Differences in Implicit Attitudes in West and East Germans as Measured by the Go/NoGo Association Task and Event-related EEG Potentials

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Background and Objective: *Implicit social cognition* refers to attitudes and stereotypes that may reside outside conscious awareness and control but that still affect human behavior. In particular, the implicit favoritism of an ingroup, to which an individual belongs, as opposed to an outgroup, to which the individual does not belong, characterized as ingroup bias, is of interest and is investigated here.

Method: We used a Go/NoGo association task (GNAT) and behavioral and electroencephalographic (event-related EEG potential [ERP] analysis) measures to investigate the implicit bias toward cities in East Germany, West Germany, and Europe, in 16 individuals each from West and East Germany (mixed gender, M_{age} = 24). The GNAT assesses an individual's Go and NoGo responses for a given association between a target category and either pole (positive or negative) of an evaluative dimension.

Results: Behavioral measures revealed slightly faster reaction times to the combination of European city names and negative, as compared with positive, evaluative words in both groups. ERP analysis showed an increased negativity at 400–800 ms poststimulus in the incongruent conditions of East German city/positive word pairings (in West Germans) and West German city/positive word pairings (in East Germans).

Conclusion: An implicitly moderately negative evaluation of Europe by both groups was exhibited based on the behavioral data, and an increased level of conflict arising from the "incongruent" pairings (ie, as manifestation of an implicitly negative attitude toward East Germany in West Germans, and toward West Germany in East Germans) was exhibited based on the electrophysiological data.

Key Words: GNAT, Go/NoGo, event-related potential, N450, medial frontal negativity, implicit attitudes/bias

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ACC = anterior cingulate cortex. **ERP** = event-related potential. **GNAT** = Go/NoGo association task. **IAT** = implicit association task. **RT** = reaction time.

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Besides conscious and introspectively accessible rationales and motives for action, cognitive processes that occur outside of conscious awareness and control, such as attitudes, stereotypes, and self-concepts—termed *implicit social cognition* by Greenwald and Banaji (1995)—also have a strong influence on human behavior.

The distinction between an *ingroup*, to which an individual belongs, and an *outgroup*, to which the individual does not belong, is a natural feature of group dynamics in categorizing the social world. Social bias and social prejudice denote stereotyping along the boundaries between the two groups so that more positive attitudes toward the (members of the) ingroup and more negative attitudes toward the (members of the) outgroup are held.

Social biases are a widespread and stably observable phenomenon (Greenwald and Lai, 2020; Nosek et al, 2011; Payne et al, 2017) that are believed to help individuals navigate in a complex social world and that presumably represent "cognitive shortcuts" to sort social information (Hehman et al, 2014; Kurzban et al, 2001). However, *implicit social bias* is not a simple characteristic of an individual; rather, it is an interaction between an individual and the situation that the individual is in (Gawronski and Bodenhausen, 2017; Payne et al, 2017).

Several researchers have argued that implicit social cognition can be understood as the expression of multiple memory systems: Implicit memory, as manifested, for example, in priming, contributes to the acquisition of social biases, whereas explicit memory, as manifested by awareness of retrieval, operates separately from implicit memory and therefore might not be directly involved in social bias (Lucas et al, 2019; see also Amodio and Ratner, 2011, and Amodio, 2019). Implicit social bias is modulated by social circumstances (Gawronski and Bodenhausen, 2017). Implicit association tasks (IATs) have revealed that individuals with interethnic friendships exhibited less implicit prejudice toward the respective (out) group compared with individuals who did not have close friends from the group (Aberson et al, 2004). In addition, Pettigrew and Tropp (2006) discovered that whereas (direct) intergroup contact can reduce intergroup prejudice, indirect contact—having an ingroup friend who has an outgroup friend—seems to reduce prejudice to levels that are comparable to those of direct contact (Pettigrew et al, 2007).

Implicit Social Bias in West and East Germans

Comparisons of West versus East Germans have revealed that individuals from East Germany consistently exhibited higher levels of ethnic prejudice compared with individuals from West Germany, but this effect was attributed mainly to the reduced interethnic contact opportunities and experiences of East Germans (Wagner et al, 2003). More recent investigations, however, have continued to show a higher probability for prejudice and violent attacks toward foreigners in East Germany, especially following the large influx of refugees in Germany in 2015 (Jäckle and König, 2017).

When comparing the prejudices and stereotyping of West and East Germans with respect to each other, Schmitt et al (1992) found very similar heterostereotypes of West Germans toward East Germans and East Germans toward West Germans, namely in attributing less self-responsibility to the respective *other* group by both groups. Mutual negative stereotyping among West and East Germans (the former tending to be seen, eg, as pretentious, the latter, eg, as complaining) has been well described by several researchers, including Rippl (1995), Schneider (1997), Pollack (1998), and Neller (2000), with an assumed self-demarcation—that is, segregation through defined self-images—not only of East Germans, but also of West Germans (Neller, 2000). However, there seems to be an *asymmetry* in this bias/stereotyping: The negative image of West Germans toward East Germans appears to be much stronger than the other way around (ie, the East German stereotype is commonly regarded as more negative than the West German one) (Kühnen et al, 2001).

Kühnen et al (2001) performed an IAT (Greenwald et al, 1998) using the names of East and West German cities as stimuli and found an implicit ingroup bias in both groups that was attenuated for the East Germans but increased for the West Germans when they were primed with East–West-related self-knowledge, indicative of the East German stereotype being more negative than the West German stereotype.

Using a Go/NoGo Association Task to Test Bias

Next to the classical IAT, one method that measures the implicit mental processes influencing our social perception and behavior (ie, the processes underlying social biasing) is the Go/NoGo association task (GNAT; Nosek and Banaji, 2001). The GNAT allows one to determine the strength of the association between a target category and either pole (ie, positive or negative) of an evaluative dimension. During the task, individuals are required to map the same response (Go or NoGo) to word stimuli that belong to a target category (as opposed to a comparison category) and to stimuli representing one pole of an evaluative dimension. This pairing can be evaluatively *congruent* (ie, make a response to a [subjectively] *good* category stimulus or to a positive word) or *incongruent* (ie, make a response to a [subjectively] *good* category stimulus or to a negative word).

Behavioral Measures

Response latencies are driven by congruency; that is, individuals respond more quickly when good target stimuli are paired with positive words and bad target stimuli are paired with negative words. This condition is referred to as the *congruent* condition. The idea is that it is easier to map a category and an evaluation onto the same response (ie, to respond or to withhold the response, respectively) if they are congruent, that is, previously linked by implicit attitudes. The *incongruent* condition refers to the pairing of good target stimuli with negative words or bad target stimuli with positive words, respectively, and incongruency is associated with relatively prolonged response latencies.

While in principle, it is possible that the prolonged reaction times (RTs) to incongruent stimulus pairings in IATs and the GNAT are due to additional mental processes that occur only in the incongruent condition, it has been argued using microstate analyses that actually the same processes underlie the response to both congruent and incongruent stimulus pairings in the IAT, with specific processes showing a longer duration in the incongruent condition (Schiller et al, 2016).

The GNAT, in contrast to the classical IAT, was designed to have a measure of implicit social cognition without requiring the direct involvement of complementary or contrasting objects. A further theoretical advantage when comparing the GNAT to the IAT is that the GNAT allows for an evaluation not only when a response is required (Go condition), but also when the response must be withheld (NoGo condition), which is of particular interest regarding the electroencephalographic correlates of the NoGo condition (see below). Also, because it is more difficult to withhold the response to a NoGo stimulus than to respond to a Go stimulus (Nieuwenhuis et al, 2003), researchers have argued that the GNAT is more sensitive than the IAT to response biases (Nadarevic and Erdfelder, 2011).

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Electrophysiological Measures

When conducting EEG and event-related potential (ERP) analyses during measures of implicit association, larger N200 and smaller P300 amplitudes in the incongruent condition have been reported in the IAT (Coates and Campbell, 2010). In the GNAT, the NoGo stimuli typically give rise to the so-called *NoGo N200 ERP* component, which is a negative potential beginning at ~200–300 ms post stimulus with a maximum over frontal regions of the scalp (see, eg, Jodo and Kayama, 1992, and Nieuwenhuis et al, 2003, for standard Go/NoGo tasks; see Banfield et al, 2006, van der Lugt et al, 2012, and Wagner-Altendorf et al, 2021, for ERP/GNAT experiments).

Nieuwenhuis et al (2003) suggested that the N200 during Go/NoGo tasks reflects response conflict monitoring by the anterior cingulate cortex (ACC) (ie, conflict between the prepotent [Go] response and the required withholding of the response [NoGo]). Gajewski and Falkenstein (2013) opined that the NoGo N200 reflects either the inhibition of a premature response plan or the detection or resolution of response conflict between Go and NoGo response tendencies.

The temporal course of the NoGo N200 is dependent on the congruency of the target category and the evaluative dimension: The NoGo N200 was found to be delayed in trials with an incongruent pairing of stimuli compared with congruent pairings (Banfield et al, 2006; van der Lugt et al, 2012; Wagner-Altendorf et al, 2021; Wu et al, 2014), which has been interpreted as the first manifestation of implicit attitude activation, taking place at 250–300 ms poststimulus. However, implicit attitudes can presumably be subject to changes within the first several hundred milliseconds of their formation, so that the implicit attitudes as measured by, for example, the NoGo N200, must not necessarily match the implicit attitudes as measured by behavioral GNAT parameters such as RTs (Wagner-Altendorf et al, 2021).

Another ERP component that is considered important for the present context is late frontocentral negativity, also termed medial frontal negativity or N450. Multiple studies have described a broad negative component presumably indexing conflict or ambiguity, beginning at 400+ ms poststimulus, with a maximum over frontocentral brain regions (see Larson et al, 2014, for a review; recent research articles on late negativity ERP components indicative of conflict processing include Chouiter et al, 2014; Kałamała et al, 2020; Pei et al, 2021; Rey-Mermet et al, 2019; and Wagner-Altendorf et al, 2020). For implicit social cognition, the late negativity or frontal slow wave ERP component is thought to reflect the implementation of conflict resolution in order to overcome the prepotent (biased) response tendency (Bartholow, 2010).

Present Study

We wanted to identify the implicit attitudes of a group of West Germans toward East Germany, West Germany, and Europe, as well as the implicit attitudes of a group of East Germans toward East Germany, West Germany, and Europe, with the implicit attitudes toward Europe serving as the behavioral control condition. West and East Germans provide an interesting population for studying implicit attitudes because both groups share very similar historical and cultural backgrounds but were socialized in very different political systems standing in opposition to each other (ie, democracy and pseudodemocratic socialism, respectively). Given these differences in socialization between West and East Germans, we hypothesized that the two groups would have differing implicit attitudes regarding each other. Data were collected in 2005—15 years after the reunification of Germany—so that both experiences from the period of the division of Germany and experiences after the fall of the Berlin Wall should have contributed to the implicit attitudes that we investigated in our study.

We used the GNAT to obtain both behavioral and electroencephalographic measures. The names of cities in East Germany, West Germany, and (Western) Europe were presented consecutively in a randomized order, as well as positive or negative words (eg, *sunrise* and *happiness*, or *threat* and *murder*, respectively). The individuals had to either respond via a mouse click (Go) or withhold their response (NoGo), depending on the instructions.

Behaviorally, we expected to find faster RTs for the combination of *ingroup* city names (ie, West German city names in case of individuals from West Germany, and East German city names in case of individuals from East Germany) and positive words—the congruent condition—compared with the combination of ingroup city names and negative words—the incongruent condition. For the *outgroup* city names (East German city names for the West German individuals and West German city names for the East German individuals, respectively; European city names, for both groups), we expected the opposite result (ie, slower RTs)—the pairing of outgroup city names and negative words reflecting the congruent condition and the pairing of outgroup city names and positive words reflecting the incongruent condition.

Electrophysiologically, we expected, as shown in many earlier studies, a prominent NoGo N200, indicative of response inhibition, to be delayed in the incongruent condition (eg, when individuals were required to map ingroup city names and negative words on the same response). We also expected the frontocentral late negativity to be altered according to the congruent versus incongruent condition: As incongruent pairings are assumed to lead to increased conflict, and to increased cognitive control to overcome the biased response tendency, the incongruent condition would be linked to stronger frontocentral negativity.

Taken together, we aimed to further elucidate the behavioral and electrophysiological correlates of implicit attitudes and (ingroup) bias, an understanding of which is crucial for elaborating the mechanisms through which implicit social behavior is learned or unlearned (Amodio and Ratner, 2011), and which might even contribute to adjusting our own behavior (ie, align it with certain values; Lucas et al, 2019).

METHOD

Participants

We recruited 16 healthy, right-handed individuals (8 women, M_{age} = 24.1 years, age range = 20–29) from West Germany via announcements at the University of Hannover—mostly students from the Medical School Hannover and the University of Hannover in Hannover, West Germany. As inclusion criteria, all of the participants were native speakers of German and had been born in West Germany. None of the participants had lived in East Germany for >1 year. This group was investigated in the ERP lab of the neurology department of the Medical School Hannover.

We recruited 16 healthy, right-handed individuals (8 women, M_{age} = 23.3 years, age range = 10–29) from East Germany via announcements at the University of Magdeburg—mostly students from the University of Magdeburg in Magdeburg, East Germany. As inclusion criteria, all of the participants were native speakers of German and had been born in East Germany. None of the participants had lived in West Germany for >1 year. This group was investigated in the ERP lab of the neuropsychology department at the University of Magdeburg.

We determined the sample size of 16 participants in each group based on effect sizes from prior GNAT experiments with comparable sample sizes (eg, Banfield et al, 2006; van der Lugt et al, 2012; see also, Wu et al, 2014).

The study was reviewed and approved by the ethics committee of the Otto von Guericke University in Magdeburg, Germany. The participants provided written informed consent to participate in the study.

Go/NoGo Association Test

Creating the GNAT

For the GNAT, we chose German words for unambiguous valence and matched positive and negative German words (40 in each category) for length and word frequency (Baayen et al, 1993). A full list of the words used in the GNAT is provided in Table 1. A comparison of the word stimuli in both conditions using the scientific database SUBTLEX-DE (Brysbaert et al, 2011) showed no difference in lexical frequency of the stimuli as indicated by the lgSUBTLEX value ($M_{positive\ words}$ = 2.19; $M_{negative\ words}$ = 2.18; P = 0.96, unpaired t test).

We selected the East German, West German, and European cities by means of a pilot study (with 10 individuals each from West and East Germany) to ensure sufficient certainty in their assignment to the correct location. The piloting individuals classified the location of the respective city (1 = *correct*, 2 = *incorrect*, and 3 = *don't know*) and further indicated on a 5-point scale how certain they were about this assignment (5 = *very uncertain* to 1 = *very certain*). For the experiment, we chose only cities that had a mean value of ≤1.3 for the correctness of the assignment and that were assigned with a mean certainty of ≤1.8.

Based on these criteria, we selected 20 East German cities and then matched 20 West German cities for the number of inhabitants in the city and the number of letters in the name. We also matched 20 European cities for the number of syllables and letters, but here, the most well-known cities were included to ensure recognition of the city names used.

A comparison of the city names using the scientific database SUBTLEX-DE (Brysbaert et al, 2011) showed no difference in lexical frequency of the East and West German cities as indicated by the lgSUBTLEX value ($M_{East\ German\ cities}$ = 0.42; $M_{West\ German\ cities}$ = 0.51; P = 0.6, unpaired t test). The lexical frequency of the European city names was significantly higher ($M_{European\ cities}$ = 1.5; P < 0.0001, unpaired t test). A full list of the city names is provided in Table 1.

Presenting the GNAT

We presented the word stimuli in black (Arial, 16 pt) against a white background on a computer screen. The participating individuals were seated 90 cm from the computer screen. The task consisted of the following six blocks:

- Respond to all East German cities and to all positive words.
- Respond to all East German cities and to all negative words.
- Respond to all West German cities and to all positive words.
- Respond to all West German cities and to all negative words.
- Respond to all European cities and to all positive words.
- Respond to all European cities and to all negative words.

Within each block, all of the words were presented twice, resulting in a total stimulus count of 240 words per block. The blocks were presented in a randomized order. Before each block, 15 practice runs were conducted so that the individuals could become accustomed to the respective task.

At the start of each trial, a fixation cross was centrally presented for a random duration between 1000 and 2000 ms, immediately followed by a word that remained on the screen for 1500 ms, followed again by a fixation cross for 1000–2000 ms until the end of the trial. The individuals were required to make a Go/NoGo decision on the presentation of each stimulus, depending on the instructions provided at the start of the block.

We instructed the individuals to respond as quickly as possible, according to the given instruction, via a mouse button press (Go) or by withholding their response (NoGo), respectively. They pressed the button with the index finger, for three blocks with the right hand and for another three blocks with the left hand. For half of the individuals, this order was reversed (ie, starting with the left hand).

Figure 1 provides a schematic drawing of the trial procedure.

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TABLE 1. List of Word Stimuli Used in the Go/NoGo Association Task (Originally in German)

Positive words	lachen, abenteuerlustig, gastfreundlich, genüsslich, fantastisch, niedlich, fabelhaft, liebevoll, appetitlich, herzerfreuend, Beglückung, lebenshungrig, Blumen, Tanzen, Aufgeregtheit, Feiertag, Fröhlichkeit, Kuss, Paradies, spitze, Belohnung, Sonnenschein, Umarmung, Jackpot, behilflich, hervorragend, sympathisch, Freude, Sonnenaufgang, beliebt, Humor, Triumph, Glück, Vertrauen, super, wunderbar, ausgezeichnet, Applaus, Seide, begabt (laugh, adventurous, hospitable, enjoyable, fantastic, cute, fabulous, affectionate, appetizing, heart-warming, gladness, life-hungry, flowers, dancing, excitement, holiday, cheerfulness, kiss, paradise, top, reward, sunshine, hug, jackpot, helpful, excellent, sympathetic, joy, sunrise, popular, humor, triumph, happiness, confidence, super, wonderful, excellent, applause, silk, talented)
Negative words	arrogant, ekelig, Beerdigung, ängstlich, anstößig, widerlich, abscheulich, herzlos, schmutzig, eigennützig, miserabel, eingebildet, Bomben, Gehässigkeit, Zahnlöcher, Desaster, Hass, Schlachthaus, Todeskampf, Ausrottung, Totschlag, Hölle, Folter, hochnäsig, Abneigung, grausam, aggressiv, böse, boshaft, brutal, gefährlich, ärgerlich, zornig, traurig, Bedrohung, Gefängnis, Mord, Verbrechen, Krankheit, Zerstörung (arrogant, disgusting, funeral, fearful, offensive, loathsome, vile, heartless, filthy, selfish, miserable, conceited, bombs, spitefulness, tooth holes, disaster, hate, slaughterhouse, death throes, extermination, manslaughter, hell, torture, uppity, dislike, cruel, aggressive, evil, spiteful, brutal, dangerous, angry, wrathful, sad, threat, prison, murder, crime, disease, destruction)
East German cities	Neubrandenburg, Greifswald, Potsdam, Erfurt, Magdeburg, Wismar, Zwickau, Leipzig, Jena, Brandenburg, Rostock, Neuruppin, Gera, Dessau, Cottbus, Stralsund, Chemnitz, Weimar, Dresden, Schwerin
West German cities	Neumünster, Lübeck, Gießen, Aachen, Wiesbaden, Hildesheim, Trier, Lüneburg, Würzburg, Nürnberg (Nuremberg), Kiel, Mannheim, Flensburg, Wilhelmshaven, Heilbronn, Bayreuth, Bochum, Münster, Mainz, Kassel
European cities	Monaco, London, Sevilla (Seville), Valencia, Reykjavik, Birmingham, Mailand (Milan), Zürich (Zurich), Brüssel (Brussels), Toulouse, Wien (Vienna), Glasgow, Bordeaux, Malaga, Barcelona, Nizza (Nice), Dublin, Kopenhagen (Copenhagen), Rotterdam, Neapel (Naples)

Data Acquisition

We recorded EEG from 29 scalp tin electrodes mounted in an elastic cap against a reference at the left mastoid process. The electrophysiological signals were then filtered online with a bandpass of 0.01–70 Hz (half-amplitude cutoffs) and digitized at a rate of 250 Hz. Electrode impedances were kept at <5 KΩ. Vertical and horizontal electrooculograms were monitored from electrodes that were placed below the right eye, and at the left and right outer canthi, respectively. EEG and electrooculogram data were recorded using Acquire software. ERPs were obtained via averaging the EEG signal stimulus-locked to the presentation of the city names using EEGLAB (Delorme and Makeig, 2004) and ERPLAB

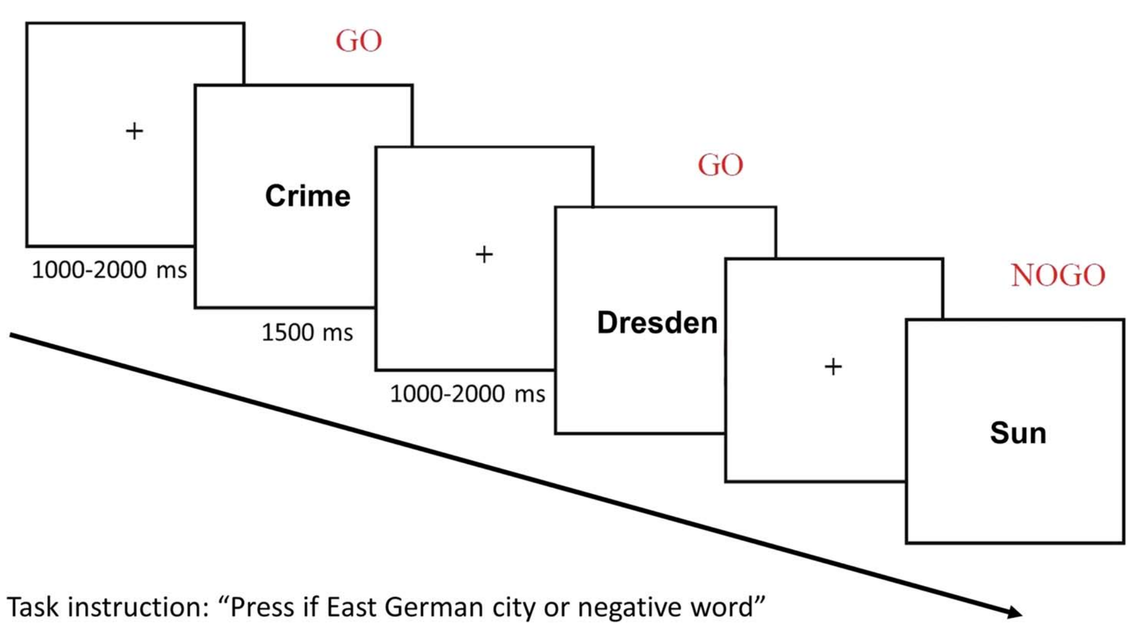

FIGURE 1. Schematic drawing of the trial procedure of the Go/NoGo association task. The individual views a random series of stimuli comprising the names of East German, West German, and European city names, as well as words with a positive or negative connotation. The task is to press the mouse button as fast as possible for one city category (in this example, East Germany) and one word category (in this example, negative words) while withholding responses for the other categories.

(Lopez-Calderon and Luck, 2014). RTs were recorded using Presentation software.

Statistical Analysis

Behavioral Data

The individuals' RTs to the East German, West German, and European city names were analyzed with GraphPad Prism (version 9, Graphpad Software) using paired t tests and one-sample t tests, as indicated. RTs >2000 ms, which occurred very rarely (< 0.5% of trials), were not considered for analysis (cutoff). D scores (see Greenwald et al, 2003, for D score analysis in the IAT, and, eg, Jiang et al, 2022, for D score analysis in the GNAT) were obtained by calculating the difference of the mean RTs between the negative word condition and the positive word condition for the respective city name type and then dividing the difference by the standard deviation in these conditions (Jiang et al, 2022; Nosek et al, 2014). Positive D scores are indicative of a positive implicit evaluation of the respective city name type; negative D scores are indicative of a negative implicit evaluation of the respective city name type.

Electroencephalographical Data

To remove ocular artifacts, we used independent component analysis. To account for nonocular artifacts such as amplifier blocking or sudden jumps in amplitude, we used the moving window peak-to-peak threshold ERPLAB function, with a threshold potential that was individually adjusted for each individual after visual inspection of long stretches of EEG. Epochs containing these artifacts were excluded from the analysis; 2.3% of the trials were discarded due to a high artifact rate. ERPs were filtered with a 12-Hz low-pass filter. For baseline correction, we defined the baseline as the interval from –100 to 0 ms. From the resulting data, averages for each segment and individual were determined; subsequently, grand averages were calculated for all of the individuals in each group.

The individuals' ERPs following presentation of the names of East German, West German, and European cities were quantified using routines from ERPLAB. Statistics were performed employing the open-source tool Jamovi (version 1.0.71; https://www.jamovi.org) and using repeated-measures ANOVAs with Huynh-Feldt correction. Uncorrected F values, but corrected P values, are reported.

Visual inspection of the grand average ERP waveforms of all of the individuals revealed a frontal negativity beginning at ~300 ms that was more pronounced in the NoGo condition compared with the Go condition. This finding considerably reflects the NoGo N200, although the onset is somewhat later than in comparable studies (eg, Banfield et al, 2006, observed the NoGo N200 at 230+ ms for the congruent condition and at 280+ ms for the incongruent condition; Wu et al, 2014, at 250–450 ms; and Wagner-Altendorf et al, 2021, at 250–400 ms). The fact that a NoGo N200 delay of the incongruent rather than the congruent condition could not clearly be identified in the present study may have contributed to the later onset.

Because some GNAT studies have focused on the Go P300 instead of the NoGo N200 (Cai and Wu, 2021; Jiang et al, 2022), a centroparietal P300 effect must be delineated here. The Go P300, however, has a broader temporal distribution, extending to 600–800 ms post stimulus (therefore occasionally called P3/LPP [late positive potential] waveform by Jiang et al, 2022), and is clearly distinct from the negative (N2) peak observed here, which we, therefore, interpreted as NoGo N200.

We quantified the NoGo N200 component using repeated-measures ANOVAs to test for differences between the four conditions (Go-congruent, Go-incongruent, NoGo-congruent, NoGo-incongruent) in the mean amplitude between 300 and 450 ms. Because the NoGo N200 is known to have a frontal maximum, we performed the analysis at electrode sites F3, F4, and Fz (Wagner-Altendorf et al, 2021).

Visual inspection of the grand average ERP waveforms also revealed a late frontocentral negativity, beginning at ~400 ms post stimulus in the Go condition, which differed in the West German group after the presentation of the East German city names between the positive and negative word (ie, incongruent vs congruent) condition, and in the East German group after presentation of the West German city names. We quantified this effect on the Go congruent-minus-incongruent difference waveforms by determining the mean amplitude between 400 and 800 ms using repeated-measures ANOVAs to test for differences between the conditions. Because the late frontocentral negativity is present over frontal and frontocentral sites, we performed the analysis at electrode sites F3, F4, Fz, Fc1, and Fc2.

RESULTS

Behavioral Data

West German Group

The mean RT of the West German group to East German city names was similar when the city names were combined with positive ("Press if East German city or positive word" condition) or negative ("Press if East German city or negative word" condition) words: 699 ms versus 711 ms; $P = 0.68$ (paired t test). The mean RT of the West German group to West German city names was faster when the city names were combined with positive words, which was, however, not statistically significant: 736 ms versus 766 ms; $P = 0.06$ (paired t test). The mean RT of the West German group to European city names was faster when the city names were combined with negative words, which also was not statistically significant: 719 ms versus 692 ms; $P = 0.08$ (paired t test).

D scores did not differ significantly from zero (one-sample t tests): East German city names: 0.08 ($t = 0.69$; $P = 0.50$); West German city names: 0.16 ($t = 2{:}08$, $P = 0.06$); European city names: –0.15 ($t = 1.67$; $P = 0.11$).

East German Group

The mean RT of the East German group to East German city names was similar when the city names were combined with positive or negative words: 682 ms versus 679 ms; $P = 0.87$ (paired t test). The mean RT of the East German group to West German city names was slightly faster when the city names were combined with negative words, which was, however, not statistically significant: 741 ms versus 723 ms; $P = 0.24$ (paired t test). The mean RT of the East German group to European city names was faster when the city names were combined with negative words, which also was not statistically significant: 696 ms versus 673 ms; $P = 0.08$ (paired t test).

D scores did not differ significantly from zero (one-sample t tests): East German city names: 0.01 ($t = 0.12$; $P = 0.9$); West German city names: –0.07 ($t = 1.05$; $P = 0.31$); European city names: –0.12 ($t = 1.63$; $P = 0.12$).

Figure 2 provides the RTs of both groups to the East German, West German, and European city names. The respective D scores are provided as Figure S1 in the supplementary digital content (http://links.lww.com/CBN/A124).

When combining the West Germans and East Germans into one group for analyzing their RTs to European city names, the group showed significantly faster RTs for the combination of European city name and negative word compared with the combination of European city name and positive word: 683 ms versus 708 ms; $P = 0.01$ (paired t test). Also, the D scores for the two groups combined differed significantly from zero for European city names (one-sample t test): –0.13 ($t = 2.37$; $P = 0.02$).

A comparison of the D scores of the West and East German groups revealed a significant difference between the two groups for West German city names: 0.16 versus –0.07; $P = 0.03$ (East German city names: 0.08 vs 0.01; $P = 0.67$; European city names: –0.14 vs –0.12; $P = 0.85$).

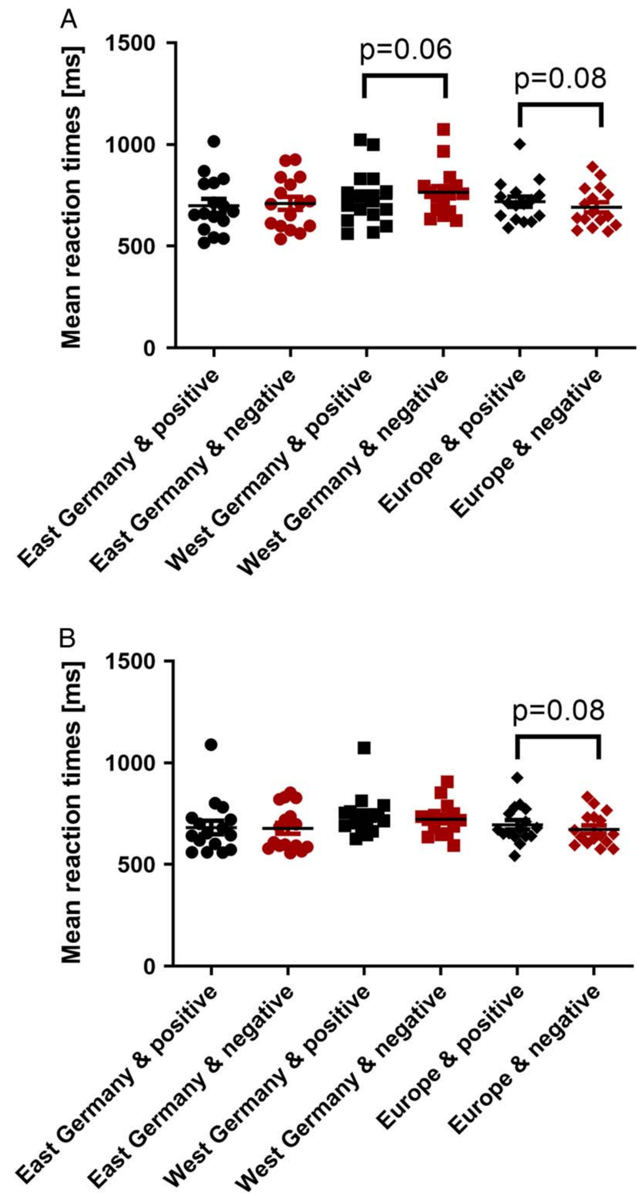

FIGURE 2. A. Reaction times of West Germans in classifying East German, West German, and European city names, when individuals had to respond to both a city name and one pole of an evaluative word category (positive/negative). The combination "West Germany & positive" was associated with faster reaction times compared with the combination "West Germany & negative," whereas the combination "Europe & positive" was associated with slower reaction times compared with the combination "Europe & negative." Both findings were not statistically significant ($P = 0.06$ and $P = 0.08$, respectively; paired t test). Data are presented as M + SEM. **B.** Reaction times of East Germans in classifying East German, West German, and European city names, when individuals had to respond to both a city name and one pole of an evaluative word category (positive/negative). The combination "Europe & positive" was associated with slower reaction times compared with the combination "Europe & negative"; the difference was not statistically significant ($P = 0.08$; paired t test). Data are presented as M + SEM.

Electrophysiological Data

NoGo N200

ERP data showed a robust NoGo N200 effect after the presentation of West German, East German, and European city names, which was more prominent in the West German group.

We analyzed the NoGo N200 effect by testing the mean amplitude between 300 and 450 ms for F3, F4, and Fz electrodes with a 2 (Go/NoGo) × 2 (word category: positive/negative) × 3 (electrode: F3/Fz/F4) repeated-measures ANOVA, which revealed the following results.

West German Group. A significant difference for the Go versus NoGo condition was seen after the presentation of East German city names ($F_{1,15} = 19.84$, $P < 0.001$, $\eta^2_P = 0.57$), West German city names ($F_{1,15} = 25.05$, $P < 0.001$, $\eta^2_P = 0.63$), and European city names ($F_{1,15} = 20.79$, $P < 0.001$, $\eta^2_P = 0.58$).

East German Group. No significant difference for the Go versus NoGo condition was seen after the presentation of East German city names when testing for the three frontal electrodes ($F_{1,15} = 2.8$, $P = 0.12$, $\eta^2_P = 0.16$). However, a significant difference for the Go versus NoGo condition was seen when testing only for Fz ($F_{1,15} = 4.91$, $P = 0.043$, $\eta^2_P = 0.25$). No significant difference for the Go versus NoGo condition was seen after the presentation

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of West German city names ($F_{1,15} = 3.55$, $P = 0.08$, $\eta_P^2 = 0.19$). A significant difference for the Go versus NoGo condition was seen after the presentation of European city names ($F_{1,15} = 14.93$, $P = 0.002$, $\eta_P^2 = 0.5$).

Figures 3 and 4 contain the stimulus-locked grand average ERP waveforms of the West and East German groups, respectively, after the presentation of East German, West German, and European city names.

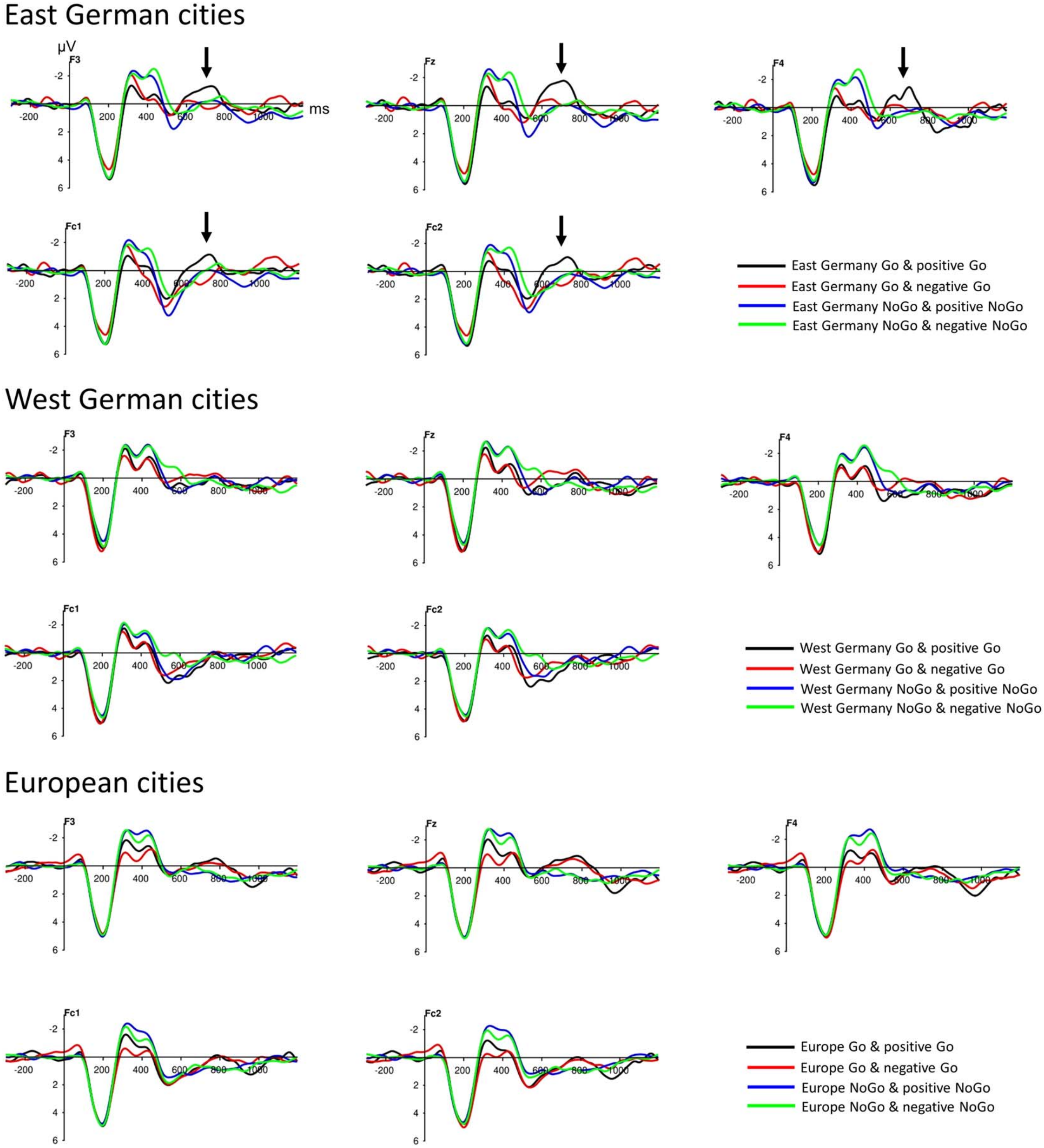

FIGURE 3. Stimulus-locked grand average ERP waveforms of the West German group at frontal and frontocentral electrode sites after the presentation of East German, West German, and European city names. NoGo conditions are associated with a larger negativity at ~300–450 ms, which is the NoGo N200 component. For East German city names, the "Go & positive" condition shows a significantly pronounced negativity at 400–800 ms compared with the "Go & negative" condition (pointing arrows). This finding does not hold for West German and European city names. Waveforms were filtered with a 12-Hz low-pass filter. **ERP** = event-related potential.

FIGURE 4. Stimulus-locked grand average ERP waveforms of the East German group at frontal and frontocentral electrode sites after the presentation of East German, West German, and European city names. NoGo conditions are associated with a larger negativity at ~300–450 ms, which is the NoGo N200 component. Similar to the West German group, but now for West German city names, the "Go & positive" condition shows a significantly pronounced negativity at 400–800 ms compared with the "Go & negative" condition (pronounced at Fz electrode; pointing arrow). Waveforms were filtered with a 12-Hz low-pass filter. **ERP** = event-related potential.

Topographies of the NoGo N200 are provided as Figure S2A in the supplementary digital content (http://links.lww.com/CBN/A124).

Frontocentral Negativity

To test for differences in late frontocentral negativity, we analyzed the mean amplitude of the Go-minus-NoGo difference wave, between 400 and 800 ms post stimulus, with a 2 (word category: positive/negative) × 5 (electrode: F3/F4/Fz/Fc1/Fc2) repeated-measures ANOVA.

West German Group. This analysis revealed a nonsignificant main effect in late frontocentral negativity for the word category in the West German group after the presentation of East German city names: $F_{1,15} = 3.89$; $P = 0.067$; $\eta^2_P = 0.21$; with the electrode main effect ($F_{4,60} = 2.04$, $P = 0.12$, $\eta^2_P = 0.12$) and the Word Category × Electrode interaction ($F_{4,60} = 2.66$, $P = 0.054$, $\eta^2_P = 0.15$) also nonsignificant. Visual inspection revealed the effect to be strongest over the Fc1/Fc2 electrode sites; restricting the analysis to these two electrodes revealed a then significant main effect for word category: $F_{1,15} = 5.09$; $P = 0.039$; $\eta^2_P = 0.25$.

East German Group. The East German group's ERP showed a similar effect, but after the presentation of West German city names (ie, pronounced negativity in the incongruent condition [West German city names and positive words] compared with the congruent condition). A 2 (word category: positive/negative) × 5 (electrode: F3/F4/Fz/Fc1/Fc2) repeated-measures ANOVA, between 400 and 800 ms post stimulus, revealed a significant main effect for word category ($F_{1,15} = 6.13$; $P = 0.026$; $\eta^2_P = 0.29$) and a significant Word Category × Electrode interaction ($F_{4,60} = 3.58$, $P = 0.012$, $\eta^2_P = 0.19$), with the electrode main effect not being significant ($F_{4,60} = 1.26$, $P = 0.3$, $\eta^2_P = 0.08$).

For the other city name conditions, the frontocentral late negativity for positive versus negative words was not found to be significant.

Figure 5 shows the Go-minus-NoGo difference waveforms in the West and East German groups after the presentation of East German, West German, and European city names. Topographies of the frontocentral late negativity component are provided as Figure S2B in the supplementary digital content (http://links.lww.com/CBN/A124).

DISCUSSION

The present study addressed implicit attitudes toward East German, West German, and European city names, as measured by behavioral parameters and event-related EEG potentials, in both West and East German individuals. Data were obtained 15 years after the fall of the Berlin Wall, so both experiences from the period of the division of Germany and experiences from the time after the reunification are supposed to have contributed to the observed effects.

Behavioral Data

When combining the data from both the West and East German groups, the behavioral data showed statistically significant evidence for an ingroup bias—that is, the implicit favoritism of an ingroup, to which an individual belongs, and the implicit relatively negative stereotyping of an outgroup, to which the individual does not belong—as indicated by faster RTs to European city names when the names were combined with negative compared with positive evaluative words. Whereas the West Germans showed faster RTs to West German city names when the names were combined with positive compared with negative evaluative words, which is indicative of an implicitly positive attitude toward Western Germany, the East Germans showed slightly faster RTs to West German city names when the names were combined with negative evaluative words, which is indicative of a neutral or implicitly slightly negative attitude toward Western Germany.

Thus, the behavioral results of our study seem to support our hypothesis of an implicit ingroup bias among both West and East German individuals. However, this finding is rather weak (statistically significant for the RTs to European city names when combining the data from the West and East German groups), representing only a mild implicit bias toward ingroup favoritism when evaluating German and European city names. An IAT study by Kühnen and colleagues (2001) of West and East Germans found an ingroup bias in both groups (Schmitt et al, 1992), which is in line with well-described findings of interethnic bias in differing cultural contexts (Aberson et al, 2004; Amodio and Devine, 2006; Blommaert et al, 2012; Diesendruck and Menahem, 2015; Hagendoorn, 1995; Paolini et al, 2021; Tsukamoto et al, 2013).

Electrophysiological Data

The electrophysiological data of both groups showed a negativity beginning at 250–300 ms post stimulus that was, for most of the city name categories, pronounced and prolonged in the NoGo compared with the Go condition. This finding likely represents the No-Go N200, although the effect is rather late (with the Go vs NoGo difference being prominent at 300–450 ms post stimulus) compared with other studies (Banfield et al, 2006; van der Lugt et al, 2012). However, the relative delay of the NoGo N200 in the incongruent compared with the congruent condition, which has been reported in numerous studies (Banfield et al, 2006; van der Lugt et al, 2012; Wagner-Altendorf et al, 2021; Wu et al, 2014), could not be identified in the present study: Both the West and East German groups' ERPs showed no significant delay for either the pairing of an ingroup city name and a negative word or the pairing of an outgroup city name and a positive word (ie, for the incongruent conditions). Thus, the ex ante hypothesized ERP result could not be found, which may represent an actually weak congruency/incongruency difference (ie, weak implicit bias).

When analyzing the ERP late negativity in the Go-minus-NoGo difference waveforms between 400 and 800 ms after the presentation of city names, however, significant differences were present: In the Go condition of the West German group, no difference was found for West German and European city names for positive versus negative word pairings; however, after the presentation of East German city names, the West German group's ERPs showed a pronounced frontocentral negativity for the pairing with positive compared with negative words.

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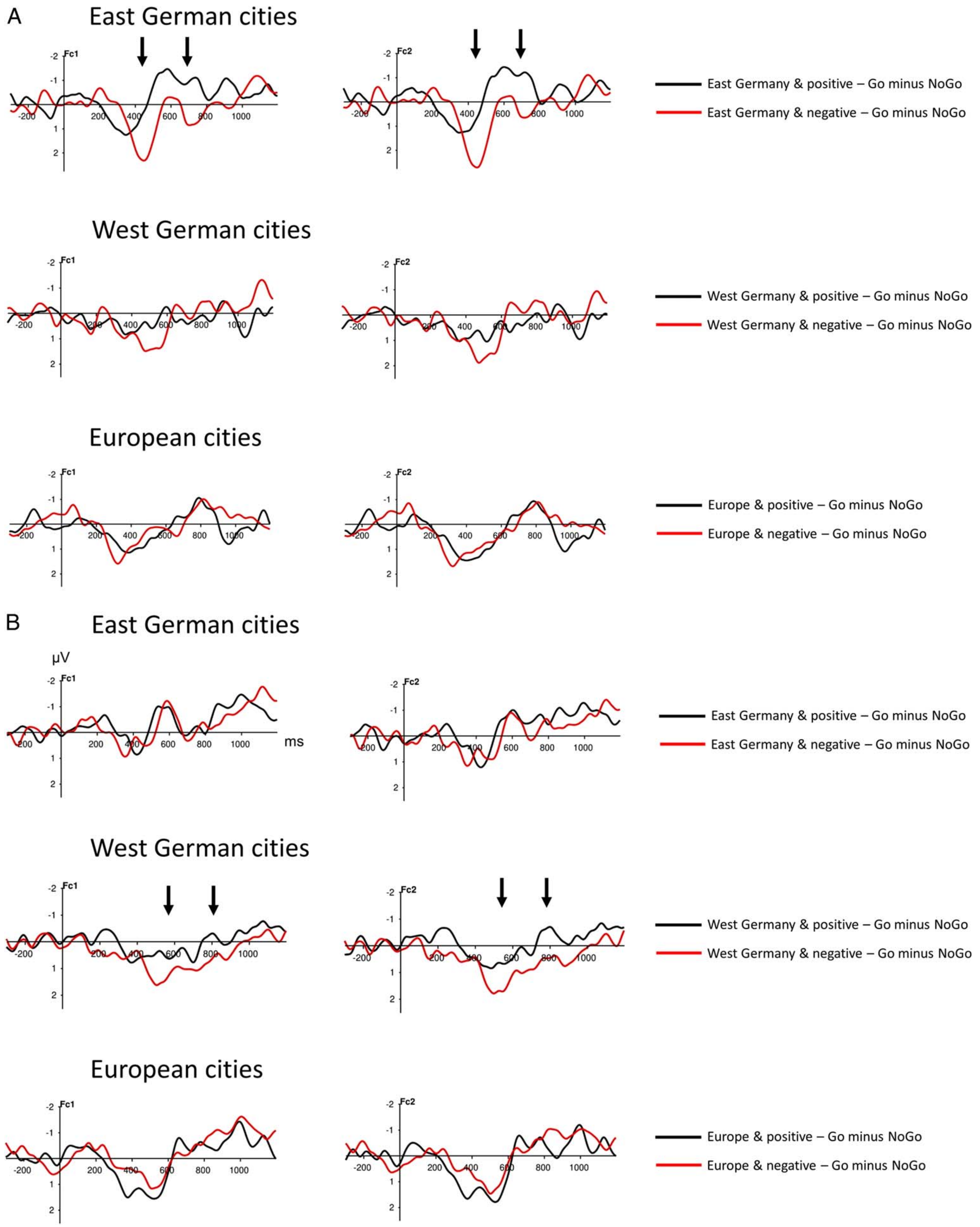

FIGURE 5. A. Go-minus-NoGo difference waveforms in the West German group at electrode sites Fc1 and Fc2 after the presentation of East German, West German, and European city names. For East German cities, the Go-minus-NoGo difference wave shows a significant negative deflection at 400–800 ms in the "positive word" condition compared with the "negative word" condition (pointing arrows). **B.** Go-minus-NoGo difference waveforms in the East German group at electrode sites Fc1 and Fc2 after the presentation of East German, West German, and European city names. For West German cities—similar to the effect observed for East German cities in the West German group—the "positive word" condition is associated with a pronounced negativity at 400+ ms compared with the "negative word" condition (pointing arrows). Waveforms were filtered with a 12-Hz low-pass filter.

In the East German group, a similar effect, but for West German city names, was present: The assumed incongruent condition—pairings of West German city names and positive words—was associated with a pronounced frontocentral negativity at 400+ ms compared with the congruent condition, reaching statistical significance at 400–800 ms post stimulus over the frontal and frontocentral electrodes.

As the pairing of East German city names and positive words, in West Germans, and of West German city names and positive words, in East Germans, reflect the incongruent condition, this pronounced late negativity might be interpreted as a marker of (higher) conflict arising when less associated items, such as East German city names and positive words for West German individuals, have to be mapped to the same response key, and thus be indicative of an implicit negative evaluation of Eastern Germany by West Germans (and vice versa). However, this electrophysiological finding—evidence for a mild negative bias of West Germans toward East Germany, and of East Germans toward West Germany—only partly matches the behavioral finding—(statistically partly significant) evidence for a positive bias of West Germans toward West Germany and for a negative bias of both West and East Germans toward Europe. This partial discrepancy could be due to the overall weak expression of the biases and should make one cautious in interpreting the data; although it should be noted that behavioral and electrophysiological measures of implicit attitudes do not always match (Enke et al, 2016).

Broad negative ERP deflections—observed at 400+ ms post stimulus at the frontocentral electrode sites and occasionally referred to as N450, medial frontal negativity, late frontal negativity, or negative slow wave—have been interpreted as a marker of conflict in several studies (Bartholow, 2010; Larson et al, 2014; Liotti et al, 2000; Rey-Mermet et al, 2019; West, 2003; West et al, 2005). A term neutral to exact timing such as *late negativity* may be preferred over N450 because the timing of the negative deflection varies across studies and can span beyond 700+ ms, possibly reflecting two or more transient ERP effects (West and Bailey, 2012). The neural generator of the conflict-indexing ERP components is thought to be the ACC (Botvinick et al, 2001, 2004; West, 2003)—a structure that was found to also be implicated, in ACC-insular circuits, in implicit ingroup (racial) prejudice (Liu et al, 2015; see also, Amodio et al, 2004), whereas explicit prejudice was found to correspond with increased ACC response to decreasing prototypicality in racial stereotype (Cassidy et al, 2017).

When studying implicit social cognition, the late negativity or negative slow wave ERP component in particular has been described as reflecting the implementation of conflict resolution necessary to overcome the prepotent (ie, biased) response tendency (Bartholow, 2010). A study by Siyanova-Chanturia et al (2012) investigating gender stereotype-related ERPs described a conflict-indexing N400 component after the presentation of incongruent female stereotype–masculine pronoun combinations. Hehman et al (2014) reported a greater N400 amplitude to stereotype-incongruent compared with stereotype-congruent associations in a racial stereotype priming task; White et al (2009) similarly showed a pronounced N400 effect after incongruent gender-stereotype pairings. These findings are in line with the here-described pronounced negativity in the “East German city name and positive word” condition when presented to West Germans and in the “West German city name and positive word” condition when presented to East Germans, thus indicating the incongruency of the respective German cities and positive evaluation (ie, an implicitly negative attitude of West Germans toward East Germany and of East Germans toward West Germany).

Study Limitations

The sample size of the study, 16 participants per group, was determined based on the sample sizes of comparable GNAT/ERP experiments (Banfield et al, 2006; van der Lugt et al, 2012; Wagner-Altendorf et al, 2021; Wu et al, 2014). However, given the potentially small intergroup differences in implicit attitudes between West and East Germans 15 years after the reunification of Germany, this sample size might be too small, as reflected in only partly statistically significant results.

Regarding the differences in the ERPs between the two groups, the behavioral and electrophysiological findings of the present study match only partly. Although theoretical considerations and previous data support the interpretation of a pronounced late negativity as a marker of conflict and incongruency (ie, negative implicit attitudes), the described finding is post hoc—as we expected, primarily a delay of the NoGo N200 component—with post hoc findings being a questionable effect in ERP research (Luck and Gaspelin, 2017). Further research is needed to validate the hypothesis that a pronounced late negativity at 400+ ms can be established as a marker of negative implicit attitudes in GNAT paradigms.

CONCLUSION

Our study provides both behavioral and electrophysiological, although weak, evidence for an ingroup bias in both West and East Germans. The rather moderate extent of the implicit bias might be attributed to the fact that all of the individuals—being students at the universities of Hannover (West Germany) and Magdeburg (East Germany)—belonged to an academic milieu, which generally tends to be more liberal minded. Implicit social bias is known to increase with greater cultural and ethnic divergence (Hagendoorn, 1995).

West and East Germans share the same language and have large historical and cultural overlaps; thus, this ethnic convergence may well produce a weaker ingroup bias toward the other group. Still, implicit biases in both groups, as well as (sociocultural) differences between West and East Germany, are likely to still be relevant because of historical differences as well as differences in socialization (Jäckle and König, 2017). As a potential measure of implicit social bias, the late negativity in the ERP in the GNAT needs further investigation.

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