

The Effect of Segregation on Intergroup Relations

Ryan D. Enos*
Christopher Celaya†

Abstract

Inter-ethnic residential segregation is correlated with intergroup bias and conflict, poorly functioning states and civil societies, weak economic development, and ethnocentric political behavior. Because of these correlations, segregation has been a subject of long-standing interest. However, segregation has not been assigned in randomized controlled trials, so the observed correlations between segregation and these outcomes may be spurious and the mechanism behind these correlations is poorly understood. In two experiments we randomly assign segregation in a laboratory and demonstrate that segregation affects perceptions of other people and causes intergroup bias in costly decision-making. These experiments include the randomized assignment of in-person subjects to the experience of a spatially segregated environment. Rather than segregation merely inhibiting intergroup contact, we demonstrate that segregation directly affects perception and thus can affect intergroup relations even when holding contact constant.

*Department of Government, Harvard University; renos@gov.harvard.edu

†Department of Government, Harvard University; ccelaya@fas.harvard.edu

Across and within societies, residential ethnic segregation is correlated with individual discriminatory behaviors and attitudes (Allport, 1954; Baybeck, 2006; Alesina and Zhuravskaya, 2008; Oliver, 2010; Rothwell, 2012; Uslaner, 2012; Zingher and Steen Thomas, 2014; Dill and Jirjahn, 2014; Enos and Gidron, 2016), low-capacity states and civil societies (Massey and Denton, 1993; Alesina, Baqir and Easterly, 1999; Gerometta, Haussermann and Longo, 2005; Alesina and Zhuravskaya, 2008; De Kadt and Sands, 2014; Quillian, 2014), poor economic outcomes (Li, Campbell and Fernandez, 2013), violent conflict (Corvalan and Vargas, 2015), and ethnocentric political behavior (Enos, 2016*b*). Ethnic segregation is also an ongoing and, by some measures, growing phenomenon in the United States (Lichter, Parisi and Taquino, 2015) and other industrialized countries (Glitz, 2014).

Because of their profound consequences, the effects of segregation have generated intense interest among academics and policy makers. However, issues of selection have limited researchers' ability to measure those effects. In addition to potential omitted variable bias, a situation of reverse causality between segregation and intergroup behaviors and attitudes is also quite plausible. Furthermore, the mechanism through which segregation affects sociopolitical outcomes remains unclear—when segregation is argued to cause changes in intergroup relations, the mechanism is often assumed to be a lack of intergroup contact (e.g., Ananat and Washington (2009)), but this assumption is rarely tested and, to our knowledge, has never been tested using a randomized controlled trial.

This manuscript makes two contributions: first, we demonstrate that there is a causal effect of segregation on behavior and attitudes via a randomized controlled trial. Second, we identify a new mechanism for the effect of segregation on behavior and attitudes by holding intergroup contact fixed, thus removing this most commonly assumed mechanism and demonstrating that segregation directly affects behavior via another cognitive channel.

We demonstrate that segregation directly affects cognition, causing perceptions of greater intergroup differences and also causing increased discriminatory behavior. By randomly

assigning segregation in a controlled setting, we hold individual characteristics, such as pre-existing intergroup attitudes, constant. Furthermore, by controlling intergroup contact, we demonstrate that segregation can affect intergroup relations, even if the groups' ability to interact is not constrained. This alternative mechanism raises potential public policy challenges, which we address in the conclusion.

Causal Effects and Mechanisms of Segregation on Intergroup Behaviors

We define segregation as the degree to which two groups share the same geographic space. Residential segregation's relationship with wide-ranging outcomes has been a subject of intense and long-standing scientific interest to a broad range of researchers, including political scientists, demographers, economists, psychologists, and sociologists. As noted above, segregation has been shown to be correlated with a host of potentially negative outcomes. Most of those we cite, as well as others, implicitly or explicitly argue that segregation has a causal effect on these outcomes. For example, Massey and Denton (1993) in their landmark study of racial segregation in the United States say, "[racial segregation] systematically undermines the social and economic well-being of blacks in the United States." Segregation has also been a subject of long-standing public policy interest because the regulation of housing and other land use is central to the activity of most economically developed states. However, despite this widely-accepted importance, the mechanisms by which segregation is correlated with negative outcomes, or whether segregation even is causally related to these outcomes, is poorly understood.

Correlations between segregation and macro-level negative social outcomes are often thought to operate through individual intergroup bias, including mistrust, animosity, and discrimination between members of segregated groups (e.g., Uslaner (2012)). But, research

on the causal effect of interpersonal contact on intergroup bias notwithstanding, correlations between aggregate segregation and intergroup bias are consistent with explanations with opposite causal pathways. For example, segregation may reduce the probability of intergroup contact, leading to negative intergroup attitudes. On the other hand, negative attitudes and the subsequent sorting may cause segregation. Or the relationship between segregation and intergroup attitudes may be spurious; for example, the manipulation of ethnic tensions by politicians (Posner, 2004) could cause negative attitudes in already segregated societies or cause intergroup segregation and intergroup bias simultaneously. In fact, tellingly, in the social science literature segregation appears as both a cause (e.g., Ananat and Washington (2009)) and effect (e.g., Massey and Denton (1993)) of intergroup attitudes.

We distinguish between intergroup contact, generally, and the more specific phenomenon of spatial segregation, usually by means of residential segregation. Interpersonal contact and geographic segregation are not mere substitutes because integration or segregation is often weakly correlated with intergroup contact of the type necessary for improved intergroup relations (Hewstone, 2015). Furthermore, as we argue below, because of the importance of spatial memory and because humans tend to be most aware of spatial configurations associated with negative affect (Crawford and Cacioppo, 2002), segregation may affect cognition in ways unrelated to intergroup contact.

Meta-analytic (Pettigrew and Tropp, 2006) and quasi-experimental studies (Levin, Van Laar and Sidanius, 2003) demonstrate that sustained, direct interpersonal contact between small-scale groups, such as in schools or businesses, or cohabitation, such as with college roommates, can reduce intergroup bias. However, the relationship between large-scale diversity where segregation becomes relevant, as in a city, and intergroup contact is poorly understood and has produced inconsistent findings (Pettigrew, Wagner and Christ, 2010). And importantly, even if the effects of interpersonal contact are understood to improve intergroup relations, this does not mean that a lack of interpersonal contact is the exclusive

mechanism through which segregation affects intergroup attitudes. As such, while there is good evidence that contact reduces intergroup bias, studies on interpersonal contact do not necessarily address any or all of the effects of geographic segregation.

Because of the practical difficulty of experimentally assigning segregation in the laboratory or field, scholars have had to rely on observational studies (Massey and Denton, 1993), statistical instruments (Ananat, 2011), or agent-based modeling (Schelling, 1971). While experimental (Sherif et al., 1961) and quasi-experimental research (Enos, 2016*b*), in which segregation was confounded with other intergroup cleavages, suggest that segregation plays a role in intergroup relations, there have been almost no experiments in which spatial segregation is the experimental treatment.¹ The assumption that segregation affects social outcomes is therefore largely untested and the causal relationship between segregation and intergroup bias remains obscured.

We overcome problems of selection by experimentally assigning spatial segregation. We demonstrate that segregation causally affects intergroup bias and directly effects human cognition. The direct effect of segregation on cognition means that, even if selection contributes to the correlation between segregation and negative attitudes, segregation will still influence the attitudes and behaviors of the individuals who choose to live in segregated areas. Because segregation affects intergroup bias independently of the mechanism of intergroup contact, intergroup contact may not be sufficient for reducing intergroup bias in a segregated setting.

Segregation Increases the Salience of Social Categories

Categorization is a basic psychological function in humans, necessary for routine activity. People categorize in order to understand what attributes are attached to an object, including other people. For example, people categorize others to know whether they are

¹ The only exception of which we are aware is Takács (2007) who manipulated the spatial arrangement of groups in the context of network theory.

“trustworthy” or “friendly” (Kunda, 1999). When dealing with people, the categories used often include social identities, such as race or religion. Of course applying attributes based on such categorization can lead to mistakes and negative social processes, such as stereotyping.

The category a person chooses to apply to another person or group of people at a given time is called a salient category (Turner and Oakes, 1986). The salient category can range “low level categories,” such as categorizing a person by their personal identity (e.g., “Ryan” or “Chris”), and “high level categories,” such as categorizing a person by racial group (Turner et al., 1994; Wakslak et al., 2006; Haslam, Reicher and Platow, 2010). As we explain below, category salience can affect perceptions, attitudes, and behaviors, especially when a high-level category, such as race, is salient. We test for these consequences in our experiments.

Salience is a function of accessibility, e.g., how easily retrievable a category is from the mind, and *comparative fit* (Turner et al., 1994; Blanz, 1999). When the comparative fit of a category increases, the salience of a category also increases. Comparative fit is partially determined by the perceived cohesion within a collection of people, when a group of people are perceived to be more cohesive, the category label applied to them becomes more salient.

Spatial cognition is a basic function of the human mind (Muller, 1996; Burgess, Maguire and O’keefe, 2002; Ekstrom et al., 2003; New et al., 2007) which is likely central to the evolution of modern humans’ cognitive abilities (Maguire, 2006; Tavares et al., 2015). As a basic feature of cognition; we use space to make decisions, including social judgments. In fact, there is evidence that the same parts of the brain used in social cognition are used in spatial cognition (Burgess, Maguire and O’keefe, 2002; Tavares et al., 2015). Social information structures spatial memory and vice versa; “associations are built between locations and the people and objects connected to them” (Maddox et al., 2008) and physical cues in the environment can be associated with social groups (Guinote and Fiske, 2003). Moreover, humans are known to integrate affective and spatial information in extracting information about an environment and individuals are especially sensitive to spatial configurations that

involve negative affect (Crawford and Cacioppo, 2002). As such, the affective associations, such as negative stereotypes, with many social groups (Fiske et al., 2002) may mean that the location of groups is a particularly important piece of information about an environment—something people will likely notice.

The arrangement of objects in space is one important way humans categorize. The accessibility of space in the human mind—space is a (nearly) chronically accessible dimension of categorization—may mean that people are particularly likely to use space to judge comparative fit in the process of categorization; in fact, it may have been adaptive for humans to do so (Crawford and Cacioppo, 2002; Maguire, 2006) and studies of spatial memory have demonstrated the relationship between space and categorization (Hirtle and Jonides, 1985).

We propose that, because of the centrality of space in the human mind and its relevance to social categorization, spatial segregation is likely to contribute to the salience of categories by increasing comparative fit. This is likely because segregation increases perception of cohesion by grouping people together in space.

Comparative fit is related to the continuity of a group, i.e. having a “closed boundary.”² Segregation is associated with increased physical continuity and, relatedly, the convergence of group boundaries via the convergence of spatial boundaries with other social boundaries, which Brewer and Miller (1984) argued contributed to the salience of group categories. For example, if a racial group all lives on one side of town, social and spatial boundaries have converged. Greater spatial distance between groups also increases group cohesion (Henderson, 2009) and is related to greater “social distance,” (Matthews and Matlock, 2011) which, as noted below, also has behavioral and perceptual consequences. While we do not directly test the effect of distance in this manuscript, distance is positively correlated with segregation and may be a channel through which segregation indirectly increases comparative fit.

² This was the conjecture of Campbell (1958) in his study of entitativity or the coherence of a group, a concept closely related to comparative fit.

Consequences of Categorization

The salience of a social category has important consequences for perceptions, attitudes, and behaviors. When objects are categorized, people tend to accentuate differences between objects in different categories and minimize the difference between objects within a category (Capozza and Nanni, 1986). Of particular interest to our study is that people view categorized groups as homogeneous, thinking that members of these groups share attributes (Wilder, 1986), thus individual people are considered more similar or “typical” of a category. Applied to social categories, such as ethnicity or race, categorization promotes stereotyping (Yzerbyt, Corneille and Estrada, 2001), whereby attributes are perceived to be shared by members of a group and the differences between groups are perceived to be large.

Also of interest is that categorization, even when it occurs through the experimental assignment of completely arbitrary group membership, has been demonstrated to induce in-group bias in the attribution of traits, willingness to cooperate, and other-regarding behavior (Tajfel et al., 1971; Dunham, Baron and Carey, 2011; Goette, Huffman and Meier, 2012). Finally, as noted above, the “social distance” that is associated with physical distance is also related to stereotyping and discrimination (Stephan, Liberman and Trope, 2011; McCrea, Wieber and Myers, 2012). In summary, the salience of social categories is associated with a wide-range of outcomes, we designed experiments to test for the effect of segregation on these outcomes.

Based on these considerations, we test three hypotheses, on each of which a non-null finding would indicate that social categories have become more salient because of segregation:

1. Segregation will decrease perceptions of difference within a group and group members will be perceived as “prototypical” representations of their group.
2. Segregation will increase perceived differences between groups.
3. Segregation will increase group-based discriminatory behavior and attitudes.

We have proposed several related pathways between segregation and categorization. Each of these pathways is slightly different, but they all share the common feature of a being a direct effect of segregation on cognition—the way people think about groups—rather than through interpersonal contact. Our experiments do not allow us to delineate clearly between these pathways but we do show that segregation directly effects intergroup behavior consistent with theories of category salience, thereby suggesting that segregation has increased the salience of categories and offering a clearly different mechanism from those proposed in the past.

Finally, we note that as humans are increasingly concentrated in urban settings, the cognitive effects of segregation may become more acute. The need to reduce the cognitive load induced by the complexity of urban environments may lead to greater use of heuristic categorization, contributing to intergroup bias (Milgim, 1970). Segregation has greatly shaped the way we view these urban areas. Consider the meaning that would be removed from certain parts of cities if they were not associated with certain groups: London’s East End, Chicago’s South Side, Manhattan’s Harlem, and East Los Angeles, to name a few, conjure meaning, not merely because of their architecture or history, but because of the groups that are associated with these areas. This association is likely a result of segregation.

We use, admittedly, stylized experiments to study the effects of segregation, but we believe these experiments accurately capture the way segregation is represented in the mind (see below). While there are obvious shortcomings to such experiments, we believe the potential social-political importance of segregation demands a randomized controlled trial and we are the first to attempt one.

Simulating Segregation in a Laboratory

To determine the effects of segregation on perception and behavior, we run two experiments. In the first we use images of people from socially consequential groups. In the second we apply the same phenomenon using human interactions and costly behaviors. We report all measures, manipulations, and exclusions in these studies.

The studies presented here are likely an informative proxy for the cognitive processes associated with the phenomenon of interest: large-scale residential segregation. Mental representations of space include both route knowledge—a linear representation characterized by landmarks—and survey knowledge, which represents space in memory in two dimensions and includes direct spatial relationships in the form of distances and directions. While evidence shows that both types of knowledge use similar cognitive processes, it is important to note that spatial knowledge can vary depending on the source of information. Information used to structure spatial knowledge can be experienced directly—for example, by moving through an environment—or indirectly through interpersonal communication or mass media (Montello et al., 2004). Knowledge about segregation is also probably acquired in multiple ways: for example, by directly traveling through an urban area and by hearing and reading about it. In our experiments, we presented subjects with segregation through stimuli relying on both indirect representations (Study 1), which likely provides survey knowledge of the spatial relationship of groups, and direct experience (Study 2), which likely provides route knowledge. In both instances, segregation had similar effects on perception. Thus, while Study 1 is more stylized, it is true to one way in which space is represented in memory—survey representation—and thus attempts to capture one way in which people think about groups and space. Subjects in Study 2, which measures discriminatory behavior, experience space in the other way it is represented in memory—linear representation. As such, these studies also represent the indirect and direct ways that knowledge about space is acquired.

Study 1

In Study 1, we set out to test whether the segregation of objects promotes stereotyping, whereby segregated objects will be perceived to be more typical of their group and have smaller within-group difference than integrated objects (hypothesis 1).

Category members are often represented in the human mind as prototypes of the category, so that members are associated with attributes that are considered typical of the category (Kunda, 1999). People view categorized groups as homogeneous and, when making judgments, tend to privilege covariation that is consistent with known categories (Hamilton, 1981). For example, people use readily available characteristics, such as race, gender, and age, as category markers, leading them to confuse people within groups and to more easily differentiate people between groups (Taylor et al., 1978). In this experiment, we test whether segregation contributes to these processes.

We recruited subjects on Amazon’s Mechanical Turk (66% of sample) and the Harvard Digital Lab for the Social Sciences (34% of sample) and conducted five separate trials of this experiment with a total of 1,081 subjects across all five trials (47% female, mean age = 34.46 years, $SD = 11.31$; other covariates are described in the Supporting Information). We selected our sample size by arbitrarily piloting our initial trial of 365 subjects (the number of volunteer successfully recruited on the Harvard Digital Lab). Based on power calculations from this initial trial, we selected an overall sample size large enough to assure robust power. In previous tests with abstract objects (see Enos (2016a)), we conducted five independent trials, so we chose to conduct five trials here as well. In each trial, we exclude subjects in the bottom and top 5% quantiles of time used to complete the study. The substantive conclusions and statistical significance of results are unchanged when including these subjects.

Subjects were exposed to stimuli containing 16 human faces (Figure 1). The faces were from self-identified African American or white individuals. The faces were always either all

men or all women. In some cases, the white and African American faces were integrated across the stimulus (Integrated condition) and in some cases, the faces were segregated. On each stimulus, one of the faces had been altered using a morphing software to create a face that was racially ambiguous; this face was marked. In some cases, this ambiguous face was segregated with white faces (White Segregated condition) and in some case with African American faces (Black Segregated condition).

In a single trial, each subject was exposed to each stimulus of interest (Integrated, Segregated White, and Segregated Black) in random order, with 24 distraction stimuli included, each for five seconds. The distraction stimuli were similar to the stimuli of interest, except with different faces marked.

The faces used in this study were from a sample of subjects from a standing subject pool at Harvard University. These subjects took part in an unrelated study and agreed to have their photo taken with the understanding that it would be used in further research. The photos were chosen at random from the available pool of self-identified men and women African Americans and whites. The photos were converted to black and white color scale and were cropped to $774 \times 1089px$. Using Adobe Photoshop software, the background of each photo was removed and 16 photos were evenly spaced on a $533 \times 750px$ white background. This composite image was rescaled for display to $384 \times 540px$. The morphed faces were created using FantaMorph software. Each subject was exposed to one set of 80 possible different sets of faces, 40 of which were all women and 40 of which were all men, with the racially ambiguous face consistent across the Integrated and Segregated conditions within each of the sets, but with a different face for each of the 80 sets. The placement of faces on the composite image was randomly generated for each set.

Subjects were asked to rate the “appearance” of the face from “Very African-American” to “Very Caucasian” on a seven-point Likert scale. The quantity of interest in this experiment is the within-group difference (Black or white) of the perception of race between the Integrated

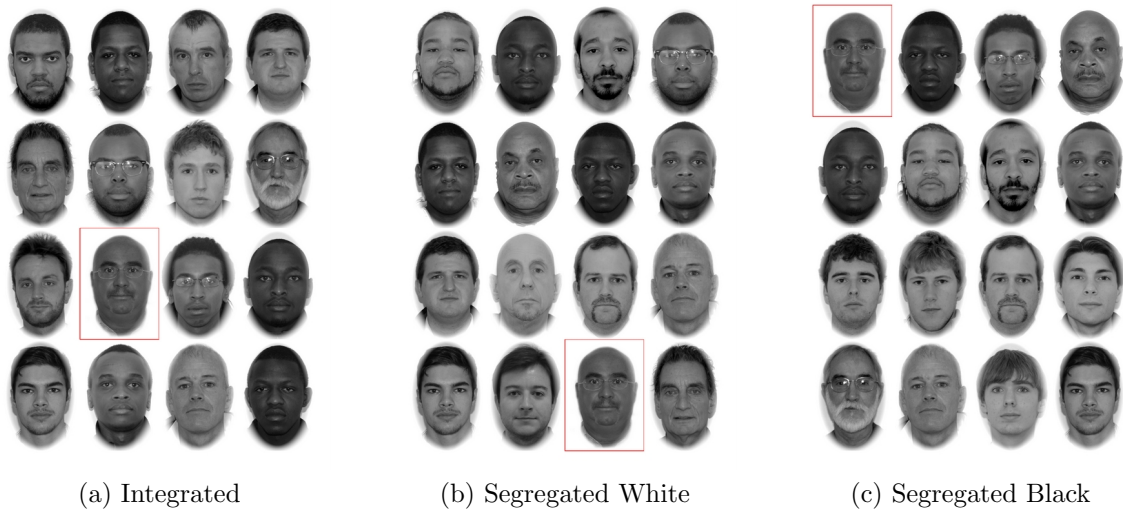


Figure 1: *Example of stimuli used in Study 1.*

and Segregated conditions. For each trial, we perform a within-subjects T-test looking for the difference of means between the White Segregated and Black Segregated conditions and the Integrated condition. We then pooled the results across trials and assessed the pooled difference-in-differences with cluster-robust standard errors.

Results

If a face was rated as more “Completely Caucasian (African American)” when segregated with white (Black) faces than when integrated with both white and Black faces, we took this as evidence that segregation caused changes in perceptions of the typicality of the face and reduced within group difference. Across each of the five trials (Table 1), perceptions of the face as African American increased when the face was segregated with Black faces and perceptions of the face as white increased when the face was segregated with white faces, allowing us to reject the Null Hypothesis of no increase in the typicality of faces (pooled result when segregated with Black faces: $\beta = -0.12$, $SE = 0.02$, $t = -4.95$, $p < .001$, $95\%CI[-0.17, -0.07]$; pooled result when segregated with white faces: $\beta = 0.10$,

Trial	Test	Beta (SE)	T value	CI	p	N
1	Black	-0.11 (0.06)	-1.78	[-0.23,0.01]	0.04	365
	White	0.09 (0.05)	1.74	[-0.01,0.2]	0.04	
2	Black	-0.18 (0.09)	-1.99	[-0.35,0]	0.02	148
	White	0.21 (0.08)	2.69	[0.06,0.37]	0.00	
3	Black	-0.2 (0.08)	-2.56	[-0.35,-0.05]	0.01	199
	White	0.07 (0.08)	0.85	[-0.09,0.22]	0.20	
4	Black	-0.11 (0.07)	-1.49	[-0.25,0.03]	0.07	196
	White	0.1 (0.08)	1.17	[-0.07,0.26]	0.12	
5	Black	-0.04 (0.06)	-0.67	[-0.17,0.08]	0.25	208
	White	0.11 (0.06)	1.72	[-0.02,0.24]	0.04	
Pooled	Black	-0.12 (0.02)	-4.95	[-0.17,-0.07]	0.00	1081
	White	0.1 (0.02)	6.66	[0.07,0.14]	0.00	

Table 1: Results from five trials of Study 1. Beta is difference between response in Segregated versus Integrated Condition. Higher numbers correspond to more “Caucasian” on the Likert scale.

$SE = 0.02$, $t = 6.66$, $p < .001$, $95\%CI[0.07, 0.14]$; pooled result when faces are integrated: $\mu = 3.6$, $SD = 1.1$). These results indicate that segregation was causing perceptions of the appearance of the face to move toward the group prototype; white faces were perceived as more white and Black faces were perceived as more Black (hypothesis 1). Thus, because segregation increases perceptions of typicality, it also causes between-group difference to be perceived as greater (hypothesis 2).

Study 2

Study 1 demonstrated that the assignment of images of humans to segregation changed perception of those images, thereby implying that segregation affects the way we perceive others. However, Study 1 did not allow us to test whether segregation affects behavior. Nor have we demonstrated that segregation is related to behavior for those actually personally experiencing segregation, which, as discussed above, is one of two ways that people acquire spatial knowledge. In Study 2, subjects experience segregation as part of a group. For

those experiencing segregation, if it increases the salience of group categories, it should be related to increased perceived differences between groups (hypothesis 2) and intergroup bias (hypothesis 3).

The basic design of this experiment is that subjects were randomly assigned to arbitrary groups and these groups were then randomly assigned to be integrated or segregated in space. The outcome of interest is differences in behavior and perceptions between these integrated and segregated conditions.

We pre-registered our design and pre-analysis plan for Study 2 with *egap* on March 11, 2015 (#20150311AA) after conducting a pilot experiment in December 2014 and prior to any data collection. Details on the pre-analysis plan are available in the Supplemental Material, which includes a description of all variables collected during the study.

Subjects from a general population were recruited via Craigslist. We targeted a sample size of 660 participants based on a review of the minimal groups and economic decision-making literature and adjusting our power calculations for the clustered nature of the analysis (see below). With no-show participants and unforeseen security and custodial costs, our final sample was limited to 285 subjects. The study was conducted over a period of 36 sessions at a university campus, with an average of nine subjects per session (56% female, mean age = 36.04 years, $SD = 14.23$). We removed one entire session and its paired session because of a pair of subjects who communicated disruptively in the waiting room. Our results are robust to the inclusion or exclusion of these subjects.

Naive subjects were invited to a laboratory and randomly assigned to one of two arbitrary groups under the guise of uncovering “perceptual type” (Otten and Moskowitz, 2000). Prior to the invitation, subjects were asked to indicate two pairs of experiment times for which they were available. They were then divided into matched pairs based on covariates collected from an online survey.³ Random assignment to experimental times was then conducted

³ The covariates used were age, gender, race, Hispanic origin, education, political party, political ideology,

within matched pairs. One of these experimental times was then randomly assigned to the Segregated condition and one to the Integrated condition. Within each of these times, subjects were then matched again and randomly assigned to an arbitrary group. This last step was taken to ensure demographic and other covariate balance across arbitrary groups. Subjects were randomized into a lecture hall seat (where putative arbitrary group assignment occurred), a waiting room seat, and a private room for response collection. Assignment to the Allocation task (see below) was also random with a probability of assignment of 0.35.

Assignment to a treatment condition—Segregated or Integrated—affected subjects’ spatial relationship with other subjects for a period prior to data collection. In the Integrated condition, subjects were randomly assigned seats in a waiting area. In the Segregated condition, subjects were assigned seats in the waiting area so that they were spatially divided by arbitrary group (Figure 2). Each subject’s type was denoted by the color of the folder—either orange or purple—placed at their assigned seat. Subjects were directed to this waiting room under the guise of allowing time for the experimenters to prepare rooms for data collection. They remained in silence in this arrangement for five minutes before being given instructions and moved to another location. No interaction between subjects was allowed in either condition. This varied spatial arrangement in the waiting room was the treatment in the experiment.

Upon exiting the waiting room, subjects were directed to individual, private rooms and were anonymously asked (1) their perceptions of directly observable, physical attributes of the groups, (2) their perceptions of social attributes of the groups, and (3) their attribution of valence characteristics to the groups and were requested (4) to perform a costly allocation task between members of the groups. All questions were asked about both the group to which the subject had been randomly assigned (Ingroup) and the other group (Outgroup). Tasks 1 and 2 were designed to measure segregation’s effect on perception. Tasks 3 and 4

weight, and height.

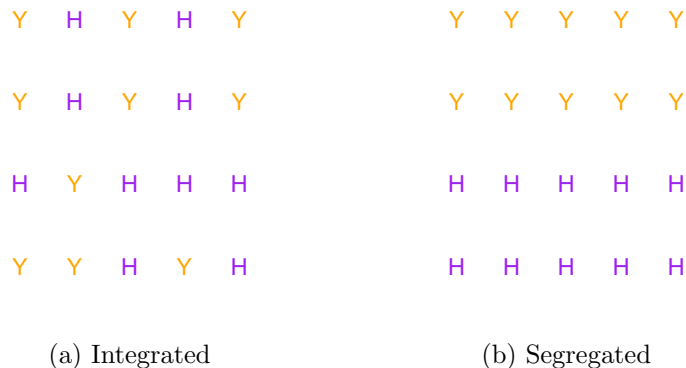


Figure 2: *Examples of waiting room configurations in Study 2.*

were designed to measure discriminatory behavior and attitudes. All interactions with the subjects were performed by naive research assistants. Detailed descriptions of all protocols for Study 2 are available in the Supporting Information.

To measure perceptions of the physical characteristics of the groups, we asked subjects to make their best guess about the age, height, and weight of the average member of each group. We also asked subjects to endorse a statement, using a seven-point Likert-scale, about whether “when it comes to appearance I have things in common” with each group.

To measure perceptions of social characteristics, we asked subjects to make their best guess about the income and political ideology of the average member of each group.⁴ We also asked subjects to endorse a statement, using a seven-point Likert scale, about whether they had “things in common” with each group.

To measure valence attributions, we asked subjects to endorse statements about whether each group was “capable,” “intelligent,” “stupid,” and/or “incompetent” (Sidanius, Pratto and Mitchell, 1994), using a seven-point Likert scale.

All subjects were asked the physical perception, social perception, and valence attribution

⁴ It is also possible to compare their responses to their own reported age, height, weight, income, and political ideology which they had recorded in a survey before being invited to the experiment. This survey was completed at least three days before the experiment.

questions. The ordering of question type and the group about which they were asked were random for each subject. Questions of each type were combined by a simple average to form three scales. We tested for within-subject difference-in-differences in responses to questions about the Ingroup and Outgroup between the Segregated and Integrated conditions.

For the costly allocation task, subjects played a dictator game in which they were asked to anonymously allocate a portion of \$10 to a randomly selected member of each group and to keep the rest. This is a common measure of willingness to discriminate between groups (e.g., Henrich et al. (2001)). Subjects' allocations were made completely in private with a credible guarantee of anonymity. With these responses we also tested for within-subject difference-in-differences in allocation to the Ingroup and Outgroup between the Segregated and Integrated conditions. This task was assigned to 101 subjects, who were randomly sampled from each session. These subjects performed this task before the other tasks.

Effect sizes were estimated via Randomization Inference (Gerber and Green, 2012), accounting for the blocked assignment of subjects into times, and including covariate adjustments for male (coded 0/1), non-white (0/1), Hispanic (0/1), and college graduate (0/1), which were collected in the survey prior to invitation to the experiment.⁵ Because of random assignment, these covariates are balanced across treatment groups and our results are insensitive to their inclusion. For the physical perceptions scale, due to the free-response nature of the questions, the outer 5th percentile is dropped from the response distribution for each open-ended question. Results are robust to this decision. Our hypothesis is directional, so we report one-tailed p-values, but the rejection of the null-hypothesis at conventional levels of significance ($p < .05$) is insensitive to this decision for two of three of the results we report and all three p-values are less than .10 in a two-tailed test.

⁵ Randomization Inference allows us to estimate correctly adjusted standard errors to account for the blocked and clustered nature of the treatment assignment. An alternative strategy would be to estimate cluster robust standard errors in a regression framework. This yields similar results.

Results

Subjects in the Segregated condition were more likely to perceive greater differences between the Ingroup and Outgroup in both the social ($\beta = 0.13$, $SE = 0.08$, $p < .05$, $95\%CI[-0.03, 0.28]$; baselines when integrated: $\mu = -0.07$, $SD = .57$) and the physical ($\beta = 0.22$, $SE = 0.09$, $p < .01$, $95\%CI[0.04, 0.40]$; baseline when integrated: $\mu = -0.12$, $SD = 0.57$) dimensions than subjects in the Integrated Condition.

Importantly, subjects in the Segregated condition had greater intergroup bias in the allocation task, allocating \$0.40 more to the Ingroup over the Outgroup than did those in the Integrated condition ($\beta = 0.40$, $SE = 0.17$, $p < .01$, $95\%CI[0.07, 0.71]$; baseline when integrated: $\mu = -0.17$, $SD = 0.86$) (Table 2), demonstrating that segregation is powerful enough to affect even costly decision making.

The results from the physical and social differences tasks allow us to reject the Null of no difference in perception between the Integrated and Segregated conditions while results from the allocation task allow us to reject the Null of no difference in intergroup bias between conditions. However, subjects showed no difference in valence attributions between groups ($\beta = 0.03$, $SE = 0.09$, $p = 0.39$, $95\%CI[-0.15, 0.29]$; baseline when integrated: $\mu = 0.38$, $SD = 0.76$). This may be because social desirability prevents most respondents from expressing such perceptions.⁶

We also examined results with subjects subset by proximity in order to check whether simple proximity to the Ingroup and Outgroup is driving the different results between the conditions. In the Supporting Information, we include only subjects who were sitting equidistant from both members of the Ingroup and Outgroup. The results are similar to or stronger than results when we use the full sample. This allows us to eliminate concerns that subjects

⁶ Consistent with this notion, the median response to each individual valence characteristic, when subjects were asked about the Ingroup or Outgroup, was always “Disagree” or “Slightly Disagree.” Also consistent is that, in other research, we tried to induce category-consistent stereotypes amongst Online subjects by using a paradigm similar to that in Study 1 and were unable to induce variation in negative attributions in general.

Measures	Beta (SE)	CI	P	D	N
Allocation	0.40 (0.17)	[0.07,0.71]	0.00	0.41	101
Attribution	0.03 (0.09)	[-0.15,0.20]	0.39	-0.01	284
Social Perceptions	0.13 (0.08)	[-0.03,0.28]	0.05	0.23	283
Physical Perceptions	0.22 (0.09)	[0.04,0.40]	0.01	0.39	174

Table 2: *Results of Study 2 for allocation task (Row 1), valence attributions (Row 2), social perceptions (Row 3), and physical perceptions (Row 4).*

in the Integrated condition show less intergroup bias simply because of their proximity to members of the Outgroup, rather than spatial segregation, *per se*.

Conclusion

With these experiments, we are the first to demonstrate that segregation directly affects perceptions and costly behaviors. While we randomly assigned spatial segregation, holding all else constant, we did not test segregation over large-scale spaces, such as metropolitan areas. Extrapolating from the laboratory to real-world segregation gives a sense of how the outcomes we observe will likely be magnified outside the laboratory, where segregation can be large-scale and long-standing. If segregation can influence attitudes and even induce discriminatory behavior when applied to small, arbitrary groups for mere minutes, then consider its power to shape attitudes and behaviors when it is a persistent feature of an environment and is correlated with meaningful social divisions, such as class, ethnicity, and religion.

In opening this manuscript, we discussed the relationship between segregation and negative social outcomes. This relationship can be found in a variety of different settings and includes a wide variety of socio-political phenomena. Our research suggests this relationship is causal. Beyond published research, recent history suggests that understanding the relationship between segregation and intergroup attitudes is growing in importance. Events in

Europe, such as mass-immigration and terrorism, and in the United States, including urban unrest in places like Ferguson, Missouri, demonstrate the continued challenge of successful integration and the dangers associated with societies that are diverse, yet segregated. Looking forward, economic and technological change promises to increase diversity in many parts of the world and, as such, research on the effects of segregation will likely grow in importance.

While our results are based in the laboratory, they provide a mechanism and show a causal relationship for a long line of observational studies in natural settings, which we reviewed in the introduction. As such, although further research is obviously needed, our results may also have implications for public policy designed to promote ethnic integration. Much of the focus of government and private efforts, especially in the United States, is on public or private nonresidential spaces such as schools and businesses. These policies are often implemented to promote intergroup equality and harmony through intergroup contact, by means other than residential integration. Efforts that do involve residential space, such as college campuses or public housing, are often limited in scope. Our research suggests that, due to the effects of segregation on human perception and behavior, these efforts may be missing a crucial piece of the puzzle. As long as residential ethnic segregation remains largely intact across metropolitan and larger areas, the positive effects of diversity in nonresidential institutions may be restricted due to countervailing effects of segregation.⁷

⁷ Some governments have legally mandated integration of housing, such as Singapore (Vasoo and Lee, 2001). Also, in the United States, the 1968 Fair Housing Act and recent court cases (Texas Department of Housing and Community Affairs Et Al. v. Inclusive Communities Project, Inc., Et. Al (2015)) have attempted to address residential segregation.

References

- Alesina, Alberto and Ekaterina Zhuravskaya. 2008. Segregation and the Quality of Government in a Cross-section of Countries. Technical report National Bureau of Economic Research.
- Alesina, Alberto, Reza Baqir and William Easterly. 1999. "Public Goods and Ethnic Divisions." *The Quarterly Journal of Economics* 114(4):1243–1284.
- Allport, Gordon W. 1954. *The Nature of Prejudice*. Cambridge, MA: Addison-Wesley.
- Ananat, Elizabeth Oltmans. 2011. "The Wrong Side(s) of the Tracks: The Causal Effects of Racial Segregation on Urban Poverty and Inequality." *American Economic Journal: Applied Economics* 3(2):34–66.
- Ananat, Elizabeth Oltmans and Ebonya Washington. 2009. "Segregation and Black political efficacy." *Journal of Public Economics* 93(5):807–822.
- Baybeck, Brady. 2006. "Sorting Out the Competing Effects of Racial Context." *Journal of Politics* 68(2):386–396.
- Blanz, Mathias. 1999. "Accessibility and Fit as Determinants of the Salience of Social Categorizations." *European Journal of Social Psychology* 29(1):43–74.
- Brewer, Marilynn and Norman Miller. 1984. Beyond the Contact Hypothesis: Theoretical Perspectives on Desegregation. In *Groups in Contact: The Psychology of Desegregation*, ed. Marilynn Brewer and Norman Miller. San Diego, CA: Academic pp. 281–302.
- Burgess, Neil, Eleanor A. Maguire and John O'keefe. 2002. "The Human Hippocampus and Spatial and Episodic Memory." *Neuron* 35:625–641.
- Campbell, Donald T. 1958. "Common Fate, Similarity, and Other Indices of the Status of Aggregates of Persons as Social Entities." *Behavioral Science* 3(1):14–25.
- Capozza, Dora and Renato Nanni. 1986. "Differentiation Processes for Social Stimuli with Different Degrees of Category Representativeness." *European Journal of Social Psychology* 16(4):399–412.
- Corvalan, Alejandro and Miguel Vargas. 2015. "Segregation and Conflict: An empirical analysis." *Journal of Development Economics* 116:212–222.
- Crawford, L Elizabeth and John T Cacioppo. 2002. "Learning Where to Look for Danger: Integrating Affective and Spatial Information." *Psychological Science* 13(5):449–453.
- De Kadt, Daniel and Melissa Sands. 2014. The Natural Limits of Segregation and Re-Integration. In *American Political Science Association, Annual Meeting*. Washington DC:

- Dill, Verena and Uwe Jirjahn. 2014. "Ethnic residential segregation and immigrants' perceptions of discrimination in West Germany." *Urban Studies* 51(16):3330–3347.
- Dunham, Yarrow, Andrew Scott Baron and Susan Carey. 2011. "Consequences of "Minimal" Group Affiliations in Children." *Child Development* 82(3):793–811.
- Ekstrom, Arne D, Michael J Kahana, Jeremy B Caplan, Tony A Fields, Eve A Isham, Ehren L Newman and Itzhak Fried. 2003. "Cellular networks underlying human spatial navigation." *Nature* 425(6954):184–188.
- Enos, Ryan D. 2016a. *The Space Between Us: Social Geography and Politics*. Book Manuscript, Harvard University.
- Enos, Ryan D. 2016b. "What the Demolition of Public Housing Teaches Us About the Impact of Racial Threat on Political Behavior." *American Journal of Political Science* 60(1):123–142.
- Enos, Ryan D. and Noam Gidron. 2016. "Intergroup Behavioral Strategies as Contextually Determined: Experimental Evidence from Israel." *Journal of Politics* 78(3):851–867.
- Fiske, Susan T, Amy JC Cuddy, Peter Glick and Jun Xu. 2002. "A Model of (Often Mixed) Stereotype Content: Competence and Warmth Respectively Follow from Perceived Status and Competition." *Journal of Personality and Social Psychology* 82(6):878.
- Gerber, Alan S. and Donald P. Green. 2012. *Field Experiments: Design, Analysis, and Interpretation*. New York: Norton.
- Gerometta, Julia, Hartmut Haussermann and Giulia Longo. 2005. "Social Innovation and Civil Society in Urban Governance: Strategies for an Inclusive City." *Urban Studies* 42(11):2007–2021.
- Glitz, Albrecht. 2014. "Ethnic Segregation in Germany." *Labour Economics* 29:28–40.
- Goette, Lorenz, David Huffman and Stephan Meier. 2012. "The Impact of Social Ties on Group Interactions: Evidence from Minimal Groups and Randomly Assigned Real Groups." *American Economic Journal: Microeconomics* 4(1):101–115.
- Guinote, Ana and Susan T Fiske. 2003. "Being in the Outgroup Territory Increases Stereotypic Perceptions of Outgroups: Situational Sources of Category Activation." *Group processes & intergroup relations* 6(4):323–331.
- Hamilton, David L. 1981. *Cognitive Processes in Stereotyping and Intergroup Behavior*. Mahwah, NJ: Lawrence Erlbaum.
- Haslam, S Alexander, Stephen D Reicher and Michael J Platow. 2010. *The New Psychology of Leadership: Identity, Influence and Power*. Psychology Press.

- Henderson, Marlene D. 2009. "Psychological Distance and Group Judgments: The Effects of Physical Distance on Beliefs about Common Goals." *Personality and Social Psychology Bulletin* 35:1330–1341.
- Henrich, Joseph, Robert Boyd, Samuel Bowles, Colin Camerer, Ernst Fehr, Herbert Gintis and Richard McElreath. 2001. "In Search of Homo Economicus: Behavioral Experiments in 15 Small-scale Societies." *American Economic Review* 91(2):73–78.
- Hewstone, Miles. 2015. "Consequences of Diversity for Social Cohesion and Prejudice: The Missing Dimension of Intergroup Contact." *Journal of Social Issues* 71(2):417–438.
- Hirtle, Stephen C and John Jonides. 1985. "Evidence of Hierarchies in Cognitive Maps." *Memory & Cognition* 13(3):208–217.
- Kunda, Ziva. 1999. *Social Cognition: Making Sense of People*. Cambridge, MA: MIT Press.
- Levin, Shana, Colette Van Laar and Jim Sidanius. 2003. "The Effects of Ingroup and Outgroup Friendships on Ethnic Attitudes in College: A Longitudinal Study." *Group Processes & Intergroup Relations* 6(1):76–92.
- Li, Huiping, Harrison Campbell and Steven Fernandez. 2013. "Residential Segregation, Spatial Mismatch and Economic Growth across US Metropolitan Areas." *Urban Studies* 50(13):2642–2660.
- Lichter, Daniel T., Domenico Parisi and Michael C. Taquino. 2015. "Toward a New Macro-Segregation? Decomposing Segregation Within and Between Metropolitan Cities and Suburbs." *American Sociological Review* 80(4):843–873.
- Maddox, Keith B, David N Rapp, Sebastien Brion and Holly A Taylor. 2008. "Social Influences on Spatial Memory." *Memory & Cognition* 36(3):479–494.
- Maguire, Eleanor A. 2006. *Neuroergonomics: The Brain at Work*. New York: Oxford University Press chapter Spatial Navigation, pp. 131–135.
- Massey, Douglas S. and Nancy A. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, MA: Harvard University Press.
- Matthews, Justin L and Teenie Matlock. 2011. "Understanding the Link Between Spatial Distance and Social Distance." *Social Psychology* .
- McCrea, Sean M, Frank Wieber and Andrea L Myers. 2012. "Construal Level Mind-sets Moderate Self-and Social Stereotyping." *Journal of personality and social psychology* 102(1):51.
- Milgim, Stanley. 1970. "The Experience of Living in Cities." *Science* 167:1461–1468.
- Montello, Daniel R., Mary Hegarty, Anthony E. Richardson and David Waller. 2004. Spatial Memory of Real Environments, Virtual Environments, and Maps. In *Human Spatial Memory*, ed. Gary L Allen. Mahwah, NJ: Lawrence Erlbaum.

- Muller, Robert. 1996. "A Quarter of a Century of Place Cells." *Neuron* 17(5):813–822.
- New, Joshua, Max M Krasnow, Danielle Truxaw and Steven JC Gaulin. 2007. "Spatial adaptations for plant foraging: women excel and calories count." *Proceedings of the Royal Society of London B: Biological Sciences* 274(1626):2679–2684.
- Oliver, J. Eric. 2010. *The Paradoxes of Integration: Race, Neighborhood, and Civic Life in Multiethnic America*. Chicago: University of Chicago Press.
- Otten, Sabine and Gordon B. Moskowitz. 2000. "Evidence for Implicit Evaluative In-Group Bias: Affect-Biased Spontaneous Trait Inference in a Minimal Group Paradigm." *Journal of Experimental Social Psychology* 36:77–89.
- Pettigrew, Thomas F and Linda Tropp. 2006. "A Meta-Analytic Test of Intergroup Contact Theory." *Journal of Personality and Social Psychology* 90(5):751–783.
- Pettigrew, Thomas F, Ulrich Wagner and Oliver Christ. 2010. "Population Ratios and Prejudice: Modeling Both Contact and Threat Effects." *Journal of Ethnic and Migration Studies* 36(4):635–650.
- Posner, Daniel N. 2004. "The Political Salience of Cultural Difference: Why Chewas and Tumbukas are Allies in Zambia and Adversaries in Malawi." *American Political Science Review* 98(4):529–545.
- Quillian, Lincoln. 2014. "Does Segregation Create Winners and Losers? Residential Segregation and Inequality in Educational Attainment." *Social Problems* 61(3):402–426.
- Rothwell, Jonathan T. 2012. "The Effects of Racial Segregation on Trust and Volunteering in US Cities." *Urban Studies* 49(10):2109–2136.
- Schelling, Thomas C. 1971. "Dynamic Models of Segregation." *Journal of Mathematical Sociology* 1(2):143–186.
- Sherif, M., O.J. Harvey, B.J. White, W. Hood and C.W. Sherif. 1961. *Intergroup Conflict and Cooperation: The Robbers Cave Experiment*. Norman, OK: University Book Exchange.
- Sidanius, Jim, Felicia Pratto and Michael Mitchell. 1994. "In-group Identification, Social Dominance Orientation, and Differential Intergroup Social Allocation." *Journal of Social Psychology* 134(2):151–167.
- Stephan, Elena, Nira Liberman and Yaacov Trope. 2011. "The Effects of Time Perspective and Level of Construal on Social Distance." *Journal of Experimental Social Psychology* 47(2):397–402.
- Tajfel, Henri, M. G. Billig, R. P. Bundy and Claude Flament. 1971. "Social Categorization and Intergroup Behavior." *European Journal of Social Psychology* 1(2):149–78.

- Takács, Károly. 2007. "Effects of Network Segregation in Intergroup Conflict: An Experimental Analysis." *Connections* 27(2):59–76.
- Tavares, Rita Morais, Avi Mendelsohn, Yael Grossman, Christian Hamilton Williams, Matthew Shapiro, Yaacov Trope and Daniela Schiller. 2015. "A Map for Social Navigation in the Human Brain." *Neuron* 87(1):231–243.
- Taylor, Shelley E, Susan T Fiske, Nancy L Etcoff and Audrey J Ruderman. 1978. "Categorical and Contextual Bases of Person Memory and Stereotyping." *Journal of Personality and Social Psychology* 36(7):778.
- Turner, J. C., P. J. Oakes, S. A. Haslam and C. McGarty. 1994. "Self and Collective: Cognition and Social Context." *Personality and Social Psychology Bulletin* 20(5):454–463.
- Turner, John C and Penelope J Oakes. 1986. "The Significance of the Social Identity Concept for Social Psychology With Reference to Individualism, Interactionism and Social Influence." *British Journal of Social Psychology* 25(3):237–252.
- Uslaner, Eric M. 2012. *Segregation and Mistrust: Diversity, Isolation, and Social Cohesion*. New York: Cambridge University Press.
- Vasoo, S and James Lee. 2001. "Singapore: Social Development, Housing and the Central Provident Fund." *International Journal of Social Welfare* 10:276–283.
- Wakslak, Cheryl J, Yaacov Trope, Nira Liberman and Rotem Alony. 2006. "Seeing the Forest when Entry is Unlikely: Probability and the Mental Representation of Events." *Journal of Experimental Psychology: General* 135(4):641.
- Wilder, David A. 1986. "Social Categorization: Implications for Creation and Reduction of Intergroup Bias." *Advances in Experimental Social Psychology* 19:291–355.
- Yzerbyt, Vincent, Olivier Corneille and Claudia Estrada. 2001. "The Interplay of Subjective Essentialism and Entitativity in the Formation of Stereotypes." *Personality and Social Psychology Review* 5(2):141–155.
- Zingher, Joshua N and M Steen Thomas. 2014. "The Spatial and Demographic Determinants of Racial Threat." *Social Science Quarterly* 95(4):1137–1154.