

# Exploring a Causal Link between Language and Cultural Biases

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## Abstract

The abstract.

**Keywords:** IAT, cultural biases, gender, linguistic relativity.

## Introduction

### Study 1: Cross-cultural gender bias in implicit behavior

We quantified the degree of gender bias in a culture using data from the Implicit Association Task (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT measures the strength of respondents' associations between two pairs of concepts (e.g., male-career/female-family vs. male-family/female-career). The underlying assumption of the measure is that concepts that are represented as more similar to each other should be easier to pair together in a behavioral task, compared to two concepts that are relatively dissimilar. Concepts are paired in the task by assigning them to the same response keys in a 2AFC categorization task. In the critical blocks of the task, concepts are assigned to keys in a way that is either bias-congruent (i.e. Key A = male/career; Key B = female/family) or bias-incongruent (i.e. Key A = male/family; Key B = female/career). Participants are then presented with a word related to one of the four concepts and asked to classify it as quickly as possible by responding with one of the two keys. Slower reaction times in the bias-incongruent blocks relative to the bias-congruent blocks are interpreted as indicating an implicit association between the corresponding concepts (i.e. a bias to associate male with career, and female with family).

## Method

We analyzed an existing dataset of IAT scores collected online from a large, culturally diverse sample (Project Implicit: <https://implicit.harvard.edu/implicit/>; Nosek, Banaji, & Greenwald, 2002)<sup>1</sup>. Our analysis included all gender-career IAT scores collected from respondents between 2005 and 2016 who had complete data and were located in countries with more than 400 total respondents ( $N = 773,205$ ). We further restricted our sample based on participants' reaction times and errors using the same criteria described in Nosek, Banaji, and Greenwald (2002, pg. 104). Our final sample included 664,359 participants from 49 countries, with a median of 1,123 participants per country.

Several measures have been used in the literature to describe the difference in reaction time between bias congruent

<sup>1</sup>All analysis code can be found in an online repository: <https://github.com/mllewis/IATLANG>

## IAT Gender Bias

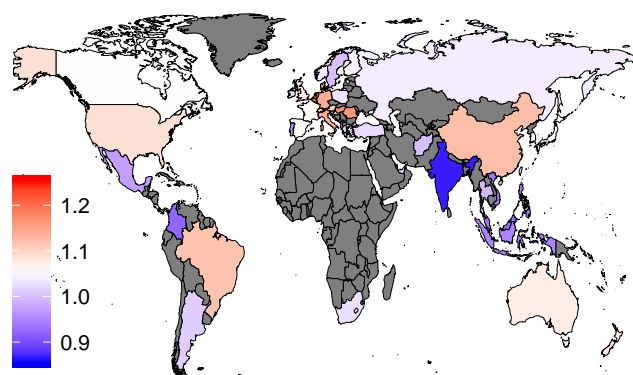


Figure 1: IAT gender bias effect size for 49 countries with available data. All countries show a gender bias, with red indicating above average and blue indicating below average bias.

and incongruent blocks. Here, we use the best performing measure, D-score, which quantifies the difference between critical blocks for each participant while controlling for individual differences in response time (Greenwald, Nosek, & Banaji, 2003). For each country, we calculated an effect size as the mean D-score divided by its standard deviation (Cohen's  $d$ ), with larger values indicate greater bias.

In addition to the implicit measure, we also analyzed an explicit measure of gender bias. After completing the IAT, participants were asked, "How strongly do you associate the following with males and females?" for both the words "career" and "family." Participants indicated their response on a Likert scale ranging from female (1) to male (7). We calculated an explicit gender bias score for each participant as the career response minus the family response, such that greater values indicated more gender bias.

Finally, we also examined an independent measure of gender parity, called the Women's Peace and Security Index (WPS, 2017), which measures inclusion, justice, and security of women by country, with larger values indicating more gender equality. We predicted this measure would be correlated with measures of implicit and explicit gender bias.

## Results

Broadly, we replicate previous findings in the literature on the gender-career IAT (Nosek et al., 2002). First, participants in all countries showed a bias to associate men with career and females with family. Figure 1 shows the magnitude of

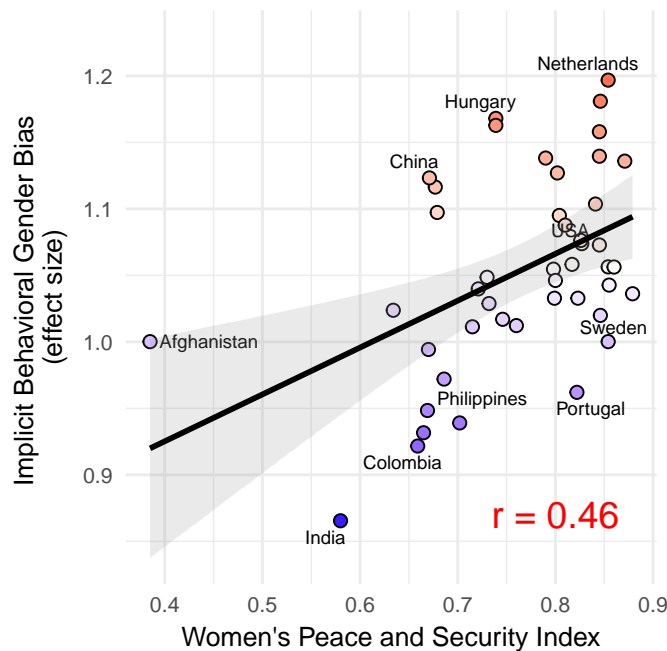


Figure 2: Magnitude of the implicit gender bias (measured by the IAT) predicted by an independent measure of gender equality, Women's Peace and Security Index (WPS). Each point corresponds to a country. Contra our prediction, we find that countries with greater gender equality have larger implicit bias.

the IAT gender bias (effect size) across all 49 countries ( $M = 0.37$ ;  $SD = 0.03$ ). Second, implicit and explicit bias measures were correlated both at the level of individual participants ( $r = 0.15$ ;  $p < .00001$ ) and at the level of countries ( $r = 0.32$ ;  $p = 0.02$ ). Third, consistent with previous findings (Nosek et al., 2002), the magnitude of the implicit bias is larger for female participants compared to males ( $t = 97.23$ ;  $p < .00001$ ).

We next asked whether our independent measure of gender equality, WPS, predicted variability in implicit and explicit gender bias by country. WPS was strongly correlated with implicit bias ( $r = 0.46$ ;  $p < .01$ ; Fig. X), but not explicit bias ( $r = -0.01$ ;  $p = 0.96$ ). However, we find that the implicit bias effect is in the opposite of the predicted direction: Countries with higher gender equality have larger implicit bias.

## Discussion

### Study 2: Cross-cultural gender bias in language

In Study 2, we ask whether participants' implicit and explicit gender biases are correlated with biases found in the semantics of participants' native languages. To model semantics, we turn to a recently developed machine-learning method for deriving lexical semantics from text: auto-encoding neural network models. The underlying assumption of these models is that the meaning of a word can be described by the words it tends to co-occur with – an approach known as distributional semantics (Firth, 1957). Under this approach, a

word like “dog” is represented more semantically similar to “hound” than “banana” because it co-occurs with words more in common with “hound” than “banana” in a large corpus of text.

Recent developments in machine learning allow the idea of distributional semantics to be implemented in a way that both takes into account many features of local language structure while remaining computationally tractable. The best known of these word embedding models is *word2vec* (Mikolov, Chen, Corrado, & Dean, 2013). The model takes as input a corpus of text and outputs a vector for each word corresponding to its semantics. From these vectors, we can derive a measure of the semantic similarity between two words by taking the distance between their vectors (using cosine distance, for example). Similarity measures estimated from these models have been shown to be highly correlated with human judgments of word similarity (e.g., Hill, Reichart, & Korhonen, 2015).

In addition to quantifying word similarity, models like *word2vec* have been used to measure the presence of social biases in the semantics of English in a way that is highly analogous to the behavioral IAT (Caliskan, Bryson, & Narayanan, 2017; henceforth *CBN*). This is done by measuring the distance in vector space between the same sets of words that are presented to participants in the IAT task. *CBN* demonstrate that these distance measures are highly correlated with reaction times in the behavioral IAT task, suggesting that the biases measured by the IAT are also found in the lexical semantics of natural language.

In Study 2, we use the method described by *CBN* to measure the biases in the semantics of the natural languages spoken in the countries of participants in Study 1. While *CBN* only analyzed biases for models trained on English, we extend their method to compare biases across a wide number of languages. To do this, we take advantage of a set of models that have been pre-trained on a corpus of Wikipedia text in a large number of languages (Bojanowski, Grave, Joulin, & Mikolov, 2016). In Study 2a, we replicate the *CBN* findings with the Wikipedia corpus; In Study 2b, we show that the implicit gender biases reported in Study 1 for individual countries are correlated with the biases found in the semantics of the natural language spoken by those participants.

### Study 2a: Replication of Caliskan, et al. (2017)

**Method** We use a word embedding model that has been pre-trained model on the corpus of English Wikipedia using the fastText algorithm (Bojanowski et al., 2016)<sup>2</sup>. The model contains 2,519,370 words with each word represented by a 300 dimension vector.

Using the Wikipedia fastText model, we calculate an effect size for each of the 10 biases reported in *CBN* which correspond to behavioral IAT results existing in the literature: flowers/insects/pleasant/unpleasant, instruments/weapons/pleasant/unpleasant, European-

<sup>2</sup>Available here: <https://github.com/facebookresearch/fastText/>

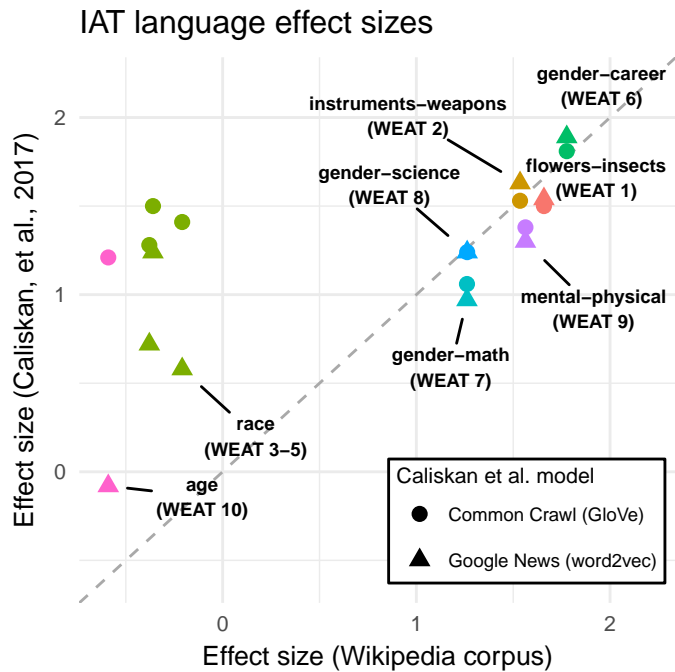


Figure 3: Effect sizes for the 10 IAT biases types (WEAT 1-10) reported in Caliskan et al. (2017; CBN). The effect sizes reported in CBN are plotted against effect sizes from the Wikipedia corpus. Point color corresponds to bias type, and point shape corresponds to the two CBN models trained on different corpora and with different algorithms.

American/Afro-American/pleasant/unpleasant<sup>3</sup>, males/females/career/family, math/arts/male/female, science/arts/male/female, mental disease/permanent/temporary, and young/old/pleasant/unpleasant (labeled as WEAT 1-10 in CBN). We calculate the bias using the same effect size metric described in CBN, a standardized difference score of the relative similarity of the target words to the target attributes (i.e. relative similarity of male to career vs. relative similarity of female to career). This measure is analogous the behavioral effect size measure in Study 1 and, like for the behavioral effect size, larger values indicate larger bias.

**Results** Figure 2 shows the effect size measures derived from the Wikipedia corpus plotted against effect size estimates reported by CBN from two different models (trained on the Common Crawl and Google News corpora). With the exception of biases related to race and age, effect sizes from the Wikipedia corpus are comparable to those reported by CBN. In particular, for the gender-career IAT – the bias relevant to our current purposes – we estimate the effect size to be 1.78, while CBN estimates it to be 1.81 (Common Crawl) and 1.89 (Google News).

<sup>3</sup>CBN test three versions of this bias.

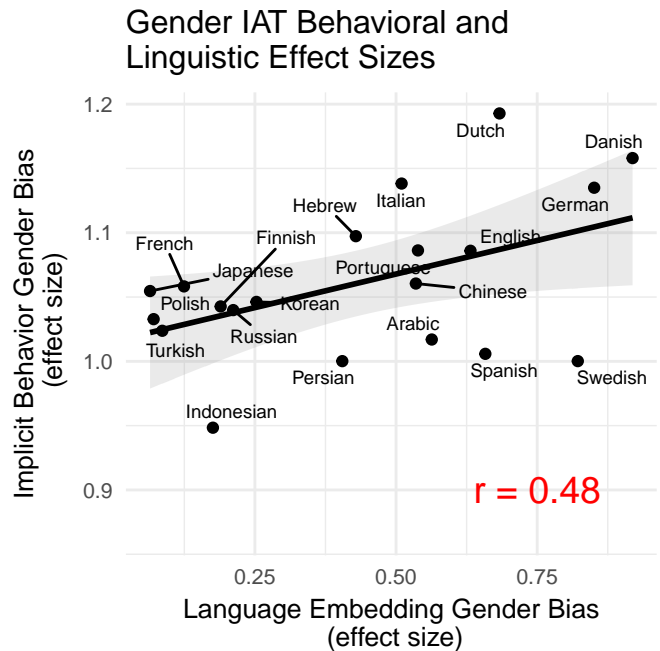


Figure 4: Gender bias effect size for each language from the behavioral IAT task (averaging across countries; Study 1) versus gender bias effect size estimated from embedding models trained on each language.

## Study 2b: Predicting implicit bias with language IAT

With our corpus validated, we next turn toward examining the relationship between psychological and linguistic gender biases. In Study 2b, we estimate the magnitude of the gender-career bias in each of the languages spoken in the countries described in Study 1 and compare it with estimates of behavioral gender bias from Study 1. If language causally influences psychological gender bias, we predict these two measures should be positively correlated.

**Method** For each country included in Study 1, we identified the most frequently spoken language in those countries using the CIA factbook (Central Intelligence Agency, 2017). This included a total of 32 unique languages. For a sample of 20 of these languages (see Fig. 3), we had native speakers translate the set of 32 words from the gender-career IAT, with a slight modification<sup>4</sup>. The original gender-career IAT task (Nosek et al., 2002) used proper names to cue the male and female categories (e.g. “John,” “Amy”). Because there are not direct translation equivalents of proper names across languages, we instead used a set of generic gendered words which had been previously used for a different version of the gender IAT (e.g., “male,” “man,” “female,” “woman,” Nosek et al., 2002).

We used these translations to calculate an effect size from the models trained on Wikipedia in each language, using the

<sup>4</sup>The language sample was determined by accessibility to native speakers, but included languages from a variety of language families.

same method as in Study 2a. We then compared the effect size of the linguistic gender bias to the behavioral gender bias, averaging across countries that spoke the same language (weighting by sample size).

**Results** Implicit IAT gender bias effect sizes were positively correlated with effect sizes of gender bias estimated from the native language embedding model ( $r = 0.48$ ;  $p = 0.03$ ; Fig. 3), suggesting that countries that have more gender bias encoded in their language also have a larger psychological gender bias. Explicit gender bias was not reliably correlated with language gender bias ( $r = 0.23$ ;  $p = 0.32$ ).

## Discussion

### Study 3: Grammar and Gender Bias

Study 2 suggests that psychological gender bias and linguistic gender bias are correlated, consistent with the idea that language may play a causal factor in shape gender bias in behavior. Nevertheless, Study 2 is also consistent with a second hypothesis in which the causal influence goes the opposition direction: Psychological gender bias leads to a gender bias becoming encoded in the language. In Study 3, we test the causal hypothesis more directly by examining whether there is a relationship between psychological gender bias and language along a linguistic dimension that is unlikely to be subject to change – namely, grammatical gender. While of course grammars do change, they are less malleable than the semantics of words, and thus less likely to be affected by psychological biases. We predict, therefore, that if there is some causal influence of language on psychological biases languages that encode gender grammatically will tend to have larger psychological gender biases.

## Method

## Results

## Discussion

## Conclusion

## References

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