

SS<sub>att</sub> = sociosexual attitude subscale of the Sociosexuality Scale (SS); SS<sub>beh</sub> = sociosexual behavior subscale of the SS

<sup>a</sup> Percentage of incorrect responses in the combined tasks.

<sup>b</sup> Reliability was evaluated with regard to the three 20-trial blocks in the combined task.

<sup>c</sup> Reliability was evaluated with regard to the six 20-trial blocks in the combined task.

\*  $p < .05$ .

<sup>1</sup> The effect sizes remained highly similar with regard to reliability, correlation with explicit sociosexuality, and sex differences when the full SA-IAT data obtained during a whole year were analyzed, and these effects were all confirmed at the  $p < .001$  level due to the much larger sample ( $N = 1611$ ).

## Discussion

The findings for the two SA-IAT versions suggest that (a) the full version should be preferred to the short version because of the higher reliability of the full version, and (b) the SA-IAT is a more valid measure of implicit sociosexuality than the IAT.<sup>2</sup>

The much larger interindividual variance of the Internet IAT, as compared with the full SA-IAT, suggests that the IAT effects were confounded with interindividual differences to associate conversation more with a stranger than with a partner. As the stranger-situation ratings in the laboratory study suggested, these additional interindividual differences were largely independent of the target interindividual differences, namely to associate sex more with a stranger than with a partner. Because of this additional variance component, the variance was higher in the IAT than in the SA-IAT. The more negative mean in the IAT as compared with the SA-IAT suggests that the confounding component in the IAT had a negative mean; that is, participants overall associated conversation less strongly with a partner than with a stranger, slowing down the reversed combined task, which is interpreted in terms of implicit sociosexuality as low implicit sociosexuality.

It should be noted that this is by no means the only possible interpretation. Alternatively or additionally, a comparison of the reaction times between the IAT and the SA-IAT suggests that the participants in the SA-IAT profited more from the simpler task reversal, speeding up their responses in the reversed combined block, which is interpreted as higher implicit sociosexuality. Also, the higher variance of the IAT as compared with the SA-IAT may be partly due to higher task-shift costs in the IAT, a cognitive variable that has been shown by Mierke and Klauer (2003) to confound IAT responses and to increase their variance. These task-shift costs refer to the alternating between target and attribute stimuli in the combined tasks. Although both the IAT and the SA-IAT were designed such that targets and stimuli alternated constantly from trial to trial, the associated task-shift costs may have been lower for the SA-IAT because the task was simpler.

In any case, an additional irrelevant variance component in the IAT might have suppressed its validity. Psychometric considerations support this view. If a variable  $X$  with variance  $s^2$  correlates  $r$  with a criterion  $Z$ , the sum of  $X$  and a variable  $Y$  with the same variance  $s^2$  correlates  $r\sqrt{1/2}$  with  $Z$  if  $Y$  is uncorrelated with both  $X$  and  $Z$  (a mathematical truth that can be proved algebraically). For example, applying this formula to the SA-IAT correlation of .20 with the SOI yields an expected IAT-SOI correlation of .14 if the IAT effect can be represented as the sum of the SA-IAT effect plus the effect of an uncorrelated variable with the same variance as the SA-IAT.

It is important to note that a higher validity of the SA-IAT cannot be claimed only on the basis of the implicit–explicit correlations because the true correlation between

implicit and explicit sociosexuality is unknown. If this correlation were zero, the correlational results would suggest that the SA-IAT is more strongly related to explicit sociosexuality because the procedure might be more transparent to many participants. However, the sex difference in the full SA-IAT supports the view that the SA-IAT was in fact more valid than the IAT. As expected, males showed a larger SA-IAT effect than females, and when explicit sociosexuality was controlled in an analysis of covariance, the sex difference for the SA-IAT remained nearly unchanged. Thus, the sex effect for the full SA-IAT was not mediated by explicit sociosexuality. In contrast, the sociosexuality IAT did not show this expected sex difference.

## General Discussion

Problems can arise for Implicit Association Tests if there is no clear opposite category. In this case, a neutral category can be used although it induces systematic error variance and thus reduces validity. The present study suggests that this problem can be solved using single-attribute IATs (SA-IATs). Sociosexuality was expected to be related at the implicit level to stronger stranger–sex associations relative to partner–sex associations. An IAT was constructed that used conversation as a neutral attribute; it showed satisfactory reliability but only low correlations with explicit sociosexuality and failed to show a theoretically expected sex difference. An alternative SA-IAT with sex as the only attribute showed a similar reliability but higher correlations with explicit sociosexuality and confirmed the expected sex difference even when explicit sociosexuality was controlled.

Although a single-attribute IAT was superior to a traditional bipolar attribute IAT in the present study, we cannot exclude the possibility that another sociosexuality IAT with an opposite attribute to *sex* that is more strongly associated with *stranger* by those low in sociosexuality than by those high in sociosexuality is more valid than the present sociosexuality IAT. In such a case, the construct of sociosexuality would be better compatible with the bipolar attribute assumption underlying IATs. However, it is hard to imagine that such a “naturally opposite” attribute to sex exists for sociosexuality.

Apart from this construct-specific problem, we do not claim that single-attribute IATs are always a good solution for the assessment of implicit associations involving unipolar attributes. Instead, we consider the single-attribute IAT option as an interesting hypothesis that should be tested for a wide variety of constructs. Such studies could also study correlations between an IAT and a SA-IAT for the same construct by assessing both in counterbalanced order within sex.

Last but not least, we would like to point out a problem that even single-attribute IATs cannot solve: the problem of unipolar targets. Our SA-IAT was designed to assess the

<sup>2</sup> The IATs and SA-IATs were also analyzed using the D-measure proposed by Greenwald, Nosek, and Banaji (2003), where the difference between the mean log-transformed latencies in the combined tasks is divided by the intraindividual standard deviation of these latencies. The D measure correlated above .95 with the traditional difference measure in all four studies and yielded results that were highly similar to those obtained by the traditional unstandardized difference measure. Therefore, we report here only the results for the traditional measure.

relative association strength of sex–stranger as compared with sex–partner, assuming that the sex–partner association is not positively related to sociosexuality because explicit sociosexuality has been shown to be largely independent of explicit reports of sexual interest in committed relationships. This assumption could be empirically tested at the explicit level similarly to our test of the association between sociosexuality and conversation.

Ultimately, however, it would be necessary to assess the sex–stranger association independently from the sex–partner association at the implicit level. This would require reliable and valid single-attribute, single-target association tests—that is, procedures that purely assess associations between two concepts. At a first glance, priming seems to be a candidate method, but the reported reliabilities for interindividual differences assessed with priming are discouraging (Spence, 2005). We consider the development of new instruments for the reliable assessment of interindividual differences in the strength of simple associations between one target concept and one attribute concept as an important task for the years to come.

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