

# Implicit social cognition through years: The Implicit Association Test at age 21

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## Abstract

The advent of implicit measures opened the access to processes of which people might not be completely aware but that can still influence their attitudes, preferences, and behaviors towards different objects. Among the existing implicit measures, the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) is one of the most studied and used. The descriptive literature review presented in this work was aimed at providing an overview of how the IAT has been used from the year of its first introduction until current days. Specifically, the main fields of application of the IAT, the specific topics for which it has been used, and its concurrent use with other implicit measures have been highlighted and described. When possible, information on the samples on which the studies were carried out are reported. Results indicate an on-going growth of the IAT in a constantly wider range of topics. The ability of the IAT to overcome self-presentation biases and to access the implicit aspects of attitudes have been particularly exploited for investigating biases towards different out-groups, especially in sensitive contexts.

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### **Abstract**

The advent of implicit measures opened the access to processes of which people might not be completely aware but that can still influence their attitudes, preferences, and behaviors towards different objects. Among the existing implicit measures, the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) is one of the most studied and used. The descriptive literature review presented in this work was aimed at providing an overview of how the IAT has been used from the year of its first introduction until current days. Specifically, the main fields of application of the IAT, the specific topics for which it has been used, and its concurrent use with other implicit measures have been highlighted and described. When possible, information on the samples on which the studies were carried out are reported. Results indicate an on-going growth of the IAT in a constantly wider range of topics. The ability of the IAT to overcome self-presentation biases and to access the implicit aspects of attitudes have been particularly exploited for investigating biases towards different out-groups, especially in sensitive contexts.

**Keywords:** Implicit Social Cognition; Implicit Association Test; Implicit Measures; Attitude measurement; Review.

## Introduction

According to dual-process theory of prejudice (Devine, 1989), automatic and controlled processes play fundamental but distinct roles in stereotyping and prejudice. Automatic processes are inevitably activated by a triggering stimulus, are effortless, and are responsible for the spontaneous activation of existing sequences of nodes in memory (Shiffrin & Schneider, 1977). On the other hand, controlled processes are characterized by their controllability, and need the availability of cognitive resources to be established. Consequently, controlled processes can be faked by individuals, especially when socially sensitive topics are assessed.

A common trend for the assessment of controlled and automatic aspects of attitudes is to administer a measure for the direct (or explicit) assessment, like a self-report scale, concurrently with a measure for the automatic (or implicit) assessment. Controlled processes, as assessed by self-report, have been found to be highly correlated with implicit measures tapping the same constructs when the assessment does not involve socially sensitive topics, such as racial prejudice (Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Nosek, 2007). This correlation is attenuated when the assessment involves socially sensitive topics. Moreover, controlled processes have been found to be good predictors of deliberate behaviors, while automatic processes resulted as being particularly effective in predicting non-deliberate and automatic behaviors (e.g., Wilson, Lindsey, & Schooler, 2000).

These empirical evidences brought researchers to speculate on the double nature of attitudes. Some authors (e.g. Fazio & Olson, 2003) interpreted these empirical evidences in light of a dual-process theory, for which explicit and implicit attitudes are indeed measuring different aspects. Other authors (e.g. Strack &

Deutsch, 2004) explained these results by claiming that explicit and implicit attitudes are measures deriving from a single representation.

Several tools are available for the implicit assessment of different constructs, such as the Implicit Association Test (IAT; Greenwald et al., 1998), the Go/No-go Association Task (GNAT; Nosek & Banaji, 2001), and the Sorting Paired Features task (SPF; Bar-Anan, Nosek, & Vianello, 2009), just to name a few. Nonetheless, the IAT is the implicit measure that presents the best psychometric properties (Bar-Anan & Nosek, 2014). Moreover, by appropriately changing the labels of the attitude objects and leaving its structure unaltered, the IAT is easily adaptable for the investigation of a broad range of topics (Zogmaister & Castelli, 2006), such as stereotypes, attitudes, and self-concept. This characteristic of the IAT fostered its use in different disciplines beyond implicit social cognition (Greenwald et al., 2009). The IAT is specifically designed to tap the automatic aspects of attitudes, making it more resistant to self-presentation biases (e.g., Greenwald et al., 2009). As such, its use is particularly appealing for the investigation of socially sensitive topics, such as racial prejudice. This literature review is aimed at getting an overview of the IAT use throughout the last 21 years. The focus is on the fields of application of the IAT, and on the specific topics for which it has been employed.

In the next section, the structure and the functioning of the IAT are briefly outlined. Then, the searching, filtering, and classification criteria are listed. The “Results” section presents the main findings on all the selected documents. This section is organized in sub-paragraph in which the results for each of the implicit measures resulting from the search are commented.

### **The Implicit Association Test**

The IAT is a computerized test aimed at assessing the strength of automatically activated associations between two contrasting objects (e.g., flowers and insects in a Flowers-Insects IAT) and two evaluative dimensions (e.g., *Good* and *Bad* words). It is based on the speed and accuracy with which prototypical exemplars (appearing sequentially at the center of the screen) of the above-mentioned categories (displayed at the top corners of the screen) are sorted in the category to which they belong by means of two response keys.

Usually, the IAT is composed of 7 blocks (Greenwald, Nosek, & Banaji, 2003). The first two blocks are single-categorization blocks, and they are used as pure practice blocks to let the respondents familiarize with the task and the stimuli. In the first block, exemplars of the evaluative dimensions *Good* and *Bad* are sorted in the category to which they belong by means of the two response keys. In the second block, exemplars of the object categories (e.g., *Flowers* and *Insects*) are sorted. The third and fourth blocks constitute the first IAT associative condition. Following the Flowers-Insects IAT example, in these blocks the labels of the *Good* and *Flowers* categories are displayed on the same side of the screen. Exemplars belonging to these categories are mapped with the same response key. Likewise, the labels identifying *Bad* and *Insects* categories are displayed on the opposite side of the screen, and the exemplars belonging to these categories are sorted with the same response key. The fifth block is a single categorization block, in which the labels for the *Insects* and *Flowers* categories have switched their position on the top sides of the screen. This block is a pure practice block in which respondents familiarize with the new location of the labels. The sixth and seventh blocks constitute the second associative condition of the IAT. In these blocks, *Good* and *Insects* categories share the same side of the screen and their exemplars are categorized with the same response key.

*Bad* and *Flowers* categories are placed on the opposite side of the screen, and their exemplars are categorized with the same response key.

The IAT rests on the assumption that the categorization task will be easier (i.e., faster response times and higher accuracy) when it is consistent with respondents' automatically activated associations. Sticking with the Flowers-Insects IAT, the task is supposed to be easier when flowers/positive words share the same response key and insects/negative words share the opposite response key than in the contrasting condition. The difference in respondents' performance between the two associative conditions is known as the IAT effect. The strength and direction of the IAT effect is usually expressed by means of the *D-score*, which results from the standardization of the difference in the average response time between the two conditions (Greenwald et al., 2003).

## Method

To investigate the spread of studies carried out using the IAT, the following search string was entered in Scopus database:

```
(( TITLE-ABS-KEY ( "implicit association test" ) OR TITLE-ABS-KEY ( "IAT" ) ) AND
( LIMIT-TO ( DOCTYPE,"ar" ) AND PUBYEAR > 1997 AND LIMIT-TO ( DOCTYPE,"re" ) )
AND ( LIMIT-TO ( LANGUAGE,"English" ) ) )
```

The string “implicit association test” OR “IAT” was used for the search among the documents “Title, Abstracts, Keywords” search option. The search was limited to papers or reviews published in English from 1998 (the year in which the IAT was published for the first time) till the current day of the search (October 25,

2019). No filter on the field of application was applied to avoid the underestimation of IAT applications in other disciplines besides psychology. A CSV file containing Authors names, DOI, Title, Keywords, and Abstract was then downloaded from Scopus.

Papers were excluded from this review if they met at least one of the following conditions: (i) being a literature review, a meta-analysis, a commentary, an editorial, or a book chapter, (ii) not having an Abstract, or (iii) using the “IAT” acronym to identify something different from the Implicit Association Test.

Documents were classified according to different criteria. The classification was made only by reading abstracts and keywords. For each of the following criteria, the label “Not in abstract/keywords” was used for every information that could be retrieved neither from the abstract nor from the keywords:

- **Implicit measures:** This variable identifies the specific measures used in each paper. A list of all the implicit measures retrieved from the Abstracts is reported in the Supplementary materials.
- **Macro-area:** This variable identifies the macro-area of investigation for which the implicit measure was used. The identified macro-areas were: (i) Addiction research, (ii) Clinical and dynamic psychology, (iii) Food research, (iv) Marketing research, (v) Social psychology, and (vi) Other.
- **Specific-topic:** This variable reports the specific aim of the paper, as related to the macro-area. For example, in case of addiction research studies, it reports the specific substance of addiction. A list of all the specific-topic for each macro-area is provided in the Supplementary materials.



- **Participants:** It reports the sample of participants used for the study. A complete list of all the identified samples is provided in the Supplementary materials. **Physiological measures:** It reports whether the paper included physiological measures (like EEG, tDCS, fMRI) or not.

The CSV file that was downloaded from Scopus was then imported in R (R Core Team, 2018). The abstracts of the selected papers were used to prepare a text corpus via tm package (Feinerer, Hornik, & Meyer, 2008). A word-cloud was then obtained from the corpus by means of wordcloud package (Fellows, 2018).

## Results

The search resulted in 3,467 documents. Of these documents, 1,546 were using the string “IAT” as acronym of something different from the Implicit Association Test, such as Internet Addiction Test (e.g., Cacioppo et al., 2019), Island Arc Tholeiites (e.g., Yang, Hou, Gao, & Liu, 2019) or Intra-Arterial Thrombectomy (e.g., Lee et al., 2019), and were hence excluded from the analysis. From the remaining 1,921 documents, 113 were excluded because of one of the following reasons: they did not have an abstract ( $n = 7$ ), they were a review ( $n = 47$ ), a meta-analysis ( $n = 9$ ), a commentary ( $n = 35$ ), an editorial ( $n = 1$ ), an essay ( $n = 1$ ), an addendum ( $n = 1$ ), or they cited the IAT but did not actually use it ( $n = 1$ ). Besides, eleven documents were excluded because their abstracts did not provide enough information to determine the constructs that were assessed. A total of 1,808 documents was left for inspection. The resulting document pool included a paper from 2020 (posterior to the search date), in which the IAT was used. This document was excluded from the analysis. All the following results are hence based on a document pool of 1,807 documents.

To prepare the text corpus for plotting the word-cloud, the abstracts were firstly cleaned from all the English stop words (e.g., “the”, “this”). We counted the occurrence of each word regardless of the number of times it appeared in each abstract. In this way, it was possible to compute the relative frequency of each common words in respect to the total number of documents. The word-cloud obtained from the abstracts of the papers is depicted in Figure 1.

The most common words used in the abstracts were “IAT” ( $n = 1,533$ ), “implicit” ( $n = 1,402$ ), and “measure” ( $n = 1,002$ ). They appeared in the 84.84%, 77.59%, and 55.45% of the abstracts, respectively. Additionally, the word-cloud can be used to grasp a first overview of the main fields of application of the IAT. For example, the words “social”, “bias”, “race”, and “gender” appeared in 404 (22.36 %), 402 (22.25%), 174 (9.63%), and 151 (8.36 %) abstracts, respectively.

Implicit measures other than the IAT were found by using the employed searching criteria. It must be considered that the frequency of use of implicit measures other than the IAT is underrepresented because the searching criteria were aimed specifically at findings papers using the IAT. Table 1 reports the number of papers for each macro-area investigated by employing different implicit measures.



Figure 1: Abstracts word-cloud. The bigger the word font, the higher the frequency of the word.

Overall, the macro-area “Social psychology” registered the highest frequency, immediately followed by the macro-area “Other”.

Macro-areas Clinical and dynamic psychology and Addiction also show a rather high frequency, while macro-areas Food and Marketing show the lowest frequency, with the latter one having the least frequency of all macro-areas.

Table 1: Occurrences of studies using implicit measures in each macro-area.

	Measures					Total
	IAT	IAT and Other	Modified IAT	Other Implicit	Not in abstract/keywords	
Social psychology	516	18	2	46	30	612
Other	422	31	10	73	27	563
Clinical and dynamic psychology	290	23	2	32	19	366
Addiction	113	7	1	34	4	159
Food	43	5	1	9	3	61
Marketing	34	1	0	3	8	46
Total	1418	85	16	197	91	1807

*Note:* IAT: Only IAT; IAT and Other: IAT used concurrently with at least another implicit measures; Modified IAT: Modified version of the IAT (e.g., audio IAT); Other Implicit: Other implicit measures; Not in abstract/keywords: It was not possible to retrieve the exact implicit measures from the abstract/keywords.

The IAT appears to be the most frequently used measure for the investigation of each macro-area, but this result must be taken with a grain of salt because of the searching criteria used for this review. The only reasonable comparison that can be made is between the exclusive use of the IAT as a stand-alone measure and its concurrent use with other implicit measures. About 85% of the studies using the IAT are in Social psychology and Clinical and dynamic psychology (84:31%, and 79:23%, respectively). The use of the

IAT in macro-area Other is rather high as well (74.96%). The concurrent use of the IAT with other implicit measures is under the 10% of the studies in all macro-areas. Figure 2 depicts the frequency of use of the different implicit measures from 1998 to 2019. The 21 years under consideration are represented on the *x*-axis, while the different colors represent the use of just the IAT (Only IAT), the concurrent use of the IAT and another implicit measure (IAT and other), the use of a modified version of the IAT (Modified IAT), or the use of implicit measures other than the IAT (Other). The absolute frequencies of use of the abovementioned implicit measures classification for each year are reported on the *y*-axis.

Usually, studies employing and citing the IAT use only the IAT for implicitly investigating the construct of interest. Nonetheless, the concurrent use of the IAT with other implicit measures appears to be rather common, as well as the use of other implicit measures. The use of modified versions of the IAT is rather uncommon. It is not surprising that, in the few years after the first publication on the IAT (from 1998 until 2002), only this measure appeared to be used except for 2001, where a modified version of it was employed. From 2008 on, it is possible to note a steady increase of the concurrent use of the IAT with other implicit measures, as well as the use of measures other than the IAT.

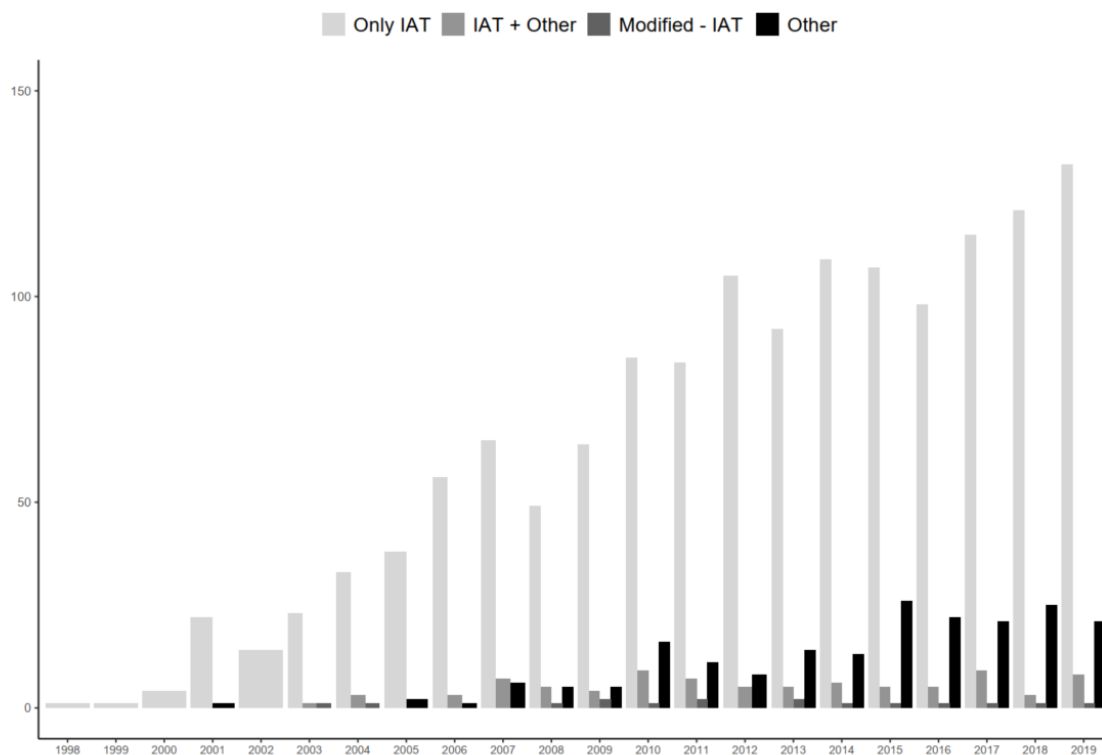


Figure 2: Frequency of use of different implicit measures from 1998 to 2019.

The next sections will comment the topic trend and the use of the implicit measures throughout the years. Specifically, sections for the IAT, for the IAT used concurrently with other implicit measures, and for other implicit measures will follow. Given the low total frequency of use of modified versions of the IAT, a section for them will not be provided.

*Only IAT.*

The documents using only the IAT were 1,418. Figure 3 depicts the trend lines of each macro-area of investigation in studies using only the IAT from 1998 to 2019.

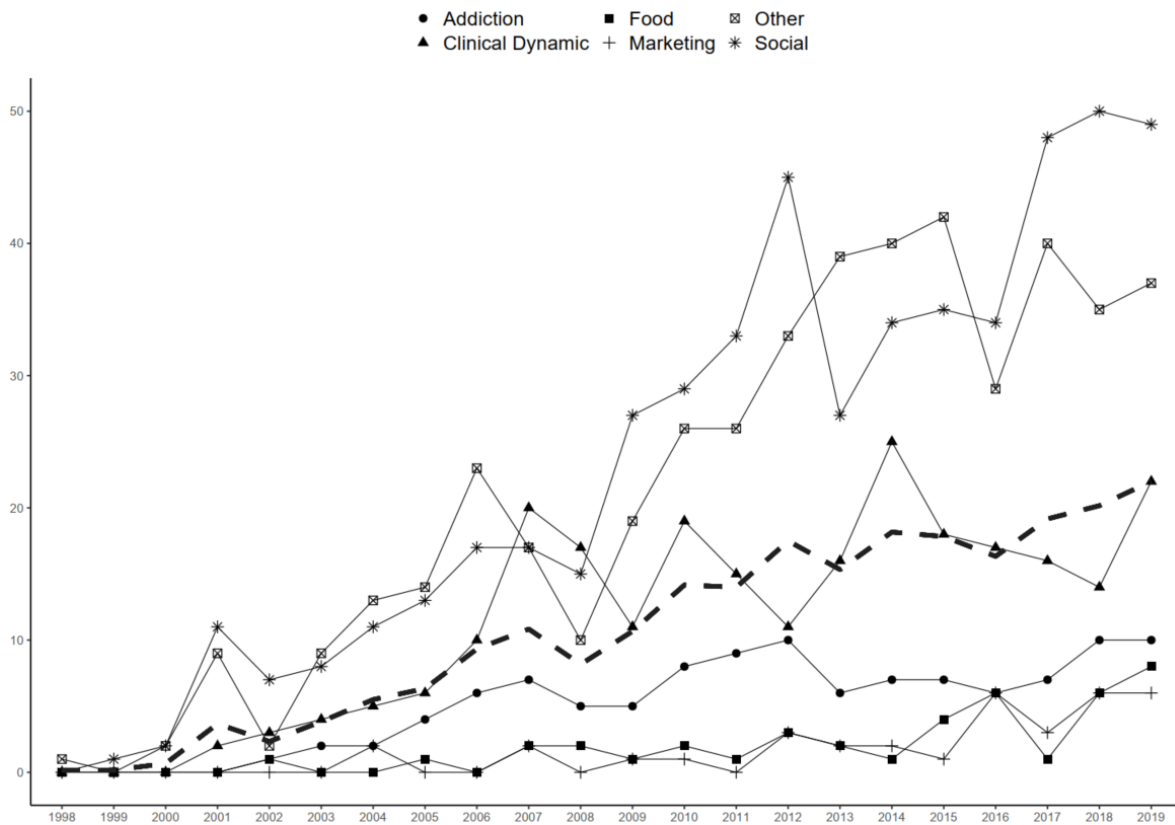


Figure 3: Trend lines of each macro-area of investigation in studies using only the IAT from 1998 to 2019.

The mean trend per year (i.e., the mean number of papers per year using the IAT) is represented by the dashed line, and it indicates a constant growth in the use of the IAT during the last 21 years. All macro-area seems to follow this trend. Despite some drops in the frequency of use of the IAT, specifically in 2008, 2013, and

2016, its frequency of use has been growing again during the past few years, with 2019 being the year registering the highest frequency of use.

Trend lines of macro-areas Social psychology and Other appear always above the mean trend line. Clinical and dynamic psychology trend line is the most inconsistent one throughout the years. Specifically, it shows a steady growth until 2007-2008, with a drop in 2009, followed by a vacillating trend until 2015, where it encounters a sort of *plateau* with a final peak in 2019. The trend lines of macro-areas Food and Marketing are similar between each other, both pointing at a higher use of the IAT during the past few years.

Table 2 illustrates the most common samples employed in studies using only the IAT. More detailed information on the specific samples used for each specific-topic of each macro-area are provided in the Supplementary materials.

Table 2: Samples used in studies employing only IAT.

	Social psychology	Othe r	Clinical and dynamic psychology	Addicti on	Foo d	Marketi ng	Total count	
Undergraduate								
students	55	39		23	29	2	0	148
Adults	58	23		13	12	4	4	114
Patients	5	16		64	17	2	1	105
Hospital personnel	62	7		0	1	0	1	71
Female	9	9		18	0	3	0	39
Children	20	4		9	3	0	0	36
Other	12	9		9	1	4	0	35
Adolescents	4	2		17	8	0	0	31
Web	13	2		2	0	0	0	17



Criminals	1	3	10	0	0	0	14
Teachers	13	0	1	0	0	0	14
Work personnel	10	3	0	0	0	0	13
Male	3	6	3	0	0	0	12
Cross cultural	4	2	3	0	2	0	11
Heavy drinkers	0	0	0	11	0	0	11
Athletes	0	2	3	3	0	0	8
Drug users	0	1	0	5	0	0	6
Autistic	1	4	0	0	0	0	5
Children dyad	3	0	0	0	0	0	3
Couples	1	1	1	0	0	0	3
Fitness people	2	1	0	0	0	0	3
Families	0	1	1	0	0	0	2
Gamers	0	1	1	0	0	0	2
Multiple	0	0	1	1	0	0	2
Old people	1	0	1	0	0	0	2
Reanalysis	1	1	0	0	0	0	2
Animals	0	1	0	0	0	0	1
Gamblers	0	0	0	1	0	0	1

The samples that were not identifiable from either the abstracts or the keywords (Not in abstract/keywords,  $n = 707$ ) have been excluded from Table 2. The samples that were not identifiable from the abstracts composed almost half of the samples for the only IAT applications (49:86%), and, consequently, the use of other samples might be underrepresented. This information can be retrieved by reading the papers. The discussion on the samples is not aimed at being exhaustive and conclusive, but rather to give an overview

of the IAT applications among different populations. Comments on the employed samples for each macro-area will be given in the corresponding subsections.

**The IAT in Social psychology.** IAT applications for the investigation of a broad range of specific-topics in macro-area Social psychology are the most frequent ones. Table 3 illustrates the frequency of IAT applications for each specific-topic of this macro-area.

Table 3: Specific-topics occurrences for macro-area Social psychology.

Specific topic	Count	Specific topic	Count
Out-group prejudice and stereotypes	205	Colonial mentality	2
Gender	65	Group identification	2
Illness related	59	Internal stigma	2
Weight bias	41	Stereotypes creation	2
Mixed social	22	Drug addicts	1
Sexuality	21	Feminism	1
Politics	20	Inclusion	1
Ageism	19	Independence	1
Religiosity	12	Powerful individuals	1
Language	11	Smokers	1
Poverty	8	Tattooed	1
SCM	8	Veterans	1
Attitude change/creation	6		

*Note:* SCM: Stereotype Content Model (Fiske, Cuddy, Glick, & Xu,2002). In this application, the SCM label includes also study on infra-humanization.

Most of the studies deals with the investigation of out-group stereotypes and prejudice, specifically related to racial prejudice. Studies on gender stereotypes follow, but with a large gap in the number of

applications in respect to the previous one. The third most common application of the IAT in this macro-area is for the investigation of illness-related attitudes. Illness-related attitudes indicate attitudes towards people with either mental or physical disabilities ( $n = 30$ ), psychiatric patients ( $n = 23$ ), people with HIV ( $n = 2$ ), cancer patients ( $n = 2$ ), general patients ( $n = 1$ ), and suicide survivors ( $n = 1$ ). Other common applications pertain to the assessment of weight bias, attitudes towards homosexuality, political preference, and ageism. Despite with a lower frequency, IAT is also used to assess attitudes towards people professing different religions, towards non-native English speakers, and bias towards people with low incomes. Papers composed by multi studies in which the attitudes towards multiple out-groups (e.g., out-group prejudice and weight bias) were concurrently investigated were common. The IAT was also used to investigate topics related to the Stereotype Content Model (SCM; Fiske et al., 2002), including infra-humanization, and to investigate the effectiveness of experimental manipulation to change/induce attitudes, even towards non-real groups.

As it can be retrieved from Table 2, the IAT has been widely used among samples composed of hospital personnel (i.e., doctors, nurses, therapists), adults, undergraduate students, teachers, and work personnel (i.e., CEOs, hiring personnel, university boards).

The common goal of the studies investigating out-group prejudice and stereotypes, illness related attitudes, and weight bias among hospital personnel was to understand whether the implicit bias towards the specific out-group influenced the quality of the provided care or on the probability of suggesting a specific surgery. The IAT was applied in a similar vein on samples composed of work personnel. Specifically, these studies were aimed at understanding whether implicit biases could undermine the probability of people belonging to minority groups, such as African-American people in the US, to be hired in a corporation or to win a position in Academia. Another interesting IAT application was for the investigation of the implicit out-

group prejudice or implicit gender stereotypes of teachers. The aim of these studies was to understand whether teachers' gender implicit attitudes (e.g., implicitly associating males with math and females with humanistic subjects) or their racial implicit attitudes (e.g., associating European-American children with higher intelligence than Hispanic children) could influence their behaviors towards the children.

**The IAT in Clinical and dynamic psychology.** Table 4 reports the occurrences of each specific topic of the macro-area Clinical and dynamic psychology.

Table 4: Specific-topics occurrences for macro-area Clinical and dynamic psychology.

Specific topic	Count	Specific topic	Count
Self-esteem	72	Attachment	5
Personality	32	Self-concept	5
Anxiety	26	Affect	2
DSM	23	Disgust sensitivity	2
Suicidal tendencies	19	Impulsiveness	2
Aggressiveness	17	Mixed clinical	2
Emotions	16	Burnout	1
Clinical sex behavior	12	Cognitive bias	1
Self-evaluation	12	Sense of guilt	1
Self-harm	10	Intelligence	1
Body perception	9	Resilience	1
Eating disorders	9	Shyness	1
Phobias	9		

*Note:* DSM: Diagnostic and Statistical Manual of Mental Disorders, and it refers to both personality disorders and mood disorders.

In this macro-area, the IAT was mostly used for the implicit assessment of self-esteem. Other common specific-topics were related to personality traits assessment, like Big Five personality traits, and anxiety. DSM psychological disorders (both personality and mood disorders) were fairly investigated as well. The IAT was also commonly used for the implicit assessment of suicidal tendencies, aggressiveness, emotions, and clinical sex behavior (e.g., pedophilia).

The most common samples used for this macro-area were composed by clinical patients (see Table 2). Applications among undergraduate students, adolescents, adults, criminals, only female samples, and children were rather common as well.

**The IAT in Addiction research.** Table 5 reports the occurrences of each specific-topic of the macro-area Addiction.

Table 5: Specific-topics occurrences for macro-area Addiction.

Specific topic	Count	Specific topic	Count
Alcohol	69	Heroin	4
Smoking	16	Gambling	3
Mixed addiction	6	Marijuana	3
Technology related	5	Coffee	2
Doping	4	Cocaine	1

*Note:* Internet related includes social network and smartphone pathological use.

Vast majority of studies in this macro-area are focused on the investigation of alcohol addiction, followed by nicotine and smoking addiction studies, with a large gap between the two specific-topics. The concurrent investigation of multiple addictions, such as drinking and smoking or drinking and gambling, was fairly uncommon, as well as the investigation of all the other specific-topics, with the implicit investigation of cocaine addiction registering only one study.

Majority of the studies for which it was possible to retrieve the samples from the abstract/keywords (Table 2) were carried out on undergraduate students, adults, patients with a diagnosis of addiction, and heavy drinkers.

**The IAT in Food research.** Most studies in this macro-area were investigating preference for different kind of food in general ( $n = 40$ ) or preference for un/healthy food ( $n = 16$ ). Two studies investigated implicit attitudes towards dieting, and other two studies investigated food perception. The remaining studies investigated a broad range of topics, including willingness to eat insects. Food craving, food self-control, and the effect of the time of day on food preference were investigated as well. In one study, it was not possible to retrieve the specific-topic from the abstract.

Majority of the samples for this macro-area of investigation were not retrievable from the abstracts or the keywords.

**The IAT in Marketing research.** Most of the studies in this macro-area were carried out for the implicit assessment of the preference for a brand over another ( $n = 10$ ). Decision making in purchasing a product ( $n = 5$ ) and perception of products labels and packaging ( $n = 4$ ) were also investigated. The investigation of all other specific-topics had a frequency of one, but this should not be surprising. Indeed, the application of the IAT in this macro-area is rather recent, with the first two papers published in 2002. Regarding the samples employed for the studies in this macro-area, in most cases it was not possible to retrieve them from the abstracts or keywords.

**The IAT in macro-area Other.** IAT applications in macro-area Other followed its applications in macro-area Social psychology. Differently from macro-area Social psychology, for which it was possible to

identify several specific-topics able to classify all the abstracts, in this case it was not possible. Indeed, this macro-area includes studies on a broad and extensive range of topics, from gender perception of odds and even numbers (Wilkie & Bodenhausen, 2015) to work related stress (Klein et al., 2012) and romantic attachment (Zayas & Shoda, 2005). Besides, this macro-area includes papers aimed at the validation of the IAT and papers aimed at its formal modeling. Given the high number of specific-topic with an occurrence of just one ( $n = 81$ , 19:19% of the total number of papers for this macro-area), they were not reported in Table 6. Nonetheless, a complete list of the specific-topics also for this macro-area is reported in the Supplementary materials.

Table 6: Specific-topics occurrences for macro-area Other.

Specific topic	Count	Specific topic	Count
Measure validation	48	Health	3
Perception	38	Legal psychology	3
Methodology	28	Reactions to \emph{D-score}	3
Autobiographical	23	Safety	3
Not in abstract/keywords	21	Sex orientation	3
Sex behavior	15	Abnormal social behavior	2
Physical activity	13	Achievement tendencies	2
Environment concern	9	Aesthetic judgment	2
Religion	9	Autism	2
Faking	8	Avoidance	2
Connection with nature	7	Body language	2
Morality	7	Death	2
City perception	6	Forgiveness	2
Road safety	6	Implicit motives	2
Violence	6	Leadership	2

Beliefs	5	Learning	2
Face perception	5	Loneliness	2
Identification	5	Motivation	2
Risk	5	Music	2
Attitudes tw technology	4	Others perception	2
Need for cognition	4	Partner	2
Stress	4	Romantic attachment	2
Work environment	4	Sense of ownership	2
Cultural topics	3	Sounds perception	2
Eye gaze	3	Time of day	2

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Most of the studies in this macro-area are aimed at the validation of the IAT, followed by studies on perception and studies on methodology. The distinction between measure validation papers and methodology papers is quite subtle. Measure validation studies include papers aimed at the validation of the IAT procedure (e.g., Greenwald et al., 1998), its score (e.g., Greenwald et al., 2003), and the factors that may affect the IAT effect (e.g., Bluemke & Friese, 2006). Specific-topic methodology includes studies in which existing formal models were used for modeling IAT data, such as the application of the Many-Facet Rasch Measurement Model (Linacre, 1960) in Anselmi, Vianello, and Robusto (2011) or the application of the Diffusion Model (Ratcliff, 1978) in Klauer, Voss, Schmitz, and Teige-Mocigemba (2007). Studies aimed at the validation of the *ad-hoc* models for IAT data, such as the Quad Model (Conrey, Gawronski, Sherman, Hugenberg, & Groom, 2005) or the Discrimination-Association Model (Stefanutti, Robusto, Vianello, & Anselmi, 2013) are included in the specific-topic methodology as well.

The IAT appears to be fairly used for investigating human perception, such as the implicit preference for symmetrical over asymmetrical patterns, and fake memories. Fake memories are mostly investigated by



means of the autobiographical IAT (Agosta, Ghirardi, Zogmaister, Castiello, & Sartori, 2011). Besides the specific topics that were not identifiable from the abstracts or the keywords, the IAT was rather commonly employed for investigating sex behaviors, such as attitudes towards safe sex, and physical activity. Regardless of the specific-topic for which the IAT was employed, Table 6 clearly indicates an expanding use of the IAT for the investigation of an always wider range of specific-topics. In the majority of cases, the specific samples were not identifiable.

*IAT and other implicit measures.*

The 85 studies using the IAT together with other implicit measures were selected.

Despite some small differences in their procedures (e.g., the presence of a response time window), the terms Single Category IAT (SC-IAT; Karpinski & Steinman, 2006) and Single Target IAT (ST-IAT; Wigboldus, Holland, & van Knippenberg, 2004) are used interchangeably to indicate the same measure (see Bar-Anan & Nosek, 2014). For this reason, they are considered together in counting their frequency of use. This decision was also driven by the fact that in some cases it was not possible to ascertain from the abstracts which one was used. The last column of Table 7 reports the occurrences of the use of the IAT together with other implicit measures.

Table 7: Frequency of use of the IAT with other implicit measures in each macro-area.

	Clinical and dynamic		Social					
IAT with	Other	psychology	psychology	Addiction	Food	Marketing	Total	
SC-IAT	5		5	1	1	1	0	13
AMP	4		2	4	0	1	1	12
IRAP	2		3	5	0	1	0	11
AMP								
Other	6		0	2	1	0	0	9

EAST	2	1	1	2	2	0	8
APT	4	0	1	1	0	0	6
GNAT	2	0	3	0	0	0	5
More than 2	2	3	0	0	0	0	5
NLT	0	4	0	0	0	0	4
AAT	0	1	0	1	0	0	2
EPT	1	0	0	1	0	0	2
AIP	0	0	1	0	0	0	1
DPT	1	0	0	0	0	0	1
NLPT	0	1	0	0	0	0	1
PAT	0	1	0	0	0	0	1
SPF	1	0	0	0	0	0	1
Stroop	0	1	0	0	0	0	1
TAT	0	1	0	0	0	0	1
WRT	1	0	0	0	0	0	1
Total	31	23	18	7	5	1	85

*Note:* SC-IAT: Single Category IAT; AMP: Affective Misattribution Procedure (Payne, Cheng, Govorun, & Stewart, 2005); IRAP: Implicit Relational Procedure (Barnes-Holmes et al., 2006); AMP and Other: Studies using IAT, AMP, and another implicit measure; EAST: Extrinsic Affective Simon Task (De Houwer, 2001); APT: Affective Priming Task (Fazio, Jackson, Dunton, & Williams, 1995); GNAT: Go/No-go Association Task; More than 2: Studies using IAT and more than 2 other implicit measures; NLT: Name Letter Task (Shinobu & Mayumi, 1997); EPT: Evaluative Priming Task (Fazio, Sanbonmatsu, Powell, & Kardes, 1986); AAT: Approach Avoidance Task; AIP: Action Inference Paradigm (Banse, Gawronski, Rebetez, Gutt, & Bruce Morton, 2010); DPT: Dot Probe Task; NLPT: Name Letter Preference Task (Nuttin, 1985); PAT: Picture Association Task (Van Leeuwen et al., 2013); SPF: Sorting Paired Features Task (Bar-Anan et al., 2009); TAT: Thematic Apperception Test; WRT: Word recognition task (Strosahl & Wilson, 1999).

The IAT was most commonly used with the SC-IAT, the Affective Misattribution Procedure (AMP; Payne et al., 2005) and the Implicit Relational Procedure (IRAP, Barnes-Holmes et al., 2006). The combined use of the IAT and the AMP was also frequently associated with the use of a third implicit measure. Specifically, they were used with the Evaluative Priming Task (EPT; Fazio et al., 1986,  $n = 5$ ), the Affective Priming Task (APT; Fazio et al., 1995,  $n = 2$ ), the Dote Probe Task (DPT,  $n = 1$ ), and the Truth Misattribution

Procedure (TMP; Cummins & De Houwer, 2019,  $n = 1$ ). The IAT was also commonly used with the Extrinsic Affective Simon Task (EAST; De Houwer, 2001), the Name Letter Task (NLT; Shinobu & Mayumi, 1997), and the APT. The concurrent use of more than two implicit measures with the IAT was rather common as well. In one study (Bar-Anan & Nosek, 2014), the IAT was used with six other implicit measures with the aim of comparing their psychometric properties. Specifically, the psychometric properties of the IAT were compared with those of the Brief IAT (B-IAT; Sriram & Greenwald, 2009), GNAT, SC-IAT, AMP, SPF, and EPT. In other two studies, the IAT was used together with the EAST and other implicit measures. In one occurrence, the IAT and the EAST were used with the NLT, while in another study, they were used with the Recoding Free IAT (RF-IAT Rothermund, Teige-Mocigemba, Gast, & Wentura, 2009). The combined use of IAT and EAST was also found in one study employing both B-IAT and NLT. In one study, the IAT was used with the NLT and two modified versions of the APT, the reaction time APT, and the error-based APT. Macro-area Other is that in which the IAT with other implicit measures is most common. Macro-areas Clinical and dynamic psychology and Social psychology follow. The joint application of implicit measures in other macro-areas is more uncommon.

Regarding the applications in the macro-area Other, majority of the studies were aimed at the validation of the implicit measure used concurrently with the IAT (i.e., the measure obtained from the IAT was used as a criterion for the validity of the other implicit measure). Besides measure validation, also perception was fairly investigated with the conjoint use of the IAT and other implicit measures. Specifically, it was investigated in three studies. In one study, it was investigated using the IAT in combination with the AMP, in another one using it in combination with the Picture Association Task (PAT; Van Leeuwen et al., 2013), and in the third one using it in combination with the EPT. Two studies investigated respondents' sexual orientation, one using the IAT with the SCIAT and one using the IAT with the APT. Given the broad

variability of the specific-topics investigated with the conjoint use of the IAT and other implicit measures, all the details are reported in the Supplementary materials and are not discussed here.

The concurrent use of the IAT with the SC-IAT was most common in the macro-area Clinical and dynamic psychology. This combination was mostly used for investigating self-esteem, aggressiveness, anxiety and personality traits. Other popular combinations of implicit measures in this macro-area were the ones with the NLT and the IRAP, mostly used for investigating self-esteem and suicidal tendencies.

In macro-area Social psychology, the most common combination was the one with the IRAP. The use of the IAT with the AMP and the use of the IAT with the GNAT were rather common as well. Less common IAT combinations in this macro-area were with the SC-IAT, the EAST, and the APT.

In macro-area Addiction, the IAT was mostly used with EAST, AAT, and SC-IAT.

*Other implicit measures.*

Table 8 reports the occurrences of use of implicit measures other than the IAT for the investigation of each macro-area. These occurrences reported in this section should be taken with a grain of salt because the frequency of use of implicit measures other than the IAT might be underestimated given the string used for the search.

Table 8: Other implicit measures, macro-area of investigation.

	Other	Social	Addiction	Clinical	Dynamic	Food	Marketing	Total
SC-IAT	38	22	20		20	7	3	110
B-IAT	12	13	11		5	0	0	41

IRAP	4	5	0	1	0	0	10
GNAT	3	1	2	2	0	0	8
AMP	3	1	0	1	0	0	5
EAST	2	0	1	0	0	0	3
AAT	0	0	0	2	0	0	2
FAST	1	1	0	0	0	0	2
SA-IAT	1	1	0	0	0	0	2
SB-IAT	2	0	0	0	0	0	2
AAT with B-IAT and							
DPT	0	0	0	0	1	0	1
ALPS	0	1	0	0	0	0	1
B-IAT with AMP	0	1	0	0	0	0	1
CF-IAT	1	0	0	0	0	0	1
DVAT	1	0	0	0	0	0	1
Flexi Twins	1	0	0	0	0	0	1
RRT	1	0	0	0	0	0	1
SB-SC-IAT	0	0	0	1	0	0	1
SC-IAT with AMP	0	0	0	0	1	0	1
SC-IAT with EAST	1	0	0	0	0	0	1
SC-IAT paper	1	0	0	0	0	0	1
Stroop	1	0	0	0	0	0	1
Total	73	46	34	32	9	3	197

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*Note:* SC-IAT: Single Category IAT; B-IAT: Brief IAT; IRAP: Implicit Relational Procedure ; GNAT: Go/No-go Association Task; AMP: Affective Misattribution Procedure; EAST: Extrinsic Affective Simon Task; AAT: Approach-Avoidance Task; FAST: Function Acquisition Speed Test (O'Reilly, Roche, Ruiz, Tyndall, & Gavin, 2012); SA-IAT: Single Attribute IAT (Penke, Eichstaedt, & Asendorpf, 2006); SB-IAT: Single Block IAT (Teige-Mocigemba, Klauer, & Rothermund, 2008); ALPS: Affective Lexical Priming Score (Lebrecht, Pierce, Tarr, & Tanaka, 2009); CF-IAT: Category Focus IAT (Siebler et al., 2010); DVAT: Dual Valence Association Test (Ibáñez et al., 2011); RRT: Relational Responding Task (Rosseel, Speelman, &

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Geeraerts, 2017); SB-SC-IAT Single Block-Single Category IAT (Zinkernagel, Hofmann, Dislich, Gschwendner, & Schmitt, 2011).

SC-IAT and B-IAT appeared to be the most common used implicit measures other than the IAT, with a large gap between their respective frequency of use.

SC-IAT appears to be mostly used in macro-area Other, followed by its use in macro-area Social psychology. It is equally used in macro-areas Addiction and Clinical and dynamic psychology. The use of the SC-IAT in macro-areas Food and Marketing was rather low, but, when looking at the use of other implicit measures in these areas, it appears to be the mostly used one. B-IAT was almost equally used in macro-areas Other, Social psychology, and Addiction, while it was slightly less used in macro-area Clinical and dynamic psychology, and no used at all in the macro-areas Food and Marketing.

### **Final Remarks**

The descriptive results of this review showed that most studies using the strings “Implicit Association Test” or “IAT” in Title, Abstract or Keywords are focused on the investigation of social psychology related topics. Among them, the investigation of racial prejudice is the most investigated one. Nonetheless, also gender studies, studies investigating attitudes towards obese people, homosexuality, and mental illness are rather popular as well. Despite it was not always possible to retrieve the samples on which the studies were carried out from the abstracts or the keywords, it is worth noting the spread of the applications of the IAT in sensitive contexts, such as hospitals and work environment. In these contexts, the

implicit attitudes held towards one of the target groups might have serious consequences, such as resulting in discriminatory behaviors, even if not intended.

Clinical and dynamic psychology is another popular field of application of the IAT, with self-esteem resulting as the most investigated topic. Many applications were aimed at the assessment of personality and mood disorders according to DSM classifications. Besides, also the investigation of suicidal tendencies, especially in samples of adolescents, resulted as a thriving field of investigation. Both food and marketing research have seen a considerable and recent growth in the use of the IAT, specifically in the past two years. During the past few years, the IAT has been applied for the investigation of many different topics, as it is witnessed by the growing trend of application in the macro-area Other in Figure 3.

As stated before, the only reasonable comparison between the frequency of use of the IAT and the frequency of use of other implicit measures was the one between the IAT as a standalone measure and the combined use of the IAT with another implicit measure. The IAT appeared to be used mostly with the SC-IAT, the AMP, and the B-IAT. However, the large gap between the frequency of applications of the IAT as a stand-alone and its combined use with another measure might indicate that the IAT does not need the concurrent use of other implicit measures, unless in validation studies. Even though this result is not conclusive and exhaustive given the search string used, the SC-IAT appeared to be also mostly used as a stand-alone measure, followed by the stand/alone use of B-IAT and IRAP.

This review shows a still growing trend in the use of implicit measures, specifically of the IAT, for the investigation of a broad and varied range of topics. It is interesting to note how applications of the IAT throughout the years have extended from classic applications in social cognition to application in other fields.

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