Protocol for a Systematic Review and Meta-Analysis of Cultural Differences and Similarities in Executive Functioning in the United States

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Abstract

Executive functioning has important implications for multiple developmental processes and outcomes. However, the degree to which executive functioning varies between and within racial/ethnic groups in the United States is less understood. To address this issue, we will conduct a systematic review and meta-analysis of overall executive functioning and its three core components: inhibitory control, working memory, and cognitive flexibility. Our goals are to: 1) examine differences across these components between Whites and minorities, as well as differences between- (e.g., African-Americans, Latinos) and within- (e.g., Latinos: Mexican-Americans, Cuban-Americans) minority groups; and 2) test potential moderators of these differences (e.g., sex, age, measure). We will address the implications of these findings in terms of support for the cultural differences and similarities hypotheses.

Keywords: executive functioning; cognitive control; executive control; inhibitory control, working memory, cognitive flexibility cultural differences hypothesis; cultural similarities hypothesis; meta-analysis.

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Research on executive functioning has increased substantially over the last decade given its important implications across developmental processes and outcomes (Karr et al., 2018). Executive functioning can be defined as higher-order cognitive processes that are involved with goal-directed behaviors, such as inhibitory control, working memory, and cognitive flexibility (e.g., Diamond, 2013; Garon, Bryson, & Smith, 2008; Miyake & Friedman, 2012). Executive functioning also underlies adaptive responses to novel, complex, and ambiguous situations (Hughes, Graham, & Grayson, 2005). In childhood and adolescence, executive functioning has been tied to emotion regulation (Carlson & Wang, 2007), reduced peer problems (Holmes, Kim-Spoon, & Deater-Deckard, 2015), and has been found to be more indicative of school readiness, as compared to IQ or early reading or math ability (Blair, 2002; Blair & Razza, 2007).

Developing appropriate executive functioning abilities has important implications for success into adulthood, with studies demonstrating the link between executive functioning and health (e.g., Moffitt et al., 2011), marital satisfaction (e.g., Eakin et al., 2004), and socioeconomic status (e.g., Moffitt et al., 2011). Although previous research has examined similarities and differences in executive function performance between countries (e.g., China and United States; Lan, Legare, Ponitz, Li, & Morrison, 2011), the magnitude of differences on executive function performance between racial/ethnic groups in the United States is less understood. Given that the demographic profile of the United States continues to become more heterogeneous, it is important understand the magnitude of differences in executive functioning performance (Passel & Cohn, 2008). The goal of this systematic review and meta-analysis is to examine the magnitude of racial/ethnic mean-level differences across executive functioning components between Whites and minorities and also between- (e.g., African-Americans, Latinos) and within- (e.g., Latinos: Mexican-Americans, Cuban-Americans) minority groups in the United States. This has important implications for developmental theory. Large White-minority mean-level differences on executive functioning, and smaller differences between- and within-minority groups, would add support to the cultural differences hypothesis (Causadias, Korous, & Cahill, 2018). In contrast, differences between Whites and minorities in executive functioning that are equal or smaller in magnitude than differences between- and within-minority groups would support the cultural similarities hypothesis (Causadias et al., 2018).

**The Development of Executive Functioning**

Executive functioning, which is tied to the prefrontal cortex, can be identified as early as infancy (Bell & Fox, 1992; Holmboe, Bonneville-Roussy, Csibra, & Johnson, 2018), with accelerated periods of development between two and five years of age, and again at puberty (Casey, Tottenham, Liston, & Durston, 2005; Doebel & Zelazo, 2015). There is heterogeneity in the conceptualization of executive functioning, also referred to as cognitive control and executive control, and its components (e.g., Karr et al., 2018), this meta-analysis will focus on three components that are well-established in the literature: inhibitory control, working memory, and cognitive flexibility.

Inhibitory control refers to the ability to deliberately restrain dominant, automatic, or prepotent responses when necessary (Miyake et al., 2012). Inhibitory control processes can be identified in late toddlerhood and continue to improve through childhood into adulthood (Williams, Ponesse, Schachar, Logan, & Tannock, 1999). Inhibitory control abilities decline with age, and researchers have consistently found that young adults tend to perform better than older adults on inhibitory control tasks (Zanto, Hennigan, Ostberg, Clapp, & Gazzaley, 2010).

Working memory refers to the ability to actively maintain information while performing one or more mental operations (Diamond, 2013; Miyake et al., 2012). Both working memory and short-term memory involve holding information in mind, however, working memory is distinct in that it requires manipulating the information being held (Diamond, 2013). Researchers have found that the ability to store and manipulate information in one’s mind can be identified in infancy (Diamond, 1995). However, working memory skills show slower developmental trajectories than other executive function abilities (Luciana, Conklin, Hooper, & Yarger, 2005).

Cognitive flexibility refers to the ability to shift back and forth between tasks, operations, or mental sets (Miyake et al., 2012). These skills allow one to problem solve in novel ways or to “think outside the box” (Diamond, 2016). Researchers suggest that cognitive flexibility builds on inhibitory control and working memory skills, thereby developing later in childhood (Davidson, Amso, Anderson, & Diamond, 2006; Garon et al., 2008). However, cognitive flexibility skills increase dramatically during the preschool period (e.g., Kloo & Perner, 2005). Cognitive flexibility continues to develop through childhood and adolescence, and declines in late adulthood (Cepeda, Kramer, & Gonzalez de Sather, 2001).

**The Cultural Differences and Similarities Hypotheses**

The cultural differences hypothesis argues that Whites and minorities in the United States are vastly different in most domains of functioning whereas all minority groups are very alike (Causadias et al., 2018). Applied to the development of executive functioning, the cultural differences hypothesis predicts White-minority differences of larger magnitude than differences between- and within-minority groups. Cultural differences in executive functioning is supported by evidence that minorities had lower scores on working memory tasks compared to their White counterparts (e.g., Dore, Waldstein, Evans, & Zonderman, 2015; Flores et al., 2017; Grant, Harries, & Chamberlain, 2018).

In contrast, the cultural similarities hypothesis argues that there are small differences between Whites and minorities in most domains of functioning, and that these disparities are equal or smaller in magnitude than differences between- and within-minority groups (Causadias et al., 2018). Applied to the development of executive functioning, the cultural similarities hypothesis predicts small or very small White-minority differences on executive function tasks, while differences between- and within-minority groups are equal or larger in magnitude. Evidence of cultural similarities in executive functioning includes past research showing that performance on a cognitive flexibility task did not differ between Hispanic and European American adults (Flores et al., 2017). Similarly, one study found no significant association between race/ethnicity and an inhibition task (Merz, Landry, Montroy, & Williams, 2017).

It is difficult to precisely elucidate cultural differences and similarities in executive functioning from individual studies. First, many individual studies that compare groups in the United States focus on contrasting Whites with a single racial/ethnic minority group (e.g., White vs. Black; Causadias et al., 2018), failing to show overall disparities between Whites and minorities, and between- and within-minorities, in the development of executive functioning. Second, addressing overall cultural differences and similarities in executive functioning is hampered by publication bias, or the decision to publish studies based on the content, size, or direction of findings (Higgins & Green, 2011). Thus, published studies more often report larger and statistically significant effects than unpublished research (Ioannidis, Munafo, Fusar-Poli, Nosek, & David, 2014).

**Systematic Reviews and Meta-Analysis**

Systematic reviews and meta-analysis can robustly estimate the magnitude of racial/ethnic differences in executive functioning and test the cultural differences and similarities hypotheses. Systematic reviews aim to comprehensively identify all relevant studies form various search engines and data repositories, including published and unpublished sources, in a way that facilities replication of the review (Higgins & Green, 2011). Meta-analytic techniques provide a method to quantitatively summarize the results across all studies identified in the systematic review, facilitating the consolidation of a cumulative developmental science (Card, 2017). Also, meta-analytic techniques emphasize estimation rather than relying on significance testing (Cumming, 2013). Although significance testing is often conducted in meta-analyses, the goal of a synthesis is to estimate the magnitude of a relation using a common metric (e.g., Cohen’s *d*) and explain the heterogeneity between studies (for a review see Gurevitch, Koricheva, Nakagawa, & Stewart, 2018). Therefore, by using meta-analytic techniques we can quantify how big are differences (or similarities) between, for example, Whites and minorities on mean levels of executive functioning. These could be very small (*d* = .01), small (*d* = .20), medium (*d* = .50), large (*d* = .80), very large (*d* = 1.2), or huge (*d* = 2.0), based on the conventions on Cohen (1992) and Sawilowsky (2009)’s conventions. Also, we can employ meta-analytic techniques to examine under which sample (e.g., age, sex) or study characteristics (e.g., outcome, measure) that the magnitude of differences remains similar or substantially varies, which could inform future studies, policies, and interventions.

Furthermore, statistical power is often increased in meta-analyses, as compared to primary studies, because meta-analytic methods pool together aggregate information from thousands of participants reported in primary studies (Cohn & Becker, 2003). However, it is not always the case that meta-analyses are adequately powered (Hedges & Pigott, 2001; Ioannidis, Stanley, & Doucouliagos, 2017). Nonetheless, it is important to consider power when testing mean level group differences, because inadequate sample sizes may lead to false positives (Ioannidis, 2005) and may bias estimates of Cohen’s *d* (Borenstein, Hedges, Higgins, & Rothstein, 2009; Card, 2012). Therefore, meta-analytic effect size estimates are likely more precise and generalizable than a single primary study. This is not to undermine the value of primary studies, but rather to emphasize the importance of cumulative science (Cumming, 2013).

To our knowledge, there is no published meta-analysis on cultural differences and similarities in executive functioning. Moreover, few meta-analyses have included racial/ethnic differences as a moderator of effect sizes for executive functioning. For instance, Lawson, Hook, and Farah (2017) pooled the results of 25 studies and found small associations between executive functioning and socioeconomic status regardless of the racial/ethnic composition of the sample, although diverse samples (*r* = .17) and predominately White samples (*r* = .16) were slightly larger than predominately Black samples (*r* = .06). However, precise estimates of racial/ethnic differences are needed because several studies that report samples with “predominately White participants” may include different racial/ethnic groups, obscuring these differences.

**The Present Study**

To address these issues, we will conduct a systematic review and meta-analysis of overall executive functioning and its three core components: inhibitory control, working memory, and cognitive flexibility. Our goals are to: 1) examine mean-level differences across these components between Whites and minorities, as well as differences between- (e.g., African-Americans, Latinos) and within- (e.g., Latinos: Mexican-Americans, Cuban-Americans) minority groups in the United States, and 2) to test for potential moderators of these differences (e.g., sex, age, measure).

We will address the implications of these findings in terms of support for the cultural differences and similarities hypotheses. If the absolute average differences between Whites and minorities on mean-levels of executive functioning are medium (0.36-0.65), large (0.66-1.00), or very large (>1.00), and are larger than the absolute average differences between- (e.g., African Americans, Latinos) and within-minority groups (e.g., Latinos: between Mexican Americans, Cuban Americans), we will consider these findings in support of the cultural differences hypothesis. In contrast, if the absolute average differences between Whites and minorities on mean-levels of executive functioning are very small (0-0.10) or small (0.11-0.35), and are less than or equal to the absolute average differences between- and within-minority groups, we will consider these findings in support of the cultural similarities hypothesis. We hypothesize that there will be differences between Whites and minorities, however, we anticipate those differences will be small in magnitude based on previous research (e.g., Grant et al., 2018; Merz et al., 2017). We also expect these differences to be equal or smaller than differences between and within racial minority groups.

This systematic review and meta-analysis will be conducted following PRISMA (2009) guidelines and will be published in PsyArXiv and pre-registered at Open Science Framework (OSF) after we receive reviewer feedback on this protocol, and before coding and data analyses.

**Method**

**Literature Search**

 We will search in online databases including PsycINFO, Web of Science, ERIC, PubMed, and ProQuest Dissertations and Theses Global to identify an initial number of articles. We will use the following string: (*cultural* OR *culture* OR *ethnic* OR *ethnicity* OR *race* OR *racial*) AND (*similarity* OR *similarities* OR *sameness* OR *likeness* OR *equivalence* OR *inequality* OR *inequalities* OR *discrepancies* OR *disparity* OR *disparities* OR *dissimilarity* OR *dissimilarities* OR *disproportionately* OR *differentiation* OR *difference* OR *differences* OR *prevalence* OR *incidence* OR *incompatibility*) AND ("*executive function*" OR "*executive dysfunction*" OR *cognitive* OR "*working* *memory*" OR "*inhibition*" OR "*inhibitory* *control*" OR "*attention* *shifting*" OR "*attention* *focusing*" OR "*sustained* *attention*" OR "*set* *shifting*" OR *shifting* OR "*cognitive* *flexibility*" OR *switching*) AND (“*United States*” OR *US*). When feasible, we will restrict the keywords to the title and abstract. Also, because Web of Science and PubMed include articles from a broad range of disciplines, we will apply additional restrictions. Based on feedback on this protocol, we included “cognitive control” and “executive control” in our conceptualization of executive functioning. Cognitive control was already accounted in our aforementioned search, but executive control was not. Thus, we will conduct an additional search using the string: (*cultural* OR *culture* OR *ethnic* OR *ethnicity* OR *race* OR *racial*) AND (*similarity* OR *similarities* OR *sameness* OR *likeness* OR *equivalence* OR *inequality* OR *inequalities* OR *discrepancies* OR *disparity* OR *disparities* OR *dissimilarity* OR *dissimilarities* OR *disproportionately* OR *differentiation* OR *difference* OR *differences* OR *prevalence* OR *incidence* OR *incompatibility*) AND (“*executive control*”) AND (“*United States*” OR *US*)

We plan to retrieve more articles using three additional methods. First, we will examine the title and abstracts of articles published in cognitive and developmental journals over the past twenty years (e.g., *Developmental Psychology, Developmental Science, Child Development, Cognitive Psychology*). Second, we will search for additional unpublished research by examining conference programs over the past ten years (e.g., *Association for Psychological Science, Society for Research on Adolescence, Society for Research on Child Development*). Third, we will examine the reference lists of eligible articles and studies that have cited them (i.e., backward and forward search, respectively).

**Inclusion and Exclusion Criteria**

We will use Rayyan QCRI (Ouzzani, Hammady, Fedoroqicz, & Elmagarmid, 2016) to facilitate the inclusion and exclusion of articles, as well as the reliability of inclusion, for the articles we identify in online databases. Three authors will independently evaluate the identified articles using the criteria below. Discrepancies will be resolved as a team.

**Variables.** We will include articles that report mean-level differences on at least one component of executive functioning (i.e., overall executive functioning, inhibitory control, working memory, cognitive flexibility), or at least provide sample means and standard deviations, for two or more racial/ethnic groups. We will only include articles with measures of executive functioning that are performance-based (e.g., go/no-go, Stroop task, backward digit span, Wisconsin card sorting task). We will exclude articles with self-reported measures of executive functioning and those that focus on higher-order executive functions such as planning and problem-solving. We chose to exclude higher-order functions because introducing additional components, on top of the typical examples of executive functioning, would increase the heterogeneity in our average mean-level differences. Including higher-order functions would also limit our ability to explain the variability attributed components and measures because higher-order functions often utilize multiple components of executive functioning (Karr et al., 2018). We will also exclude articles that examine self-regulation, cognitive ability/performance, executive attention, memory, anger or emotion regulation, or cognitive decline because these outcomes are related to, but distinct from executive function.

**Participants and geographic location.** We will include studies regardless of participants’ age, sex, culture, race, and ethnicity. However, we will exclude articles that focus only on one racial/ethnic group. Samples collected outside of the United States will be excluded. We will also exclude studies that compare US and non-US samples.

We will include studies with normative samples and exclude studies focused on clinical samples (e.g., patients with Alzheimer’s disease, juvenile delinquents, schizophrenia patients) or special populations (e.g., gifted children, pregnant adolescents). Similarly, we will exclude studies that compare normative and clinical samples. However, we plan on including studies drawn from community samples to examine the correlation of other symptoms, such as sleep disturbances or alcohol use, with executive function. We will exclude studies that generated data using computer models (e.g., Morrison, Doumas, & Richland, 2011).

**Language.** We will only include articles published in English.

**Research design.** We will include both cross-sectional and longitudinal studies. We will exclude interventions, randomized control trials, and pharmacological treatment studies because they can impact the magnitude of group differences. We will also exclude systematic reviews and meta-analyses, qualitative studies, commentaries, editorials, corrections, studies focused exclusively on medical conditions, genes, and vitamins.

Furthermore, as we code studies we will exclude studies that do not report sufficient statistics to compute a standardized mean difference (i.e., Cohen’s *d*) or those that provide an effect size that cannot be converted to Cohen’s *d*. Thus, studies that only report regression coefficients or risk and hazard ratios will be excluded. However, in these cases we will try to contact authors for more information.

**Time period.** We will not impose eligibility criteria based on the date of publication.

 **Animal studies.** We will only include studies that use human participants.

**Coding**

 **Reliability**. We created a coding manual that captures effect sizes and relevant study characteristics (see Appendix, Table A1). Three authors will code five studies together to refine the coding descriptions. Articles will be coded independently by trained graduate and undergraduate students. All articles will be coded twice independently by two coders. We will report Cohen’s Kappa (*κ*) and intraclass correlations (ICC) as measures of interrater reliability for categorical and continuous data, respectively (Orwin & Vevea, 2009).

**Mean group differences.** We will first look for means and standard deviations for executive functioning, in addition to sample size, disaggregated by race/ethnicity. If this information is not provided, we will code the reported standardized mean difference (e.g., Cohen’s *d*, Hedges’ *g*) either between two racial/ethnic groups (e.g., Whites compared to Latinos, Latinos compared to African Americans) or between Whites and minorities. If needed we will code odds ratios, t-tests, or F-tests and *χ*2 tests with one degree of freedom. Regression coefficients, risk ratios, and hazard ratios will not be coded. We will contact authors if there is incomplete data on mean differences on executive functioning and we will exclude studies if there is no data available to compare at least two racial/ethnic groups on at least one component of executive functioning, and if the authors we contact fail to provide this data.

We will code effect sizes as positive to indicate the magnitude of the *absolute* difference between groups. Thus, effect sizes will indicate the average difference between Whites and minorities, or between- and within-minorities, on mean levels of executive functioning. See Causadias and colleagues (2018) for a discussion on absolute versus relative differences in testing cultural similarities and differences.

**Moderators.** First, we will code the mean age of the sample for a particular comparison. For example, we will code the mean age for all participants included in the White-minority comparison. If the mean age is reported separately for different sexes or racial/ethnic groups, we will compute the average weighted by their sample size. Second, we will code the sex composition (i.e., % female) of the sample for a particular comparison (e.g., between Whites and minorities, between-minorities). If means and standard deviations, or effect sizes, are provided separately for males and females we will code both. Third, we will code the mean annual income and years of education as components of socioeconomic status. Parental income and education will be used as metrics of socioeconomic status if the study consisted of children and adolescents. If the mean is not provided, but the range is, we will take the midpoint of the reported range. We will also code how the authors described the sample, whether it was low, high, or mixed socioeconomic status. Fourth, we will code the component of executive functioning. For instance, we will code whether it is overall executive functioning (e.g., includes multiple components), inhibitory control, working memory, or cognitive flexibility. Fifth, we will code for the performance-based measure of executive functioning. For example, we will code if the performance-based measure is the go/no-go, backward digit span, or Wisconsin card sorting task. Sixth, we will code the date of when the data were collected. The publication date will be used in cases when the data collection date is not specified. Lastly, we will code the publication status of the article. We will code whether the article was published or unpublished (i.e., dissertation, conference presentation).

**Study Treatment and Analyses**

 We will compute a standardized mean difference (i.e., Cohen’s *d*) and its variance following Borenstein and colleagues’ (2009) methods. This standardized effect represents the difference of the means on inhibitory control, working memory, cognitive flexibility, and overall executive functioning between any two groups (e.g., Whites and Latinos) adjusted for their pooled sample standard deviation. Following Causadias and colleagues (2018), we will interpret the effect size magnitude as very small (.01), small (.20), medium (.50), large (.80), very large (1.2), and huge (2.0) based on the conventions by Cohen (1992) and Sawilowsky (2009). To estimate the average difference across studies, we will employ a random-effects model in which effect sizes are weighted by their corresponding within-study variance (*v*) and between-study variability (*τ2*). In effect, studies with larger sample sizes will be given more weight because they are often more precise estimates (Borenstein et al., 2009). We will then test moderation using a mixed-effects model, which allows for subgroup specific effect sizes.

 We will use a structural equation modeling meta-analytic approach (Cheung, 2015a) to estimate the average difference across studies on inhibitory control, working memory, cognitive flexibility, and overall executive functioning. The advantage of structural equation modeling is that it accounts for missing data using full information maximum-likelihood estimation. Thus, effect sizes from all studies will inform the average effect or moderator analyses even if they have missing data. Also, because we expect to extract multiple effect sizes from a single study (e.g., effect size for inhibitory control and working memory), there will be dependencies between effect sizes. To account for this dependency, we will cluster effect sizes within studies using a multilevel (i.e., three-level) structural equation model (Cheung, 2014).

All analyses will be conducted in the R statistical platform (version 1.1.453) with the metaSEM package (version 1.1.0; Cheung, 2015b). With this package we will estimate the average difference (i.e., intercept) for each comparison (e.g., between Whites and minorities, between-minorities) and its 95% confidence interval. We will also report the heterogeneity (*I*2)and population variance (*τ2*) for each level. *I*2 represents the percentage of systematic variability between effect sizes explained by each level, which is not attributed to random sampling error. *τ2*,on the other hand, indicates the estimated population variance both within- and between-studies. Because *I*2 and *τ2* are estimated, we will provide confidence intervals for each using likelihood-based confidence intervals (LCBI; Casella & Berger, 2002) as recommended by Cheung (2014). We will compare multiple models in which, in separate models, we restrict the variability (*τ2*)at each level to zero and also constrain them to be equal. We will also estimate our model using maximum-likelihood estimation and restricted maximum-likelihood estimation because the latter corrects for potential bias (Cheung, 2008). Furthermore, we will examine the distribution of effect sizes for extreme values (i.e., outliers). As a sensitivity test, we will exclude effect sizes that are larger than 2.5 absolute deviations below or above the median (Leys, Ley, Klein, Bernard, & Licata, 2013).

 We will test our moderators in separate models. Our coded moderators will be treated as predictors in the structural equation model. We will compare models with a predictor to the model without the predictor to determine if the model with a particular predictor explained the variability between effect sizes. If multiple predictors explain the variability in effect sizes, we will include them in one model to examine whether the moderator remained predictive over and above other moderators. First, we will examine age as a moderator by centering the mean age of the studies by the grand mean across studies to ease interpretation. The intercept will reflect the average difference for a particular comparison (e.g., between Whites and minorities, between-minorities) for studies around the grand mean whereas the slope will indicate the difference in the average effect size for each unit increase in age above the grand mean. A significant slope at *p* < .05 will suggest that effect sizes vary across mean ages. Next, we will test the moderating role of sex composition following the same approach. The intercept will be interpreted as the average difference at the grand mean percentage of females while the slope will indicate the difference in the average effect size for each unit increase. Then, we will examine income and education as moderators using the same approach. To test the moderating role of the reported socioeconomic status, component of executive functioning, and performance-based measure of executive functioning, we will create a dummy code for each category. For instance, we will create a dummy code for inhibitory control, working memory, cognitive functioning, and overall executive functioning such that all effect sizes associated with inhibitory control will be coded as one and all other components of executive functioning will be coded as zero. We will include all dummy codes for a particular moderator in the model and constrain the intercept to zero, which will estimate the average effect size for a particular comparison (e.g., between Whites and minorities, between-minorities) for each dummy code (Cheung, 2015a). We will test whether the effect sizes vary between category by testing the difference between the model with and without the dummy codes. Lastly, we will test the moderating role of the date of data collection using the same method as our other continuous variables such as mean age.

 **Publication bias.** Researchers have suggested using multiple methods to test for publication bias (Jin, Zhou, & He, 2015; Lin et al., 2018). For this reason, we will employ three tests of publication bias. First, we will test the publication status of studies as a moderator, although this test depends on whether we identify two or more unpublished studies. We will code published studies as the reference group. The intercept in this analysis will indicate the average effect size for published studies while the slope will indicate the difference in the average effect between published and unpublished studies. A significant slope at *p* < .05 will suggest that the magnitude of the average effect size varies between published and unpublished studies. Second, we will use Egger’s regression, which is a more common test of publication bias (Jin et al., 2015). The Egger’s test is a linear regression of the standardized effect on its inverse standard error (Egger, Smith, Schneider, & Minder, 1997). We will utilize the metabias command of the meta package (version 4.9-2; Schwarzer, 2007) in the R platform to conduct the Egger’s test. Third, we will conduct a sensitivity analysis using the selection method of Vevea and Woods (2005). In this approach, we will use a priori weights to represent moderate and severe one-tailed selection (Vevea and Woods, 2005). A reduction in the average effect size under the one-tailed selection weights will indicate that effects sizes near zero were less likely to be included in the analysis. We will use the weightr package (version 1.1.2; Coburn & Vevea, 2017) in the R platform.

**Preliminary Search**

To support the viability of this study, we conducted a preliminary systematic review, but we have not extracted any data from the articles we identified nor conducted any statistical analyses. We provide a table with the exact search string and restrictions/filters for each online database (see Table 1). This search was finalized on August 5, 2018. Although this preliminary search has been conducted, we are willing to refine our search based on the feedback and if it is consistent with our research questions.

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Table 1

*Search String and Number of Initially Identified Studies for Each Database*

|  |  |
| --- | --- |
| Database | Search String |
| PsycINFO | ti((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) OR ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) AND ("United States" OR US)Additional Search String:ti((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND (“executive control”)) OR ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND (“executive control”)) AND (“United States” OR US) |
| Web of Science | TOPIC: ((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility)) *AND* TITLE: (("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) *NOT* TOPIC: (cell OR cellular OR mice OR monkey OR koala OR cancer OR medicine OR medication OR alzheimer's OR diabetes OR "cognitive behavioral therapy")**Refined by**: COUNTRIES/REGIONS: (USA)Additional Search String:TOPIC: ((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility)) *AND* TITLE: (("executive control”)) *NOT* TOPIC: (cell OR cellular OR mice OR monkey OR koala OR cancer OR medicine OR medication OR alzheimer's OR diabetes OR "cognitive behavioral therapy")**Refined by**: COUNTRIES/REGIONS: (USA) |
| ERIC | ti((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) OR ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) AND ("United States" OR US)Additional Search String:ti((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive function" OR "executive control”)) OR ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility) AND ("executive control”)) AND ("United States" OR US) |
| PubMed | ((((cultural[Title/Abstract] OR culture[Title/Abstract] OR ethnic[Title/Abstract] OR ethnicity[Title/Abstract] OR race[Title/Abstract] OR racial[Title/Abstract])) AND (similarity[Title/Abstract] OR similarities[Title/Abstract] OR sameness[Title/Abstract] OR likeness[Title/Abstract] OR equivalence[Title/Abstract] OR inequality[Title/Abstract] OR inequalities[Title/Abstract] OR discrepancies[Title/Abstract] OR disparity[Title/Abstract] OR disparities[Title/Abstract] OR dissimilarity[Title/Abstract] OR dissimilarities[Title/Abstract] OR disproportionately[Title/Abstract] OR differentiation[Title/Abstract] OR difference[Title/Abstract] OR differences[Title/Abstract] OR prevalence[Title/Abstract] OR incidence[Title/Abstract] OR incompatibility[Title/Abstract])) AND ("executive function"[Title/Abstract] OR "executive dysfunction"[Title/Abstract] OR cognitive[Title/Abstract] OR "working memory"[Title/Abstract] OR "inhibition"[Title/Abstract] OR "inhibitory control"[Title/Abstract] OR "attention shifting"[Title/Abstract] OR "attention focusing"[Title/Abstract] OR "sustained attention"[Title/Abstract] OR "set shifting"[Title/Abstract] OR shifting[Title/Abstract] OR "cognitive flexibility"[Title/Abstract] OR switching[Title/Abstract])) AND (“United States” OR US)**Filters activated**: Humans Additional Search String:((((cultural[Title/Abstract] OR culture[Title/Abstract] OR ethnic[Title/Abstract] OR ethnicity[Title/Abstract] OR race[Title/Abstract] OR racial[Title/Abstract])) AND (similarity[Title/Abstract] OR similarities[Title/Abstract] OR sameness[Title/Abstract] OR likeness[Title/Abstract] OR equivalence[Title/Abstract] OR inequality[Title/Abstract] OR inequalities[Title/Abstract] OR discrepancies[Title/Abstract] OR disparity[Title/Abstract] OR disparities[Title/Abstract] OR dissimilarity[Title/Abstract] OR dissimilarities[Title/Abstract] OR disproportionately[Title/Abstract] OR differentiation[Title/Abstract] OR difference[Title/Abstract] OR differences[Title/Abstract] OR prevalence[Title/Abstract] OR incidence[Title/Abstract] OR incompatibility[Title/Abstract])) AND ("executive control"[Title/Abstract])) AND (“United States” OR US)**Filters activated**: Humans |
| ProQuest Dissertations & Theses Global | ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility)) AND ti(("executive function" OR "executive dysfunction" OR cognitive OR "working memory" OR "inhibition" OR "inhibitory control" OR "attention shifting" OR "attention focusing" OR "sustained attention" OR "set shifting" OR shifting OR "cognitive flexibility" OR switching)) AND ("United States" OR US)Additional Search String:ab((cultural OR culture OR ethnic OR ethnicity OR race OR racial) AND (similarity OR similarities OR sameness OR likeness OR equivalence OR inequality OR inequalities OR discrepancies OR disparity OR disparities OR dissimilarity OR dissimilarities OR disproportionately OR differentiation OR difference OR differences OR prevalence OR incidence OR incompatibility)) AND ti(("executive control")) AND ("United States" OR US) |

**Appendix**

|  |
| --- |
| Table A1*Coding Manual of Effect Sizes and Relevant Study Characteristics*  |
| Code | Description |
| Article Number (ID\_A) | Record the ID number of the article.  |
| Study Name (ID\_R) | Record the name of the study (dataset) in which the participants were drawn from. For instance, some studies may use the Midlife in the United States dataset (MIDUS). In this example, you could record the acronym MIDUS. If the authors do not report a study name, then leave blank. |
| Report First Author's Last Name (NAME) | Record the first author’s last name. |
| Year of Report (YEAR) | Record the year the journal article was published. If article is unpublished (e.g., dissertation), record its acceptance date. |
| Publication Status (PUB\_STS) | Report whether the article is:1 = Publication, peer reviewed2 = Unpublished data (e.g., dissertations, conference presentations, thesis)3 = In press4 = Manuscript (in progress) |
| Mean of Whites (M\_WHT) | Code the mean of the executive functioning for White/European American participants. If a mean is not reported, code as 99. |
| Standard Deviation of Whites (SD\_WHT) | Code the standard deviation (SD) of M\_WHT. If the standard deviation is not reported or a mean is not reported, code as 99. |
| Mean of Non-Whites (M\_NWHT) | If a study reports one mean for all racial/ethnic minorities that are not White (e.g., White compared to non-White) code the mean of the executive functioning for participants that are not White/European American participants. If a mean is not reported, code as 99. |
| Standard Deviation of Non-Whites (SD\_NWHT) | Code the standard deviation (SD) of M\_NWHT. If the standard deviation is not reported or a mean is not reported, code as 99. |
| Mean of Blacks (M\_BLK) | Code the mean of the executive functioning for Black/African American participants. If a mean is not reported, code as 99. |
| Standard Deviation of Blacks (SD\_BLK) | Code the standard deviation (SD) of M\_BLK. If the standard deviation is not reported or a mean is not reported, code as 99. |
| Mean of Latinos (M\_LAT) | Code the mean of the executive functioning for Latino/Hispanic participants. If a mean is not reported, code as 99. |
| Standard Deviation of Latinos (SD\_LAT) | Code the standard deviation (SD) of M\_LAT. If the standard deviation is not reported or a mean is not reported, code as 99. |
| Mean of Asians (M\_ASN) | Code the mean of the executive functioning for Asian/Asian American. If a mean is not reported, code as 99. |
| Standard Deviation of Asians (SD\_ASN) | Code the standard deviation (SD) of M\_ASN. If the standard deviation is not reported or a mean is not reported, code as 99. |
| Effect Size - Statistical Value (ES\_VAL) | Code as 99 if at least two means were provided in the article (i.e., values for at least two of codes M\_WHT, M\_NWHT, M\_BLK, M\_LAT, M\_ASN). In other words, if means were provided do not code the effect size reported in the article.If means are not provided, code the effect size that captures the differences between two racial/ethnic groups or between Whites and minorities. Record the effect size for each racial/ethnic comparison conducted. Thus, one article may have multiple row. First, look for results of Cohen's d or Hedges g. If neither are reported, code results of t-tests, f-tests (with one degree of freedom), or odds ratios. If only a correlation is provide code Pearson's r. If multiple effect sizes are reported (e.g., one for White-Latino differences and one for Latino-Black differences) record each on a separate row. If means or effect sizes are not reported, set the article aside. |
| Effect Size - Confidence Interval (ES\_CILB) | Record the record the 95% CI lower bound (lowest value) of ES\_VAL if reported. If the 95% CI is not reported or if ES\_VAL was coded as 99, then code as 99. |
| Effect Size - Confidence Interval (ES\_CIUB) | Record the record the 95% CI upper bound (highest value) of ES\_VAL if reported. If the 95% CI is not reported or if ES\_VAL was coded as 99, then code as 99. |
| Effect Size - Statistic Type (ES\_ST) | Code the type of effect size for code ES\_VAL. Always try to code Cohen's d or Hedge's first. If ES\_VAL was coded as 99, code as 7.1 = Cohen's d2 = Hedges g3 = Pearson's r4 = t-test5 = F-test (1, df)6 = Odds Ratio (OR)7 = At least two means were coded (ES\_VAL = 99). |
| Executive Functioning Performance Task (EF\_TSK) | Code the type of performance assessment, task, or test used to measure the executive functioning reported for code EFS. If multiple types are reported, code each on separate rows. Thus, one article may have multiple rows. If none of the below codes apply, do not code.If a self- or other-report was used to measure executive functioning (e.g., BRIEF), do not code.1 = Go/No-Go or Continuous Performance Task2 = Backward Digit Span (only Backward, not Forward)3 = Wisconsin Card Sorting4 = Fluency Task (verbal, category, design)5 = Stroop6 = Color Trails/Trail Making7 = Sentence Span8 = Tower of Hanoi/London9 = Flanker Task10 = Composite (includes multiple measures) |
| Executive Functioning Performance Task Other (EF\_TSKO) | Write the type of executive functioning task specified as 9 = Other or Composite in code EF\_TASK. If a composite was indicated for EF\_TSK, write all performance tests used to form the composite (e.g., could be a mixture of 1 through 8). If ES\_TASK was not coded as 9, leave blank.  |
| Component of Executive Functioning (EFS) | Code the component (or factor) of executive functioning related to the means or ES\_VAL. If multiple types are reported, code each on separate rows. If an overall composite is reported in the article plus the individual components, then code each on its own row. Also, if a standardized score and a raw score are reported, code each on its own row. Thus, one article may have multiple rows. The article needs to reference the below codes exactly, that is, they need to say they are measuring inhibitory control (or inhibition, working memory, cognitive flexibility (or set-shifting) or a composite of at least two of the aforementioned. If none of the components below are specifically referenced and reported, do not code the article. 1 = Inhibitory Control (also referred to as Inhibition)2 = Working Memory3 = Cognitive Flexibility/Set-Shifting4 = Executive Functioning (overall, across two or more of the above components) |
| Effect Size Notes (ES\_VARS) | If ES\_VAL was coded as 99, then leave this code blank. Otherwise, record the variables and direction of the effect size. For instance, record if Whites or racial/ethnic minorities had higher or lower scores on executive functioning tests.  |
| Date of Data Collection (EF\_YEAR) | Code the date that the executive functioning performance task, reported in code EF\_TASK, was administered to participants. This will likely be different from the publication date (code YEAR). If a range of date is provide take the midpoint of the range and round up to the nearest year if needed. For instance, add the highest year and lowest year and divide by two. If not reported, then code as 99.  |
| Sample Size - Total (N) | Code the total number of participants across all means (if means were recorded) or participants included in estimating ES\_VAL. Sometimes this may be different from the total sample size (e.g., a subgroup was used). If the article does not provide the specific sample size, then use the total number of participants include in the study (usually under the Participants section). If not reported code as 99. |
| Minimum Age in Years (AGE\_MIN) | Record the youngest age of the participants included in the sample. For instance, if the age of participants ranged from 8 to 24 years old, record 8. If the study does not provide the age range, then code as 99. |
| Minimum Age in Years (AGE\_MAX) | Record the oldest age of the participants included in the sample. For instance, if the age of participants ranged from 8 to 24 years old, record 24. If the study does not provide the age range, then code as 99. |
| Mean Age in Years (AGE\_MEAN) | Record the mean age of participants. If two mean ages are reported (e.g., one for Whites and one for racial/ethnic minorities), compute the weighted average; [(sample size of Whites X mean age of Whites) + (sample size of Latinos X mean age of Latinos)] / (the total number of Whites and Latinos). If not reported, then code as 99. |
| Sex Composition - Total = Percentage of females in total sample (SEX) | Record the proportion of females up to two decimals (i.e., proportion of females out of the total sample, .54) within the study sample. If a number is given rather than a proportion, then divide the total number of females by total sample size. If not reported, then code as 99. If means or ES\_VAL are reported separately for males and females, then record each on its own row.  |
| Mean Annual Income (INC) | Record the mean annual income of the sample. If the study includes children, record the mean of the parent's annual income or household annual income. If a range of annual income is provided, take the midpoint of the reported range. For instance, add the upper and lower values of the reported range and divide by two. If income is reported in the thousands (e.g., instead of $34,500, the article reports 34.5), move the decimal three spaces to the right (e.g., 34.1 = 34100). If annual income is not reported, then code as 99. |
| Mean Education Level in Years (EDUC) | Record the mean number of education (in years) completed of the sample (e.g., 13). If the study includes children, record the mean of the parent's education. If a range of years completed is provided, take the midpoint of the reported range. For instance, add the upper and lower values of the reported range and divide by two. If the article reports education categorically (e.g., high-school degree, bachelor degree), code as 88. If education level is not reported, then code as 99. |
| Socioeconomic Status Composition (SESCOMP) | Record the socioeconomic status composition of the sample. For instance, authors will say if the sample of the study is mostly low-income or affluent. If the authors mention that the sample is diverse in terms of social class, status, income, education, or occupation, or if the authors refer to the sample as a community or nationally representative sample then this would be considered 3 = mixed socioeconomic status. Also, if percentages are reported for the distribution of income, education, or socioeconomic status and it appears that there are both high and low values (high and low income, or high and low education levels), then code as 3 = mixed.1 = Low (e.g., low-income, socioeconomic disadvantaged)2 = High (e.g., affluent, upper class)3 = Mixed (e.g., diverse, income levels varied)4 = Not reported |
| Percentage of African American/Black Participants (ETH\_BLK) | Record the proportion (e.g., .54) of Black/African American participants included in the study. If a number is given, then divide the number of Black/African American participants by the total number of participants. If not reported, then code as 99.  |
| Percentage of Asian American Participants (ETH\_ASN) | Record the proportion (e.g., .54) of Asian American participants included in the study. If a number is given, then divide the number of Asian American participants by the total number of participants. If not reported, then code as 99.  |
| Percentage of Latino/Hispanic Participants (ETH\_LAT) | Record the proportion (e.g., .54) of Latino/Hispanic participants included in the study. If a number is given, then divide the number of Latino/Hispanic participants by the total number of participants. If not reported, then code as 99. |
| Percentage of American Indian/Native American/First Nation Participants (ETH\_AI) | Record the proportion (e.g., .54) of American Indian/Native American/First Nation participants included in the study. If a number is given, then divide the number of American Indian/Native American/First Nation participants by the total number of participants. If not reported, then code as 99.  |
| Percentage of White/European American Participants (ETH\_WHT) | Record the proportion (e.g., .54) of White/European American participants included in the study. If a number is given, then divide the number of White/European American participants by the total number of participants.  |
| Percentage of Pacific Islander Participants (ETH\_PI) | Record the proportion (e.g., .54) of Pacific Islander participants included in the study. If a number is given, then divide the number of Pacific Islander participants by the total number of participants. If not reported, then code as 99.  |
| Percentage of Mixed Race/Biracial Participants (ETH\_MR) | Record the proportion (e.g., .54) of Mixed Race/Biracial participants included in the study. If a number is given, then divide the number of Mixed Race/Biracial participants by the total number of participants. If not reported, then code as 99. |
| Percentage of participants who reported "other" as ethnicity (ETH\_OTH) | Record the proportion (e.g., .54) of Other participants included in the study. If a number is given, then divide the number of Other participants by the total number of participants. Other would stand for any race/ethnicities that were not listed above or for those who reported Other when asked. If not reported, then code as 99.  |
| Notes | Report any uncertainties or related information about the codes above. |