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Executive Functioning in Pediatric Youth: A Meta-Analysis

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Executive Functioning in Pediatric Youth: A Meta-Analysis

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Biography

The author was born in Grandville, Michigan, June 1990. He graduated from Grandville High School, received his Bachelor of Arts degree in Psychology from DePaul University in 2012, and received his Master of Arts in Clinical Child Psychology from DePaul University in 2015.

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Abstract

Executive functioning (EF) represents a set of cognitive skills that are important for daily functioning. EF can be influenced by a number of biopsychosocial factors, many of which are present in the pediatric population (i.e., youth with at least one medical condition). It is important to understand EF in this population as it affects aspects of their physical health (e.g., treatment adherence). Previous meta-analyses have been conducted to examine EF in the pediatric population, and they have generally found deficits in EF compared to healthy peers. However, these previous meta-analyses have only focused on specific medical conditions (e.g., pediatric youth with cancer). To the author's knowledge, there has never been a meta-analysis of EF in the pediatric population more broadly. The current study serves to begin the process of closing this gap in the literature. Publications on EF in pediatric youth with a medical condition (i.e., cancer/tumor, epilepsy/seizure, or diabetes) were collected and used in a meta-analysis. Findings suggest pediatric youth have lower EF compared to healthy peers as a whole, though differences between the illness groups were noted. The epilepsy/seizure literature report the largest EF deficits across the various EF skills, and the diabetes group only showed small (though clinically and statistically significant) deficits in the domain of planning/organization. These findings provide early evidence for the benefit of considering cross-illness factors when working with pediatric youth, and suggest this area warrants further study.

Introduction

Executive functioning (or executive functions) has been an increasing focus of research in the field of psychology. It is believed to play a major role in the psychosocial and academic/work functioning of individuals, and has been found to be influenced by a myriad of different factors. Unfortunately, previous studies examining executive functioning have been inconsistent in their operationalization of executive functions (as detailed below), creating a need to aggregate the results in a helpful and meaningful way. Having a better understanding of executive functioning, pariticularly in populations most heavily impacted by executive functioning, can help set the stage for the development of widely applicable and efficacious interventions.

There are many different ways executive functioning can be negatively affected in youth due to its overarching role and long lasting development. One population that is known to face many adversities is the pediatric population, or children who have at least one medical condition. While some studies have examined executive functioning in subgroups of this population, such as children with cancer (e.g., Christ, Moinuddin, McKinstry, DeBaun, & White, 2007; McNally, Rohan, Pendley, Delamater, & Drotar, 2010; Wolfe et al., 2013), our knowledge of executive functioning in the pediatric population more broadly is lacking. In order to better address executive functioning difficulties in pediatric youth, and help improve their long-term outcomes, it is important to gain a better understanding of just how executive functioning is impacted in the population.

Executive Functioning

General information. "Executive functioning" represents a collection of individual cognitive skills that play a role in day-to-day functioning. Conceptually, executive functioning

(EF) represents the brain conducting second-level processing of basic sensory inputs. That is, at the "lower level" the brain processes information available through the senses individually. This information is then processed and integrated, which is the role of EF (Stuss, 1992). Therefore, EF mastery plays a significant role in how people understand and interact with their environment.

Unfortunately, comprehensive models of understanding EF are lacking. This is likely in part due to the disagreement about what can be classified as executive functions. As is discussed in more detail below, there has been research on individual components that influence EF, such as biology and development. Yet there is a need to understand EF within the context of various influencing factors, especially among populations that are uniquely subjected to EF challenges.

While no comprehensive model exists, different researchers have conceptualized EF in various ways, with common skills including: inhibition, shifting attention, emotional control, initiation, working memory, planning/organizing, organization of materials, and self-monitoring (Gioia, Isquith, Guy, & Kenworthy, 2000). These skills can be consolidated in different ways as well, such as the Behavioral Regulation and Metacognition indices of the Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia et al., 2000), or "cool" (i.e., cognitive) and "hot" (i.e., emotional) components (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009).

Some researchers have argued that these EF skills represent a single EF factor, which is supported by the high level of correlation among the skills (for a review, see Garon, Bryson, & Smith, 2008). However, others have also argued that the skills are all unique, as evidenced by factor analyses demonstrating the skills loading onto separate factors (Garon et al., 2008). More recently, models have suggested that the reality is a combination of the two, with the different skills being unique but highly correlated and dependent upon one another (Garon et al., 2008). In

support of this perspective, some past studies have found evidence that EF skills develop at different times (e.g., Stuss, 1992), potentially because later skills depend upon earlier skill development.

Development of EF skills occurs throughout childhood and adolescence, with signs of their development being present in preschool (Carlson & Wang, 2007) and improvement being measurable until at least 15 years of age (Best, Miller, & Naglieri, 2011). For youth, EF is a very important set of skills to develop due to its link to academic functioning (particularly "cool" EF; Best et al., 2011; Brock et al., 2009). A meta-analysis by Alvarez and Emory (2006) suggests that by adulthood EF skills are reliant on various pathways throughout the brain, suggesting all phases of brain development have implications for the development of EF.

Of note, there are two primary ways to assess EF: performance-based measures and rating scales/questionnaires. Previous research has suggested that these two types of measurement methods pick-up different underlying constructs (Toplak, West, & Stanovich, 2013). Conceptually, questionnaires may identify more "real world" EF whereas performance-based measures can help to assess specific targeted skills. Therefore, it is also possible to consolidate EF findings in these ways and it is helpful to examine EF performance across measurement types.

Longitudinal implications. EF has been thought to be an important set of skills for achievement in various facets of life throughout development. Beginning in early life, EF plays a role in how well students will perform in school. As Bull, Espy, and Wiebe (2008) state, "for children just entering school many of the tasks they are faced with are completely novel and as such may place particularly heavy demands on cognitive processes"(p.4) such as EF. To support this idea, it has been found that EF skill levels in preschool can predict future learning a few

years into grade school (Bull et al., 2008). Unfortunately, without intervention, EF deficits have been found to persist from childhood to young adulthood, at least in a sample of youth with Attention Deficit/Hyperactivity Disorder (ADHD; J. Biederman et al., 2007). Because the effects of EF deficits are long-term and pervasive, it is important to better understand what may lead to EF deficits (e.g., chronic medical conditions) so at-risk populations can be targeted.

Development. The development of EF is influenced by various psychosocial and biological factors. For example, parenting dimensions have been found to predict EF development, particularly support for autonomy (Bernier, Carlson, & Whipple, 2010). There has also been mixed evidence of single parenthood affecting EF development, though it is still unclear to what extent socioeconomic status (SES) confounds this relationship (Sarsour et al., 2011). Language may play a role in EF development as well, though it is confounded with other aspects of the home environment (Sarsour et al., 2011). In at least one study, temperamental reactivity and financial stressors were found to interact when predicting future EF in young children (Raver, Blair, & Willoughby, 2013). In a summary of how EF can be developmentally affected by a number of psychosocial components, Ylvisader and Feeney (2002) wrote the following:

> "a variety of distinct research strategies converge on the following developmental themes: executive self-regulation of behaviour begins early in infancy, develops slowly, continues to develop through adolescence, can be facilitated with well conceived supports, and is variable in relation to context (domain of content and setting), motivation, and cultural values" (p. 57).

Biologically, EF has been historically associated with the Prefrontal Cortex (PFC). However, this view is no longer held by many, as there is growing evidence that the PFC

interacts with many other areas of the brain in regards to EF (Alvarez & Emory, 2006; Stuss, 1992). Because EF relies on many areas of the brain, it is believed that the development of different skills at different times of life is in part due to the differential development of the brain (Stuss, 1992). The consequence of this relation to brain development is that EF skills are theoretically vulnerable to various brain insults throughout development, including from medical etiologies and treatments.

Correlates. EF has been studied extensively in relation to psychopathologies, particularly ADHD (Biederman et al., 2004). Children with ADHD have been found to have deficits in several EF skills compared to peers, though similar deficits have been found in other psychopathology groups (e.g., oppositional defiant disorder, conduct disorder, autism; Sergeant, Geurts, & Oosterlaan, 2002). More recently, this line of research has expanded more to include Posttraumatic Stress Disorder (PTSD) as well. Several studies have found traumatic experiences to be predictive of poorer executive functioning, including war-related (Polak, Witteveen, Reitsma, & Olff, 2012) and familial trauma (DePrince, Weinzierl, & Combs, 2009). These articles note that not all traumas are associated with poor EF outcomes, though they highlight the need to better understand how experiences may result in poor EF developmental trajectories.

Pediatric Population

As the literature demonstrates, EF is a set of important skills that can be influenced by an array of psychosocial and biological factors. The majority of the literature on EF thus far has focused on the general population, or medically healthy children with psychological disorders, and looked primarily at how a small set of factors influences EF (e.g., Fishbein et al., 2009; Garon et al., 2008). In summary, these studies have found that EF develops throughout childhood and adolescence, leaving it vulnerable to adversities such as low SES, parenting style, and

various other factors. However, it is unclear how EF may be influenced in a pediatric population that is atypical from the general population and is marked by a number of factors that are likely to affect EF development. These factors include reduced school attendance (Fowler, Johnson, & Atkinson, 1985; Kearney, 2008), exposure to medications with neurocognitive side effects (e.g., antiepileptics; Mitchell, Zhou, Chavez, & Guzman, 1993), reduced biological efficiency of EF pathways (e.g., corpus callosotomy in epilepsy), and high levels of psychosocial stress (Lavigne & Faier-Routman, 1992).

The pediatric population represents youth who have at least one medical condition (e.g., diabetes, epilepsy, cancer). Research with youth in this population has found that many of the factors highlighted above as relevant for EF are impacted. The work that has been done thus far has focused on specific populations with specific medical conditions (e.g., cancer). This includes some previous meta-analyses regarding neurocognitive functioning within a specific condition. For example, Naguib, Kulinskaya, Lomax, and Garralda (2009) conducted a meta-analysis of 24 studies examining neurocognitive functioning in pediatric youth with Type 1 diabetes and found overall reduced intellectual functioning. Another meta-analysis suggests that pediatric youth receiving chemotherapy for Acute Lymphoblastic Leukemia (ALL) have impairments in some aspects of EF (Peterson et al., 2008). While there have been some meta-analyses looking at pediatric populations more broadly (e.g., examining social competence; Martinez, Carter, & Legato, 2011), they have not examined EF. Therefore, there is a gap in the literature regarding EF in pediatric populations more broadly.

Various medical conditions have different etiologies and prognoses, meaning the specific effects in regards to EF likely vary (especially since there are very few “common” medical conditions in pediatric youth, meaning there is a wide variety of conditions to consider; Pless &

Perrin, 1985). Nonetheless, deficits in EF broadly are being identified, with some of the predictors such as parenting, home environment, and trauma showing consistent relationships across a wide range of medical conditions.

Biological factors. There is a direct physiological component that needs to be taken into consideration when working with the pediatric population. As mentioned above, EF is primarily represented in the PFC of the brain, though it relies on other areas of the brain as well. Brain tumors are the second most common form of cancer in pediatric youth (Ward, DeSantis, Robbins, Kohler, & Jemal, 2014). These tumors, combined with the radiation of the brain and surgeries needed to treat them, cause damage to the brain tissue. This damage puts at least pediatric youth with cancer at risk of poor EF outcomes, which may partially explain the poor cognitive and academic outcomes that have been found in this population (Anderson, Godber, Smibert, Weiskop, & Ekert, 2000).

However, cancer is not the only diagnosis with biological implications for EF. For example, Sickle Cell Disease (SCD) can lead to strokes in various areas of the brain, which may damage cortical tissue that is crucial for EF pathways and lead to potential EF challenges. In fact, SCD has been linked to deficits in ability to maintain attention, lowered intellectual functioning, and lowered academic skills (Bonner, Schumacher, Gustafson, & Thompson, 1999; Wang et al., 2001). Spina bifida, a medical condition that directly affects the central nervous system (CNS), has also been associated with poorer EF outcomes compared to healthy controls (Burmeister et al., 2005). There is also evidence of reduced EF associated with epilepsy (MacAllister et al., 2012), a medical condition marked by abnormal electrochemical patterns in the brain that can result in neuronal damage.

Finally, various chemicals may affect the CNS. This can include medications (e.g., chemotherapy; Copeland, Moore, Francis, Jaffe, & Culbert, 1996), but also effects of the condition itself. For example, deficits in EF have been found in pediatric youth who have hyperglycemic episodes related to diabetes (for a review, see Desrocher & Rovet, 2004) which can result in elevated levels of ketones. Therefore, pediatric youth have unique risk factors for EF development in regards to CNS function.

Psychosocial factors. Medical conditions have far-reaching effects within a child's socioecological network, which has implications for psychological wellbeing. Parenting stress (Cousino & Hazen, 2013) and parental monitoring (Ellis et al., 2007) are related to EF, and are affected by a child's medical condition. Pediatric youth may have fewer opportunities to function as independently as their same-age peers, which has implications for their EF development (at least in early childhood; Bernier et al., 2010). In addition, many medical conditions found in the pediatric population have the potential to be traumatic. The mere diagnosis of a medical condition, particularly one that is associated with morbidity, can be traumatic for families (Landolt et al., 2002). The literature on these potentially traumatic events (PTEs) often refers to these traumas as Pediatric Medical Traumatic Stress (PMTS; Price, Kassam-Adams, Alderfer, Christofferson, & Kazak, 2016). It is possible that youth who experience more traumatic events related to their medical condition(s) may have worse EF outcomes.

Environmental factors. Finally, broader environmental variables linked to EF, such as low SES, are disproportionately relevant in the pediatric population compared to the general population. Low SES families are at a heightened risk of having poor health (e.g., via altered immunological processes; Miller, Chen, & Cole, 2009). The potential reasons for this are far-reaching, and include lack of resources available to maintain health (e.g., food

availability/accessibility in a neighborhood affecting obesity rates; Rosenkranz & Dzewaltowski, 2008). Not only can these factors lead to higher rates of medical conditions, but they have also been found to negatively affect EF development. For example, a study of kindergartners found that those from low SES families demonstrated lower performance on several EF tasks compared to middle class peers (Noble, Norman, & Farah, 2005). It has also been suggested that low SES leads to heightened stress levels, which may alter the stress response system in a way that negatively affects neurocognitive functioning (Hackman & Farah, 2009) and potentially physical health. Many environmental factors tend to affect and interact with one another, but as a whole they likely have a strong impact on development of EF skills for pediatric youth. A summary of these EF-related factors can be found in Figure 1.

Implications. It is important to have a better understanding of EF in this population more broadly. Non-adherence to treatment regimens, which can have medical implications, is common within the pediatric population (La Greca & Mackey, 2009). This non-adherence may in part be due to EF deficits making it difficult for pediatric youth to comply. For example, pediatric youth with insulin-dependent diabetes often must complete calculations to determine the necessary insulin dose (with a formula that can change over time), and they need to estimate glucose content of food. This conceptually requires self-monitoring (to remember to check/calculate), sequencing abilities (to recall appropriate order of steps), planning/organization (to have everything ready in advance), inhibition (to limit snacking), and working memory (to complete the calculations). Indeed, two studies of pediatric youth with diabetes have found that higher EF was associated with better treatment adherence (Bagner, Williams, Geffken, Silverstein, & Storch, 2007; Perez et al., 2017). A third study found that youth-reported attention problems were associated with poorer diabetes regiment adherence (Turner, Berg, Butner, & Wiebe,

2018). Another similar study found evidence of EF influencing glycemic control through treatment adherence (McNally et al., 2010). In addition, EF challenges may help explain some of the difficulties that are seen in this population (e.g., poor performance on neuropsychological batteries compared to healthy classmates, potentially due to early EF challenges hindering progress in several academic domains; Noll et al., 2001). Only by understanding the extent of EF challenges in this population can we effectively target the deficits in treatment.

In addition, it is important to understand EF within this population as a whole rather than examining EF for specific conditions. By getting a better understanding of whether or not there are common EF deficits across conditions, or potentially patterns of EF deficits in illness groups, we can more effectively generalize our treatments across illness groups. In the pediatric population, rare conditions are the norm rather than the exception (Pless & Perrin, 1985). Therefore, it is not feasible to assess EF for each illness separately. In addition, comorbid medical conditions are common (Newacheck & Stoddard, 1994). By having an understanding of the extent to which EF deficits are common (or vary) across conditions, clinicians can more confidently form effective assessment and intervention programs for a given pediatric patient even if no research has been done on the patient's specific presentation of medical conditions. That being said, it is also not feasible to conduct a large study looking at the pediatric population as a whole. Therefore, it is important to identify a way to select initial conditions to study that can help to represent the pediatric population more broadly. One such way is based on level of Central Nervous System (CNS) involvement, which has been used to categorize multiple conditions in the past (e.g., Deidrick, Grissom, & Farmer, 2009). By examining conditions with varying degrees of CNS involvement, there can be more generalizable findings for the pediatric population more broadly.

Summary

EF represents an important set of skills that play a significant role in day-to-day functioning and likelihood of future productivity and success. Pediatric youth with chronic medical conditions, who have many illness-related complications that can negatively impact EF development, are not well understood as a population in regards to EF. As mentioned above, some work has been done to examine EF in pediatric youth, with the focus primarily being on pediatric youth with specific conditions (e.g., McNally et al., 2010). This previous work can be used to create a preliminary conceptual model of EF in pediatric youth (Figure 1). Yet, there has never been a meta-analysis specific to EF in pediatric youth with chronic medical conditions as a whole, or comparing multiple medical conditions in the pediatric population.

The current study seeks to begin the process of filling this gap in information by conducting a meta-analysis of EF in pediatric youth with chronic medical conditions that have varying degrees of CNS involvement (specifically: cancer/tumor, epilepsy/seizure, diabetes). In addition, different methods of measuring EF are assessed to help identify potential differences that have been found in other studies (e.g. Toplak et al., 2013). Doing so will help to further determine all of the relevant factors related to EF in pediatric youth, and can help inform EF treatments for these youth. The current study seeks to address the following hypothesis and research questions:

Hypothesis/Research Questions

1. Hypothesis: Pediatric youth with chronic medical conditions (i.e., cancer/tumor, epilepsy/seizure, diabetes) will have lower EF skills overall compared to healthy same-age peers.

2. Research Question 1: Are children with particular medical conditions more likely to have deficits in EF?
3. Research Question 2: Do EF patterns vary as a function of the format of EF measure used?

Method

Meta-Analysis

The current study used a meta-analytic approach to address the primary hypothesis and research questions. Meta-analysis differs from other studies that examine a single set of data (i.e., primary or secondary analyses), and instead uses the results of various studies as data to be further analyzed (Card, 2012). A structured system was utilized to complete the literature review and abstraction of the relevant data from the publications, based on recommendations by Card (2012). The current study was also conducted in general compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher, Liberati, Tetzlaff, & Altman, 2009) guidelines.

Inclusion Criteria

In order to be included in the current study, published research needed to meet the following criteria:

1. The samples used were exclusively comprised of children/adolescents (up to the age of 19) at the time of assessment.
2. Youth in the sample had at least one qualifying medical condition. Comorbid conditions were acceptable (though rarely represented in the literature).
3. Analyses and results included information about pediatric youth compared to healthy same-age peers, in regards to EF.

    a. In lieu of an included healthy control group, studies with standardized scores, or raw scores for assessments for which we had sufficient information from the normative sample, were permitted.

4. The data were from independent samples. To the extent possible, studies with overlapping samples (e.g., multiple articles from a single overarching longitudinal study) were identified and only one set of measurements from a given measure with the sample were used.
    a. Multiple publications on the same sample were permitted, but only if there were not overlaps in the measures (e.g., if one publication reported scores for Digit Span while another reported scores for Rey Complex Figure).
    b. For longitudinal studies, the baseline timepoint was used by default. Exceptions to this included: 1) if EF measures were only used at a later timepoint, or 2) the baseline measurements were confounded in some way (e.g., immediately post-intervention).
5. The study utilized at least one formal neuropsychological assessment measure that included EF as a component.
6. Sufficient information was reported to compute effect size. If there was insufficient data, authors were contacted (when possible) in an attempt to access the necessary information.
7. The article was written in English.

Literature Search

To identify as many publications as possible across databases, Google Scholar was used to conduct the searches for publications. This approach was chosen due to the wide variability to the fields, and thus databases, that studies regarding EF in pediatric youth are published within

(e.g., neurology, nursing, psychology). In addition, Google Scholar allowed for easier identification of a wider array of publication formats (e.g., dissertations, book chapters) than are often included in specific databases.

Based on reviews of the publications identified via a preliminary search, the following keywords/phrases were used in various combinations to identify preliminary publications: pediatric, youth, children, adolescents, executive functioning, executive functions, inhibition, effortful control, switching, working memory, updating, selective attention, planning, organizing, neurocognitive, neuropsychological. For a full list of the exact search phrases used, see Appendix B.

Based on a preliminary search, different medical conditions were considered for the focus of the current study. After review of the amount of available literature and characteristics of conditions, three conditions were chosen to serve as initial representations of the larger pediatric population. Those conditions were epilepsy/seizure disorders (with direct CNS involvement), cancer/tumors (with direct and indirect CNS involvement), and diabetes (with indirect CNS involvement). Of note, like many other pediatric conditions these populations are not perfectly homogenous (e.g., blood vs. solid tumor cancers, malignant vs. benign tumors, partial vs. general epileptic seizures). Studies were included if they represented a sample that was considered to demonstrate the core signs/symptoms of the chosen medical conditions (e.g., epileptic brain activity or febrile seizures and not only psychogenic non-epileptic seizures) and if the signs/symptoms could not be explained by another medical condition (e.g., tumors related to neurofibromatosis were excluded from the cancer group).

The initial literature search was completed using Google Scholar, as detailed above. Publications that appeared potentially eligible based on title were downloaded and sorted based

on condition. The primary investigator then went through every publication and identified if each publication met the necessary eligibility criteria. Systematic reviews and other meta-analyses, though ineligible due to a lack of original data, were reviewed for additional publication references. Eligible publications that provided extensive literature reviews also had their reference sections reviewed for additional potential publications. Those publications were then also gathered and screened. Finally, all eligible publications then underwent forward citation searches via Google Scholar to identify more recent literature that may be eligible. Those publications were then added to the database and screened for eligibility. Any publications that lacked the necessary data for calculating effect sizes were flagged, and the corresponding authors were contacted (if contact details were available) to request the necessary data. As part of these requests, authors were asked to share any unpublished results they may have in order to limit the effect of publication bias. A summary of the literature search process can be found in Figure 2. These publication identification strategies were based on the suggestions of Card (2012). Publication tracking was handled in an EndNote database.

Coding Procedure

Coding was primarily conducted within a Microsoft Access web database, which allowed for easy entry and data verification while allowing for easy export of the data for use in analyses. Given the format of the data, full double entry was not practical (e.g., many string variables, measure names that are sometimes represented by acronyms). Instead, a verification process was utilized, whereby one person completed initial entry of the information from a publication and a different person reviewed the entry and publication with the intent of identifying discrepancies. The primary investigator served as either the first person to enter the information from a publication, or as the person to verify an entry, for every publication in the database. Any

identified discrepancies were reviewed by the primary investigator and corrected as appropriate. The database was formatted in a way to allow for easy export to a Microsoft Excel spreadsheet, such that it could then be easily imported into the Comprehensive Meta-Analysis (CMA; Borenstein, Hedges, Higgins, & Rothstein, 2009) program for analyses.

Priority was given to entry of means, standard deviations, and subgroup sizes to allow for direct calculation of effect sizes in CMA. If necessary, t-test values, p-values, or Cohen's d values were entered with the information that was included in the publication. After export to Microsoft Excel, normative sample information was added for those entries which required comparison to a pseudo-control group. In some cases, the necessary information could not be identified for a normative sample (e.g., raw scores reported in the publication but not in the manual for the measure, measures that allow raw score comparison between groups but have no normative data), thus those entries were removed from the database. Care was taken to ensure appropriate identification of normative sample information, either via the official manual for appropriate measures (e.g., WISC-IV; Wechsler, 2003), based on the correct version of the measure, or via referenced published norms for different versions of measures (e.g., translations) or variations of common measures (e.g., different versions of Stroop and continuous performance tasks). In addition, each set of scores was reviewed by the primary investigator to determine the EF skill best represented based on the measure/subtest used. The chair of the committee reviewed these EF skill assignments to establish a professional consensus. Based on commonly-used labels for various EF skills, and the range of skills represented, the following labels/groupings were utilized: inhibition, attention, planning/organization, switching, self-monitoring, working memory/sequencing, initiate, and (for use with composites) a general category.

Finally, the effect direction needed to be coded. That is, each set of comparisons was coded based on whether participants with a medical condition showed better or worse performance on the associated measure compared to the controls. This ensured data were appropriately represented in the analyses regardless of whether higher scores indicated better executive functioning (e.g., WISC Digit Span) or worse executive functioning (e.g., BRIEF GEC). For any ambiguous scores (e.g., scale conversions), the original publications were reviewed for indications of effect direction (e.g., mention of which group performed better, notes for tables).

Statistical Analyses

The computation of effect sizes was handled by the CMA program. For standardized mean differences analyses, there are a few statistics to choose from. Cohen's *d* (Cohen, 1987) is one of the more widely used variables calculated for meta-analyses. However, *d* has been found to be biased and to sometimes over-estimate the size of mean differences (Borenstein et al., 2009). To correct for this bias, Hedges's *g* applies a correction formula to *d*, which is thought to make the estimated effect size more accurate (Borenstein et al., 2009). Therefore, *g* was the primary statistic calculated for the purposes of this meta-analysis. Given the likelihood of unaccounted factors contributing to participant performance, a random effects model was used for all analyses (Card, 2012).

To answer the research questions, moderator variables were examined. CMA conducts these moderator analyses by running analyses by group (e.g., by publication format). Moderators of interest in the current study included: publication format, source of data (i.e., performance-based measure or questionnaire), type of healthy control (i.e., included subsample or norms-based pseudo-control), medical condition, and executive function skill.

Finally, analyses were conducted to assess for potential publication bias and to estimate the robustness of the current findings. Specifically, a Failsafe *N* was calculated for all the significant results, as well as a funnel plot to assess for publication bias. Orwin's Failsafe *N* (Orwin, 1983) was used to estimate how many non-significant results (i.e., findings of Hedges's $g = 0$) would be needed for the results to fall below a threshold for a small effect size (i.e., Hedges's $g \leq 0.2$). Though imperfect (e.g., CMA calculates Orwin's Failsafe *N* based on a fixed effects model), these analyses help provide additional context to the results and can help guide future research.

Results and Analysis

Search Outcome

The literature search yielded a total of 1,575 publications that were reviewed, of which 314 publications representing approximately 25,063 participants (including those with medical conditions and any included healthy controls) met all inclusion criteria (see Figure 2). Unfortunately, not all publications provided demographic information regarding their samples. Out of the publications that provided information about gender (N = 276, 87% of publications), the gender split was relatively equal overall ($M_{Female\%} = 46.46$). Only 30% of publications (N = 96) reported information on race/ethnicity, with low representation of minority groups overall ($M_{Minority\%} = 28.97$). Mean age of participants was reported in 281 (89%) of the publications, with an overall average age of 11.09 years, and an age range of 1-19 years old. References for all eligible publications included in analyses can be found in Appendices E – G. Further information (e.g., measures for each publication used in analyses) can be found in Appendix H.

A summary of reasons for ineligibility can be found in Figure 3. Of note, not all reasons for ineligibility were listed, only the most prominent. For example, a publication may have

focused on adults and may not have included any measures of EF, but in such cases each publication was labeled as ineligible due to whichever was identified first. Therefore, the representation of ineligibility should not be considered representative of the larger literature (e.g., the number identified as focused on adults does not encompass the total number of publications in the literature focused on adults).

Statistical Results

Main analysis. First, to address the main hypothesis of the study, results comparing EF in pediatric youth to healthy controls was examined across all of the studies. A total of 1,624 comparisons were made across all the publications. The overall results were found to be statistically significant with a moderate effect size (Hedges's g = -0.473, 95% CI [-0.506, -0.441]; Z = -28.50, p < .001), with pediatric youth demonstrating worse EF overall, supporting the main hypothesis.

To examine the results further and to address the first research question, the analyses were run separated by health condition (i.e., diabetes, cancer/tumor, epilepsy/seizure). The results remained statistically significant for each group, though differences were noted in effect sizes. Results representing pediatric youth with epilepsy/seizures showed the largest overall effect size (Hedges's g = -0.558, 95% CI [-0.607, -0.509]; Z = -22.29, p < .001). In comparison, the cancer/tumor group showed a small-to-moderate effect size (Hedges's g = -0.410, 95% CI [-0.448, -0.372]; Z = -21.02, p < .001), while the diabetes group only showed a small overall effect size (Hedges's g = -0.216, 95% CI [-0.370, -0.062]; Z = -2.76, p < .01).

Next, differences in specific EF skills were examined across the illness groups. For both cancer/tumor and epilepsy/seizure, all EF skills (i.e., inhibition, attention, planning/organization, switching, self-monitoring, working memory/sequencing, initiating) were found to be

statistically significantly lower than healthy peers. However, only planning/organization was found to be significantly lower than healthy peers for children with diabetes (Hedges's g = -0.780, 95% CI [-1.295, -0.265]; Z = -2.97, p < .01). A summary of all scores can be found in Table 1.

Finally, to address the second research question, analyses were run separately for each format of data collection (i.e., performance-based measure or questionnaire). Questionnaires were found to show a moderate effect size for differences in EF between pediatric youth and healthy peers (Hedges's g = -0.554, 95% CI [-0.613, -0.495]; Z = -18.44, p < .001), while performance-based measures showed a small-to-moderate effect size (Hedges's g = -0.437, 95% CI [-0.476, -0.399]; Z = -22.18, p < .001). This slight discrepancy is not surprising, as questionnaires generally ask about everyday EF which is more likely to include a mix of EF skills being used at one time compared to performance-based measures that attempt to isolate specific skills and provide structure that may make difficulties less apparent or pervasive. In addition, performance-based measures may better identify what children are best capable of achieving, while questionnaires may identify how well children actually perform when other factors are present (e.g., when in a busy classroom, during contentious arguments with caregivers).

Supplemental analyses. To further explore factors that may have contributed to the above results, additional moderators were examined. First, the use of included healthy controls was compared to the use of norms-based pseudo-controls. Overall, publications in each group demonstrated comparable moderate effect sizes when included controls were used (Hedges's g = -0.427, 95% CI [-0.476, -0.377]; Z = -16.94, p < .001) or when pseudo-controls were used (Hedges's g = -0.503, 95% CI [-0.545, -0.460]; Z = -23.26, p < .001). In addition, effect sizes

reported in different publication formats were all found to be statistically significant and generally in the moderate range. Specific values can be found in Table 2.

Source of data collection (i.e., performance-based measure or questionnaire) was further explored as a moderator. As discussed above, while use of performance-based measures can potentially provide more objective and focused assessment of EF skills without reporter bias, it could be argued that the structured neuropsychological setting may help scaffold EF skills in a way that helps performance. EF-related weaknesses could also potentially arise when multiple EF skills are needed at one time. Therefore, questionnaires asking about EF skills in daily life may provide additional insight that is not found in the neuropsychological assessment setting. For the cancer/tumor and epilepsy/seizure groups, both sources of data showed statistically significant deficits in EF compared to healthy peers, with small to moderate effect sizes for the cancer/tumor group (-0.385 and -0.453), and moderate to large effect sizes for the epilepsy/seizure group (-0.478 to -0.796). However, for the diabetes group, only performance-based measures were found to be significant (Hedges's g = -0.398, 95% CI [-0.581, -0.215]; Z = -4.265, $p < .001$) whereas questionnaires were non-significant (Hedges's g = 0.135, 95% CI [-0.130, 0.400]; Z = 0.998, *ns*). This difference was more pronounced when limited to only comparisons of planning/organization, with large effect found on performance-based tasks (Hedges's g = -1.026, 95% CI [-1.588, -0.463]; Z = -3.573, $p < .001$) and non-significant results for questionnaires (Hedges's g = 0.233, 95% CI [-0.728, 1.194]; Z = 0.476, *ns*). This discrepancy may reflect a tendency for parents to overestimate planning/organization abilities if the child's medical condition is stable (suggesting good compliance) when other factors may contribute to that stability (e.g., parent support, partial functioning of the pancreas). A summary of these statistical results can be found in Table 3.

Publication bias. To estimate the robustness of the above results, estimates of publication bias were conducted for all statistically significant findings. That is, funnel plots and a Failsafe *N* were examined for the overall database, for all publications of the cancer/tumor and epilepsy/seizures groups, and for the planning/organization comparisons for the diabetes group. Similar to the above analyses, funnel plots examining publication bias were conducted using a random effects model; the Failsafe *N*'s were calculated using a fixed effects model due to the requirements of the analysis software. A summary of the Failsafe *N*'s can be found in Table 4.

In the funnel plot for the entire database (Figure 4), values were found to be relatively evenly dispersed. There appears to be a slight bias for non-significant results showing worse performance by pediatric youth being included in the literature compared to non-significant results showing better performance. Orwin's Failsafe *N* for the overall database estimates 1,685 comparisons between pediatric youth and healthy peers where Hedges's $g = 0$ would be necessary for the overall effect size to fall below 0.2, suggesting robust overall results.

When examining the funnel plot for the cancer/tumor group (Figure 5), a mild bias towards publication of poor performance by pediatric youth is evident. This finding may represent a tendency for published studies to focus on pediatric youth with more intensive forms of treatment (e.g., cranial radiation). However, despite this slight bias, Orwin's Failsafe *N* for the cancer/tumor group estimated 414 comparisons where Hedges's $g = 0$ would be necessary for the overall effect size to become clinically non-significant, suggesting the results would likely still remain significant even if the publication bias were not present.

For the epilepsy/seizure group, the funnel plot (Figure 6) suggests an opposite mild publication bias towards publication of findings where pediatric youth perform better than healthy peers. This may be a result of the many studies examining cognitive performance of

pediatric youth on antiepileptic medication, despite our efforts to use baseline pre-medication results when possible. Yet even with this mild publication bias, Orwin's Failsafe *N* estimated an additional 1,552 findings of Hedges's $g = 0$ would be necessary for the effect size to fall below the clinically meaningful threshold. Therefore, the results for the epilepsy/seizure population appear very robust.

Finally, the diabetes group demonstrated a slight bias towards publication of significantly poor performance (see Figure 7), at least for the publications specifically examining planning/organization ability. This may represent a tendency for the literature to focus on pediatric youth with episodes of more extreme glycemic levels (e.g., severe hypoglycemia and/or hyperglycemia). For calculating the Failsafe *N*, the threshold needed to be adjusted as the estimated Hedges's *g* based on a fixed effects model (which is used for calculation of Orwin's Failsafe *N*) was calculated to be -0.18, already below the threshold of -0.2 despite the random effects model estimating a Hedges's *g* of -0.78. A lower threshold (i.e., -0.1) was subsequently used for the diabetes group. With that threshold, Orwin's Failsafe *N* was calculated to only be 23 despite the lower cut-off, suggesting these results should be interpreted with caution as additional research in this area may find overall clinically non-significant results.

Discussion

At this time, there is no known "best practice" for assessing or treating executive dysfunction, particularly in pediatric youth. Having a more comprehensive understading of EF, especially in this population, will help to inform the development of additional treatments and can also allow for expanding upon previous intervention work in order to help increase efficacy, which has been called for in the literature (Butler et al., 2008). Along with having a better understanding of EF in pediatric populations that allows for better intervention creation, a

knowledge of patterns of deficits can allow for more targeted screening in pediatric youth. Although there may not be enough data available at this time to compare all of the EF domains across all chronic medical condition groups, the results of the current study provide a good start to this long-term research endeavor.

Overall, the results of the meta-analysis supported the primary hypothesis of this study, as pediatric youth with a chronic medical condition were found to have lower levels of EF in general compared to healthy peers. However, these results should be interpreted with care. Based on the comparison across illness groups (i.e., diabetes, cancer/tumor, epilepsy/seizure), a trend was noted for greater EF deficits with increasing levels of CNS involvement. That is, the diabetes group (with primarily indirect CNS involvement) showed only deficits in planning/organization. These findings could be a result of publication bias. The cancer/tumor group, with a mix of direct (e.g., brain tumor) and indirect (e.g., systemic chemotherapy for leukemia) CNS involvement showed small-to-moderate effect sizes that were fairly robust to mild publication bias. Finally, the epilepsy group with primarily direct CNS involvement (e.g., epileptic electrochemical activity) showed the largest effect size and had the results most robust to any publication bias.

Nonetheless, the findings suggest a generalist view could have some applicability to clinical understanding of the larger pediatric population. While there appears to be variability to the severity of the EF deficits, and which EF skills are implicated, pediatric youth with chronic medical conditions are at increased risk of EF deficits. This knowledge can be used to help inform clinical care with this population, including formulation of treatment adherence supports and psychoeducation for patients and families. For example, mobile phone applications exist that assist patients with reminders to engage in tasks related to their treatment regimen (e.g., taking a

medication, using a nebulizer), and additional tools could potentially be created that work for pediatric youth more broadly.

A noteable overall finding is that reports on questionnaires (primarily via parent-report) seem to highlight EF deficits as much as (and somewhat moreso than) performance-based measures. While referring every patient for a neuropsychological assessment is not feasible, nor necessarily indicated in all cases, these questionnaires may be beneficial for including regularly in pediatric care for chronic medical conditions. Doing so, along with a thorough interview with patients and families, may help to distinguish between patients with more severe EF deficits and those without. This identification could allow for appropriate treatment, and thus higher likelihood of good long-term outcomes in terms of adaptive functioning, academic achievement, employment, and so forth (e.g., Best et al., 2011; J. Biederman et al., 2007; Brock et al., 2009).

Strengths

The current study has several key strengths. First, the use of Google Scholar allowed for wide-spread searching across a diverse population of patients (e.g., studies in Korea and Ghana, journals in multiple disciplines). Second, the strategies used for the literature review (i.e., preliminary search, examination of references, forward citation search) helped to ensure a relatively exhaustive collection of publications. Third, this study is unique in its comparison across pediatric chronic medical conditions, widening its applicability to the field and highlighting commonalities in the experiences of these pediatric youth that are generally understudied.

Limitations

Despite its strengths, the current study also has a number of limitations. First, the analysis was conducted with only a small subset of the overall pediatric population. It would be helpful

for a more comprehensive meta-analysis to be conducted to see if the same findings generalize across additional conditions.

Second, there was limited ability for the current study to examine within-group variance. Future research should attempt to examine various subsets of pediatric populations (e.g., poor vs. good glycemic control, solid vs. blood cancer, type of seizure) to see if EF deficits appear stable across subgroups or if they are associated with specific types of complications/treatments. While this has been done in individual studies of these populations, not all publications present information in a way that allows for consistent and meaningful grouping of subsets of participants in this way.

Third, many of the results are based on measures that are currenly considered out-dated. This is in part due to the lack of a clear time cutoff to use for a meta-analysis of EF, meaning some older studies will inherently meet inclusion criteria. However, there is also a time gap between EF assessment batteries being updated and released for clinical use, and their emergence in the broader research literature. For example, the BRIEF-2 (Isquith, Gioia, Guy, & Kenworthy, 2015) is in widespread use for clinical work at the time of this study and includes changes to the division of EF skills, but the original BRIEF (Gioia et al., 2000) was almost exclusively represented in the literature at the time of our search. Fortunately, new studies on this topic are being published frequently, which means more thorough meta-analyses with more recent (and theoretically improved) measures can be done in the near future.

Fourth, not all EF skills are equally represented in this body of literature (e.g., poor representation of initiation; see Table 1). While not assessed as part of the coding process, many of the eligible articles utilized batteries that included EF as a component (e.g., the Working Memory Index on Wechsler scales; e.g., Wechsler, 2003). However, specific measures were also

selected (e.g., Wisconsin Card Sorting Task; Heaton, 1981), potentially as a result of biases researchers hold regarding what EF skills will be most implicated in a population. Future studies should seek to include more extensive batteries of EF skills in these pediatric youth to help insure deficits are not overlooked.

Fifth, only a minority (30%) of publications reported information on race/ethnicity of their samples, with more detailed demographic information (e.g., SES) even less represented in the literature. Therefore, it is unclear to what extent these results could be attributed to factors such as SES, which has been linked to both lower EF (e.g., Sarsour et al., 2011) and higher rates of experienced chronic medical conditions (e.g., obesity; Jin & Jones-Smith, 2015). Future studies should make an effort to collect and report more of this crucial information.

Finally, the current study was unable to assess for overall quality of the publications (e.g., via the Grading of Recommendations, Assessment, Development and Evaluation [GRADE; Balshem et al., 2011)] system) due to the wide variability within the represented literature (e.g., baseline measurements in medication trials, single timepoints in longitudinal observation studies, single studies using convenience sampling). Future studies on this topic will benefit from identification of a system for determining study rigor/quality (e.g., determining appropriate sampling strategies for representative samples of pediatric youth). Unfortunately, there is no way to know by simply looking at a publication whether or not the measures were administered and scored properly, which is likely the most relevant quality factor in this type of meta-analysis.

Future directions

As research into EF in pediatric populations continues to move forward, there is also a need to consider clinical implications. Executive coaching is sometimes utilized within therapy, though the efficacy of this treatment is unclear. Cognitive remediation with pediatric youth has

been assessed in the literature, including an intervention with proven efficacy demonstrated by a randomized clinical trial (Butler et al., 2008; Butler & Copeland, 2002). However, such interventions are generally intensive and primarily focused on difficulties related to selective attention, suggesting there is room for improved efficiency and efficacy via direct targeting of a wider range of skills as appropriate. Part of the reason for limited research on treatment is likely again due to disagreements about what is considered an executive function, and thus what skills should be targeted. In addition, executive coaching with pediatric youth often needs to accommodate limitations related to a child's medical condition (e.g., limited mobility), adding a layer of complexity. While the current study offers limited insight into these factors, it serves as evidence that future research into this area is warranted, and that these interventions are likely worth developing.

In addition, more work is needed to understand how EF can be better assessed in the clinical setting. Assessing all domains that can be conceptually considered as EFs involves long measures (e.g., 63-item BRIEF-2; Isquith et al., 2015), which can be burdensome for young children and their parents. If screeners can be created to assess the most frequently impacted EF skills (similar to the screener available for the BRIEF-2, but tailored to pediatric youth), some of this burden can be reduced. Such a screener could also allow primary care physicians to administer it quickly during regular outpatient appointments, an approach that is increasingly of interest for providing care and identifying mental health needs in pediatric youth more consistently (e.g., Asarnow, Rozenman, Wiblin, & Zeltzer, 2015).

Finally, these findings have implications for policy development, particularly in relation to schools. While pediatric youth are often able to receive modifications and accommodations as part of the Americans with Disabilities Act (ADA), it can sometimes be difficult for families to

navigate these policies that are already in place. This may be especially true for children who appear physically well, as has been reported on in post-concussion populations (Halstead et al., 2013). If pediatric youth show patterns of reduced EF, this may help to explain changes in academic performance and thus can warrant appropriate tailoring of school curriculum and access to the needs of patients. With appropriate supports, these youth may be able to overcome difficulties related to EF, which could in turn potentially improve their academic performance. Based on the findings of this study, schools should consider adopting policies specifically related to pediatric youth, with some emphasis on helping to support executive functioning development. Doing so can help to ensure appropriate modifications and accommodations that can be more consistently applied and in compliance with existing ADA policies.

Summary

EF skills are important for long-term outcomes in youth generally. Pediatric youth, with varying degrees of alterations to their CNS and often pervasive changes to their socioecological relationships and exposures, are at heightened risk of EF deficits. This meta-analysis found evidence to support this idea that pediatric youth with a chronic medical condition perform worse on tasks of EF overall compared to healthy peers, with a pattern of worse performance as the CNS is more directly involved. This highlights the need for further study of EF in these populations, further study of common challenges across pediatric conditions, and exploration into clinical interventions that may be feasible and efficacious to boost EF in these populations.

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Wang, W., Enos, L., Gallagher, D., Thompson, R., Guarini, L., Vichinsky, E., … Armstrong, F. D. (2001). Neuropsychologic performance in school-aged children with sickle cell disease: A report from the Cooperative Study of Sickle Cell Disease. *The Journal of Pediatrics*, *139*(3), 391–397.

Ward, E., DeSantis, C., Robbins, A., Kohler, B., & Jemal, A. (2014). Childhood and adolescent cancer statistics, 2014. *CA, 64*(2), 83–103.

Wechsler, D. (2003). *Wechsler intelligence scale for children, 4th edition*.

Wolfe, K. R., Walsh, K. S., Reynolds, N. C., Mitchell, F., Reddy, A. T., Paltin, I., & Madan-Swain, A. (2013). Executive functions and social skills in survivors of pediatric brain tumor. *Child Neuropsychology, 19*(4), 370–384.

Ylvisader, M., & Feeney, T. (2002). Executive functions, self-regulation, and learned optimism in paediatric rehabilitation: A review and implications for intervention. *Pediatric Rehabilitation, 5*(2), 51–70.

Appendix A. Conceptual Model of EF in Pediatric Youth

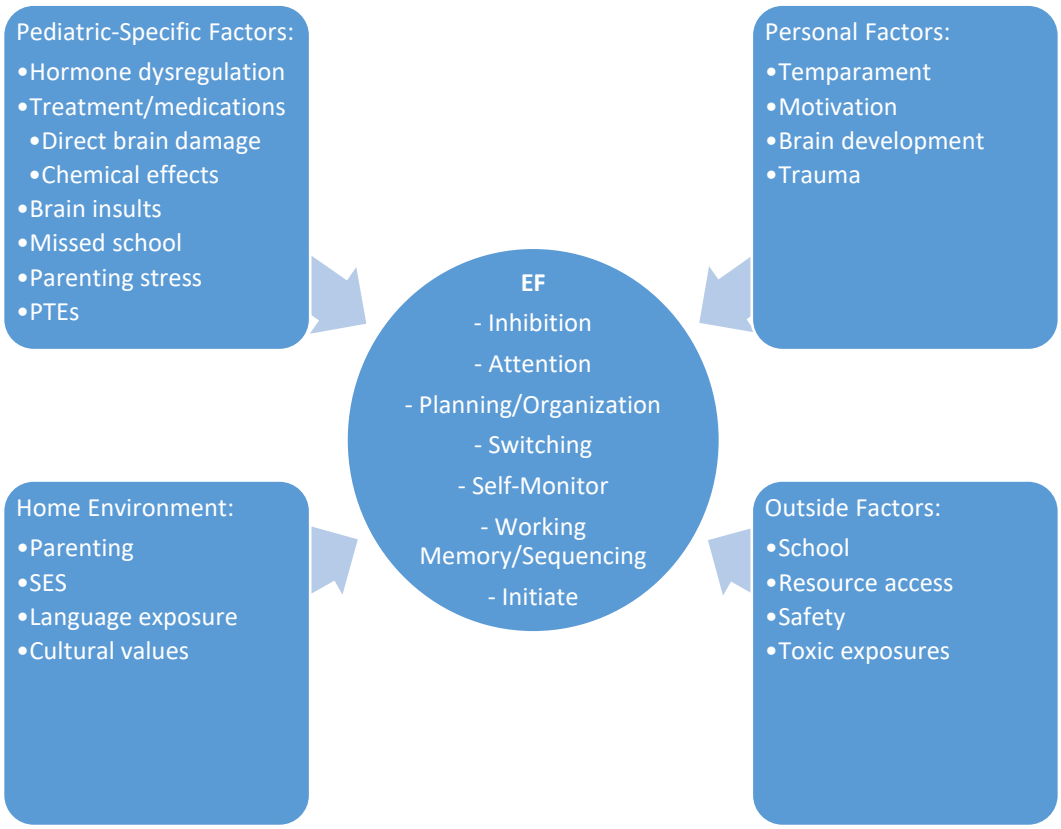

Figure 1. Conceptual Model of EF in Pediatric Youth

Appendix B. Full List of Search Terms/Phrases

1. ("executive functioning" OR "executive functions”) OR ((inhibition OR "effortful control") OR switching OR ("working memory" OR updating) OR "selective attention" OR planning OR organizing
2. (pediatric OR youth OR children OR adolescents) AND (("executive functioning" OR "executive functions) OR ((inhibition OR "effortful control") OR switching OR ("working memory" OR updating) OR "selective attention" OR planning OR organizing))
3. pediatric AND ("executive functioning" OR "executive functions")
4. “child diabetes” AND “executive functioning”
5. juvenile diabetes executive functioning
6. child diabetes working memory
7. “child diabetes” AND attention
8. child diabetes selective attention
9. (pediatric OR child) AND cancer AND “executive functioning”
10. (pediatric OR child) AND cancer AND neurocognitive
11. (pediatric OR child) AND cancer AND (attention OR “working memory”)
12. (pediatric OR child) AND (epilepsy OR seizure) AND “executive functioning”
13. (pediatric OR child) AND (epilepsy OR seizure) AND neurocognitive
14. pediatric diabetes neurocognitive
15. pediatric epilepsy neurocognitive
16. pediatric cancer neurocognitive

Appendix C. List of Coded Variables

1. Date coded
2. Coder initials
3. Study identification
    a. Study ID
    b. Study title
    c. Study authors
    d. Study year
    e. Study format
        i. Journal article
        ii. Book/chapter
        iii. Thesis/dissertation
        iv. Other/unpublished
4. Sample information
    a. Sample size (overall)
    b. Age mean (in years)
    c. Age standard deviation (in years)
    d. Age (lowest, in years)
    e. Age (highest, in years)
    f. Percent of overall sample that is female
    g. Percent of overall sample that is part of an ethnic minority group
    h. Form of control group
        i. Healthy control group
        ii. Standardized norms

5. Assessments used
    a. Boston naming
    b. BRIEF
    c. Cancellation
    d. CBCL
    e. FAS
    f. Finger tapping
    g. McCarthy Scale
    h. Peabody achievement
    i. Grooved pegboard
    j. PPVT
    k. Rey Complex Figure Task
    l. Rapid naming
    m. Stanford-Binet
    n. Trail making
    o. Vineland
    p. VMI
    q. Wisconsin Card Sort
    r. WISC
        i. -R
        ii. -III
    s. Woodcock-Johnson
        i. -R

    t. WPPSI
        i. -R
    u. WRAML
    v. WRAT
        i. -R
    w. Other (e.g., NEPSY, D-KEFS, WISC-IV)
6. Medical condition(s)
    a. Cancer
    b. Diabetes
    c. Epilepsy
7. Statistics reported (separate entries for each measure)
    a. t-value (if appropriate)
    b. p-value (if appropriate)
    c. Cohen's d (if appropriate)
    d. Measure
    e. Subtest/Subscale name
    f. Means, SD, cell size
        i. Separate for illness group and healthy controls

Appendix D. Figures and Tables for Results

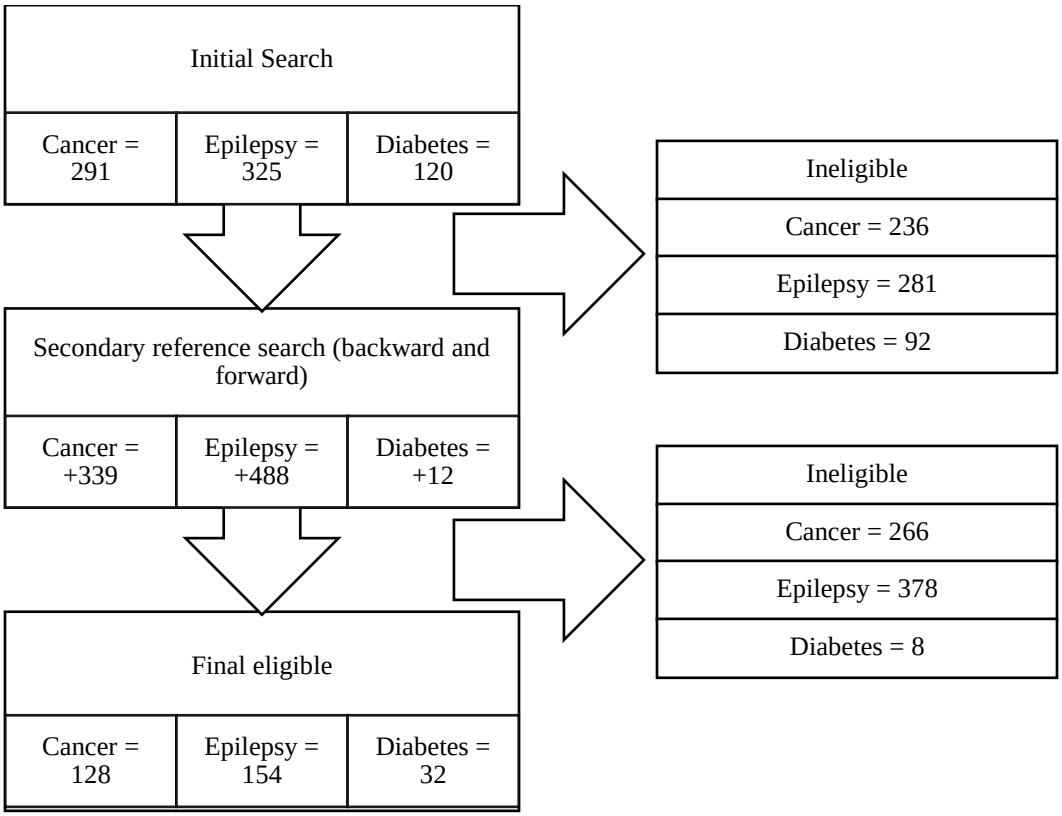

Figure 2. Literature search process.

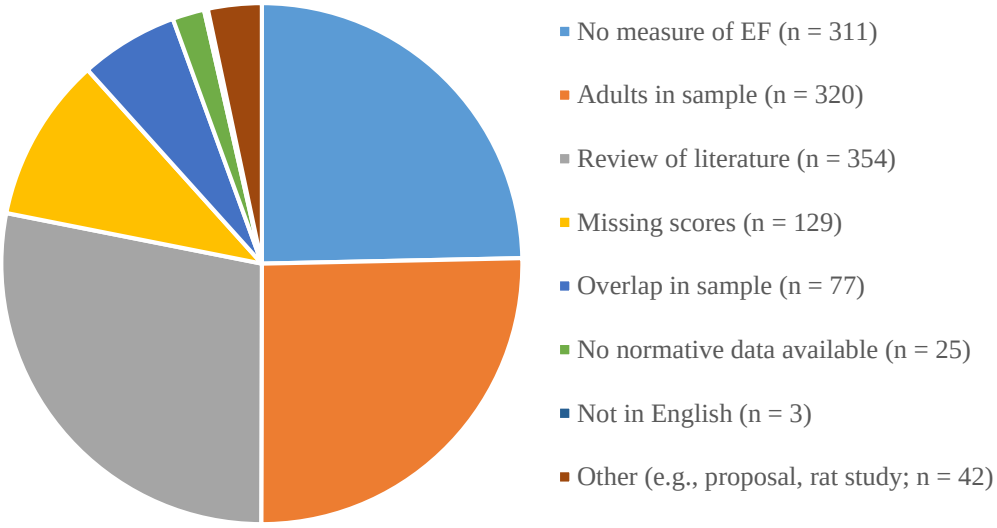

Figure 3. Reasons for ineligibility.

Note. n represents number of publications deemed ineligible for each reason.

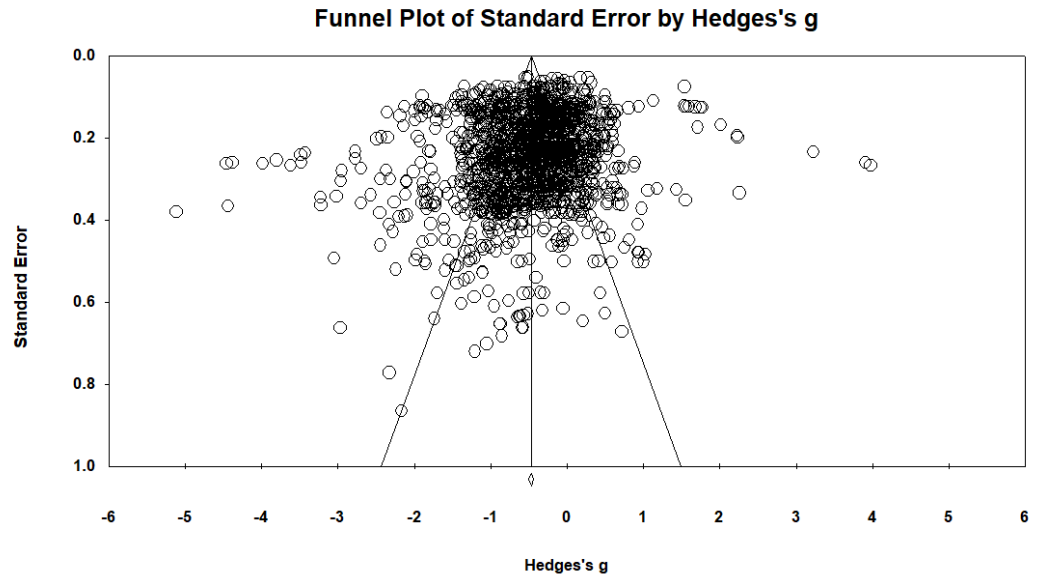

Figure 4. Funnel Plot for Overall Database

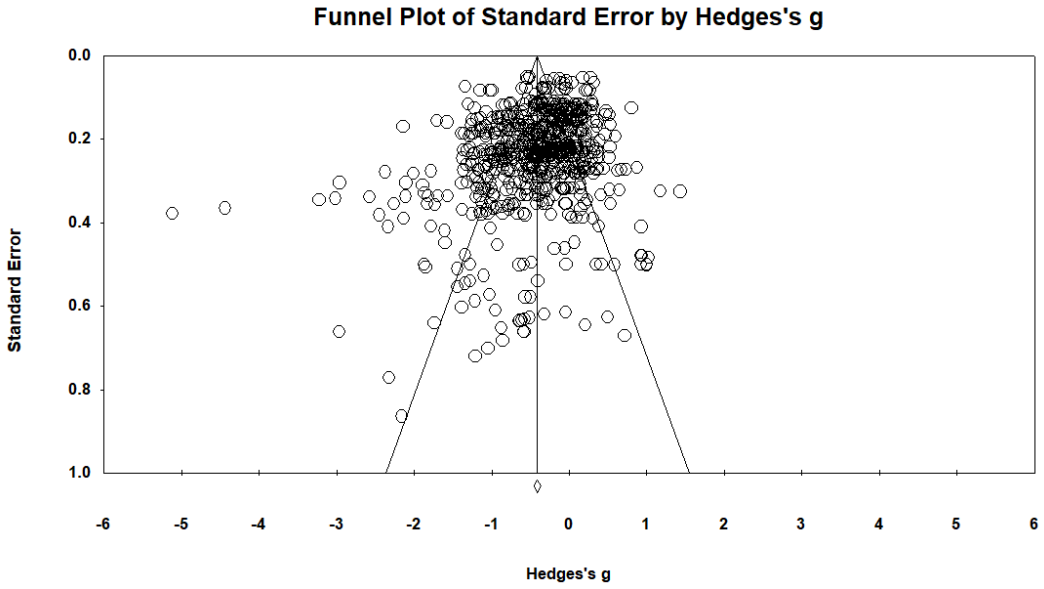

Figure 5. Funnel Plot for Cancer/Tumor Publications

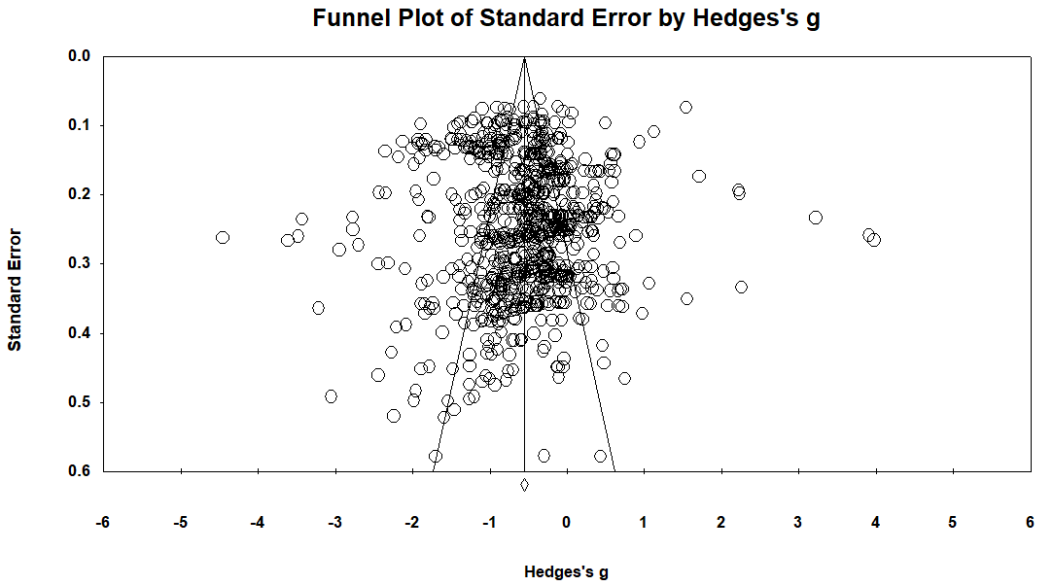

Figure 6. Funnel Plot for Epilepsy/Seizure Publications

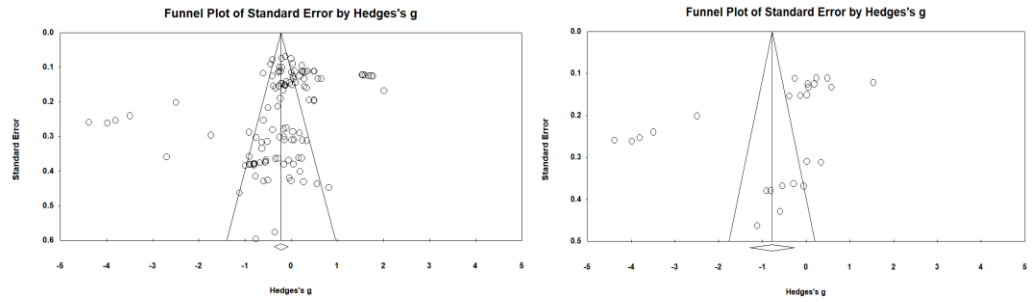

Figure 7. Funnel Plots for Diabetes Publications

Note: Plot for all diabetes comparisons on the left; plot for planning/organization comparisons on the right.

Table 1. Hedges's *g* Scores by Group and EF Skill

EF Skill	Diabetes	Cancer/Tumor	Epilepsy
Inhibition	0.008 (n = 18)	-0.176*** (n = 117)	-0.471*** (n = 194)
Attention	0.126 (n = 16)	-0.494*** (n = 113)	-0.614*** (n = 175)
Planning/Organization	-0.780** (n = 25)	-0.511*** (n = 110)	-0.461*** (n = 156)
Switching	-0.089 (n = 15)	-0.314*** (n = 118)	-0.429*** (n = 109)
Self-Monitor	0.207 (n = 6)	-0.417*** (n = 40)	-1.120*** (n = 32)
Working Memory/ Sequencing	-0.237 (n = 21)	-0.473*** (n = 170)	-0.652*** (n = 131)
Initiate	-0.296 (n = 2)	-0.509*** (n = 16)	-0.872*** (n = 10)

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; n represents number of comparisons between ill participants and controls for each skill; values based on random effects model.

Table 2. Hedges's *g* by Moderator Level

	Hedges's *g*	95% CI
Measure Type		
Performance-based (n = 1152)	-0.437***	-0.476, -0.399
Questionnaire (n = 478)	-0.554***	-0.613, -0.495
Control Type		
Included healthy controls (n = 685)	-0.427***	-0.476, -0.377
Norms-based pseudo-controls (n = 945)	-0.503***	-0.545, -0.460
Publication Format		
Journal article (n = 1453)	-0.464***	-0.499, -0.429
Thesis/Dissertation (n = 164)	-0.543***	-0.628, -0.458
Other (n = 13)	-0.667***	-0.839, -0.496

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; n represents the number of comparisons between ill participants and controls for each format; values based on random effects model.

Table 3. Hedges's *g* by Condition and Data Source

Illness Group	Performance-Based	Questionnaire
Diabetes	-0.398***	-0.135
Cancer/Tumor	-0.385***	-0.453***
Epilepsy/Seizures	-0.478***	-0.796***

Note. All *g* values are based on overall results for each medical condition group; *$p < .05$; **$p < .01$; ***$p < .001$.

Table 4. Orwin's Failsafe *N*'s by Illness Group

Illness Group	Failsafe *N**
Diabetes**	23
Cancer/Tumor	414
Epilepsy/Seizure	1,552

Note. *Calculated based on number of comparisons needed with Hedges's $g = 0$ to fall below an overall effect size of 0.2; **Calculated for the planning/organization publications only with threshold of 0.1 instead of 0.2; values based on fixed effects model.

Appendix E. List of Eligible Diabetes Articles

Berg, C. A., Hughes, A. E., King, P. S., Korbel, C., Fortenberry, K. T., Donaldson, D., . . . Wiebe, D. J. (2014). Self-control as a mediator of the link between intelligence and HbA1c during adolescence. *Children's Health Care, 43*(2), 120-131.

Berg, C. A., Wiebe, D. J., Suchy, Y., Hughes, A. E., Anderson, J. H., Godbey, E. I., . . . White, P. C. (2014). Individual differences and day-to-day fluctuations in perceived self-regulation associated with daily adherence in late adolescents with type 1 diabetes. *Journal of Pediatric Psychology, 39*(9), 1038-1048.

Bjorgaas, M., Gimse, R., Vik, T., & Sand, T. (1997). Cognitive function in Type 1 diabetic children with and without episodes of severe hypoglycaemia. *Acta Paediatrica, 86*, 148-153.

Caruso, N. C., Radovanovic, B., Kennedy, J. D., Couper, J., Kohler, M., Kavanagh, P. S., . . . Lushington, K. (2014). Sleep, executive functioning and behaviour in children and adolescents with type 1 diabetes. *Sleep Medicine, 15*(12), 1490-1499.

Conant, L. L., Wilfong, A., Inglese, C., & Schwarte, A. (2010). Dysfunction of executive and related processes in childhood absence epilepsy. *Epilepsy & Behavior, 18*(4), 414-423.

Duke, D. C., Raymond, J. K., & Harris, M. A. (2014). The Diabetes Related Executive Functioning Scale (DREFS): Pilot results. *Children's Health Care, 43*(4), 327-344.

Fitzgerald, C. J. (2013). *An examination of the role of neurocognitive functioning in illness management among adolescents with type 1 diabetes.*

Graziano, P. A., Geffken, G. R., Williams, L. B., Lewin, A. B., Duke, D. C., Storch, E. A., & Silverstein, J. H. (2011). Gender differences in the relationship between parental report of self-regulation skills and adolescents' management of type 1 diabetes. *Pediatric Diabetes, 12*(4 Pt 2), 410-418.

Hannonen, R., Tupola, S., Ahonen, T., & Riikonen, R. (2003). Neurocognitive functioning in children with type-1 diabetes with and without episodes of severe hypoglycaemia. *Developmental Medicine & Child Neurology, 45*, 262-268.

Hershey, T., Lillie, R., Sadler, M., & White, N. H. (2003). Severe hypoglycemia and long-term spatial memory in children with type 1 diabetes mellitus: A retrospective study. *Journal of the International Neuropsychological Society, 9*, 740-750.

Holmes, C. S., Dunlap, W. P., Chen, R. S., & Cornwell, J. M. (1992). Gender differences in the learning status of diabetic children. *Journal of Consulting and Clinical Psychology, 60*(5), 698-704.

Hughes, A. E., Berg, C. A., & Wiebe, D. J. (2012). Emotional processing and self-control in adolescents with type 1 diabetes. *Journal of Pediatric Psychology*, *37*(8), 925-934.

Jyothi, K., Susheela, S., Kodali, V. R. R., Balakrishnan, S., & Seshaiah, V. (1993). Poor cognitive task performance of insulin-dependent diabetic children (6-12 years) in India. *Diabetes Research and Clinical Practice, 20*, 209-213.

Mauras, N., Mazaika, P., Buckingham, B. A., Weinzimer, S., White, N. H., Tsalikian, E., . . . Reiss, A. L. (2015). Longitudinal assessment of neuroanatomical and cognitive differences in young children with type 1 diabetes: Association with hyperglycemia. *Diabetes, 64*, 1170-1779.

McNally, K., Rohan, J., Pendley, J. S., Delamater, A., & Drotar, D. (2010). Executive functioning, treatment adherence, and glycemic control in children with type 1 diabetes. *Diabetes Care, 33*(6), 1159-1162.

Northam, E., Bowden, S., Anderson, V., & Court, J. (1992). Neuropsychological functioning in adolescents with diabetes. *Journal of Clinical and Experimental Neuropsychology, 14*(6), 884-900.

Northam, E. A., Anderson, P., Werther, G. A., Adler, R. G., & Andrewes, D. (1995). Neuropsychological complications of insulin dependent diabetes in children. *Child Neuropsychology, 1*(1), 74-87.

Northam, E. A., Anderson, P. J., Jacobs, R., Hughes, M., Warne, G. L., & Werther, G. A. (2001). Neuropsychological profiles of children with type 1 diabetes 6 years after disease onset. *Diabetes Care, 24*(9), 1541-1546.

Ohmann, S., Popow, C., Rami, B., Konig, M., Blaas, S., Fliri, C., & Schober, E. (2010). Cognitive functions and glycemic control in children and adolescents with type 1 diabetes. *Psychological Medicine, 40*(1), 95-103.

Parent, K. B., Wodrich, D. L., & Hasan, K. S. (2009). Type 1 diabetes mellitus and school: A comparison of patients and healthy siblings. *Pediatric Diabetes, 10*(8), 554-562.

Perantie, D. C., Lim, A., Wu, J., Weaver, P., Warren, S. L., Sadler, M., . . . Hershey, T. (2008). Effects of prior hypoglycemia and hyperglycemia on cognition in children with type 1 diabetes mellitus. *Pediatric Diabetes, 9*(2), 87-95.

Reich, J. N., Kaspar, C., Puczynski, M. S., Puczynski, S., Cleland, J. W., Angela, K. D., & Emanuele, M. A. (1990). Effect of hypoglycemic episode on neuropsychological functioning in diabetic children. *Journal of Clinical and Experimental Neuropsychology, 12*(4), 613-626.

Rovet, J. F., Ehrlich, R. M., & Czuchta, D. (1990). Intellectual characteristics of diabetic children at diagnosis and one year later. *Journal of Pediatric Psychology, 15*(6), 775-788.

Ryan, C. M., Vega, A., Longstreet, C., & Drash, A. (1984). Neuropsychological changes in adolescents with insulin-dependent diabetes. *Journal of Consulting and Clinical Psychology, 52*(3), 335-342.

Schwartz, D. D., Axelrad, M. E., & Anderson, B. J. (2014). Neurocognitive functioning in children and adolescents at the time of type 1 diabetes diagnosis: Associations with glycemic control 1 year after diagnosis. *Diabetes Care, 37*, 2475-2482.

Semenkovich, K., Bischoff, A., Doty, T., Nelson, S., Siller, A. F., Hershey, T., & Arbelaez, A. M. (2015). Clinical presentation and memory function in youth with type 1 diabetes. *Pediatric Diabetes*.

Strudwick, S. K., Carne, C., Gardiner, J., Foster, J. K., Davis, E. A., & Jones, T. W. (2005). Cognitive functioning in children with early onset type 1 diabetes and severe hypoglycemia. *The Journal of Pediatrics, 147*(5), 680-685.

Stupiansky, N. W., Hanna, K. M., Slaven, J. E., Weaver, M. T., & Fortenberry, J. D. (2013). Impulse control, diabetes-specific self-efficacy, and diabetes management among emerging adults with type 1 diabetes. *Journal of Pediatric Psychology, 38*(3), 247-254.

Suchy, Y., Turner, S. L., Queen, T. L., Durracio, K., Wiebe, D. J., Butner, J., . . . Berg, C. A. (2016). The relation of questionnaire and performance-based measures of executive functioning with type 1 diabetes outcomes among late adolescents. *Health Psychology, 35*(7), 661-669.

Topitsch, D., Schober, E., Wurst, E., & Kryspin-Exner, I. (1998). Changes in attention with hypo- and hyperglycaemia in children with insulin dependent diabetes mellitus. *European Journal of Pediatrics, 157*(10), 802-805.

Tupola, S., Salonen, I., Hannonen, R., Verho, S., Saar, P., & Riikonen, R. (2004). Comparison of regional cerebral perfusion, EEG and cognitive functions in type 1 diabetic children with and without severe hypoglycaemia. *Eur J Pediatr, 163*(6), 335-336.

Wysocki, T., Harris, M. A., Mauras, N., Fox, L., Taylor, A., Jackson, S. C., & White, N. H. (2003). Absence of adverse effects of severe hypoglycemia on cognitive function in school-aged children with diabetes over 18 months. *Diabetes Care, 26*(4), 1100-1105.

Appendix F. List of Eligible Cancer/Tumor Articles

Aarsen, F. K., Paquier, P. F., Arts, W. F., Van Veelen, M. L., Michiels, E., Lequin, M., & Catsman-Berrevoets, C. E. (2009). Cognitive deficits and predictors 3 years after diagnosis of a pilocytic astrocytoma in childhood. *Journal of Clinical Oncology, 27*(21), 3526-3532.

Anderson, F. S., Kunin-Batson, A. S., Perkins, J. L., & Baker, K. S. (2008). White versus gray matter function as seen on neuropsychological testing following bone marrow transplant for acute leukemia in childhood. *Neuropsychiatric Disease and Treatment, 4*(1), 283-288.

Anderson, V. A., Godber, T., Smibert, E., Weiskop, S., & Ekert, H. (2004). Impairments of attention following treatment with cranial irradiation and chemotherapy in children. *Journal of Clinical and Experimental Neuropsychology, 26*(5), 684-697.

Antonini, T. N., Ris, M. D., Grosshans, D. R., Mahajan, A., Okcu, M. F., Chintagumpala, M., . . . Kahalley, L. S. (2017). Attention, processing speed, and executive functioning in pediatric brain tumor survivors treated with proton beam radiation therapy. *Radiotherapy and Oncology, 124*(1), 89-97.

Appleton, R. E., Farrell, K., Zaide, J., & Rogers, P. (1990). Decline in head growth and cognitive impairment in survivors of acute lymphoblastic leukaemia. *Archives of Disease in Childhood, 65,* 530-534.

Araujo, G. C., Antonini, T. N., Anderson, V., Vannatta, K. A., Salley, C. G., Bigler, E. D., . . . Owen Yeates, K. (2017). Profiles of executive function across children with distinct brain disorders: Traumatic brain injury, stroke, and brain tumor. *Journal of the International Neuropsychological Society, 23*(7), 529-538.

Ashford, J., Schoffstall, C., Reddick, W. E., Leone, C., Laningham, F. H., Glass, J. O., . . . Conklin, H. M. (2010). Attention and working memory abilities in children treated for acute lymphoblastic leukemia. *Cancer, 116*(19), 4638-4645.

Bava, L., Johns, A., Kayser, K., & Freyer, D. R. (2018). Cognitive outcomes among Latino survivors of childhood acute lymphoblastic leukemia and lymphoma: A cross-sectional cohort study using culturally competent, performance-based assessment. *Pediatric Blood & Cancer, 65*(2).

Briere, M. E., Scott, J. G., McNall-Knapp, R. Y., & Adams, R. L. (2008). Cognitive outcome in pediatric brain tumor survivors: Delayed attention deficit at long-term follow-up. *Pediatric Blood & Cancer, 50*(2), 337-340.

Brown, R. T., Madan-Swain, A., Pals, R., Lambert, R. G., Sexon, S., & Ragab, A. (1992). Chemotherapy for acute lymphocytic leukemia: Cognitive and academic sequelae. *The Journal of Pediatrics, 121*, 885-889.

Buizer, A. I., de Sonneville, L. M., van den Heuvel-Eibrink, M. M., & Veerman, A. J. (2005). Chemotherapy and attentional dysfunction in survivors of childhood acute lymphoblastic leukemia: Effect of treatment intensity. *Pediatric Blood & Cancer, 45*(3), 281-290.

Bull, K. S., Liossi, C., Culliford, D., Peacock, J. L., & Kennedy, C. R. (2014). Child-related characteristics predicting subsequent health-related quality of life in 8- to 14-year-old children with and without cerebellar tumors: A prospective longitudinal study. *Neuro-Oncology Practice, 1*(3), 114-122.

Bull, K. S., Liossi, C., Peacock, J. L., Yuen, H. M., & Kennedy, C. R. (2015). Screening for cognitive deficits in 8 to 14-year old children with cerebellar tumors using self-report

measures of executive and behavioral functioning and health-related quality of life. *Neuro-Oncology, 17*(12), 1628-1636.

Butler, R. W., Copeland, D. R., Fairclough, D. L., Mulhern, R. K., Katz, E. R., Kazak, A. E., . . . Sahler, O. J. (2008). A multicenter, randomized clinical trial of a cognitive remediation program for childhood survivors of a pediatric malignancy. *J Consult Clin Psychol, 76*(3), 367-378.

Butler, R. W., Hill, J. M., Steinherz, P. G., Meyers, P. A., & Finlay, J. L. (1994). Neuropsychologic effects of cranial irradiation, intrathecal methotrexate, and systemic methotrexate in childhood cancer. *Journal of Clinical Oncology, 12*(12), 2621-2629.

Callu, D., Viguier, D., Laroussinie, F., Puget, S., Boddaert, N., Kieffer, V., . . . Dellatolas, G. (2009). Cognitive and academic outcome after benign or malignant cerebellar tumor in children. *Cog Behav Neurol, 22*, 270-278.

Carey, M. E., Barakat, L. P., Foley, B., Gyato, K., & Phillips, P. C. (2001). Neuropsychological functioning and social functioning of survivors of pediatric brain tumors: Evidence of nonverbal learning disability. *Child Neuropsychology, 7*(4), 265-272.

Caron, J. E., Krull, K. R., Hockenberry, M., Jain, N., Kaemingk, K., & Moore, I. M. (2009). Oxidative stress and executive function in children receiving chemotherapy for acute lymphoblastic leukemia. *Pediatric Blood & Cancer, 53*(4), 551-556.

Cheung, Y. T., Sabin, N. D., Reddick, W. E., Bhojwani, D., Liu, W., Brinkman, T. M., . . . Krull, K. R. (2016). Leukoencephalopathy and long-term neurobehavioural, neurocognitive, and brain imaging outcomes in survivors of childhood acute lymphoblastic leukaemia treated with chemotherapy: A longitudinal analysis. *The Lancet Haematology, 3*(10), e456-e466.

Christie, D., Battin, M., Leiper, A. D., Chessells, J., Vargha-Khadem, F., & Neville, B. G. R. (1994). Neuropsychological and neurological outcome after relapse of lymphoblastic leukaemia. *Archives of Disease in Childhood, 70,* 275-280.

Christie, D., Leiper, A. D., Chessells, J. M., & Vargha-Khadem, F. (1995). Intellectual performance after presymptomatic cranial radiotherapy for leukaemia: Effects of age and sex. *Archives of Disease in Childhood, 73,* 136-140.

Conklin, H. M., Ashford, J. M., Clark, K. N., Martin-Elbahesh, K., Hardy, K. K., Merchant, T. E., . . . Zhang, H. (2017). Long-term efficacy of computerized cognitive training among survivors of childhood cancer: A single-blind randomized controlled trial. *Journal of Pediatric Psychology, 42*(2), 220-231.

Conklin, H. M., Ashford, J. M., Howarth, R. A., Merchant, T. E., Ogg, R. J., Santana, V. M., . . . Xiong, X. (2012). Working memory performance among childhood brain tumor survivors. *Journal of the International Neuropsychological Society, 18*(6), 996-1005.

Conklin, H. M., Krull, K. R., Reddick, W. E., Pei, D., Cheng, C., & Pui, C. H. (2012). Cognitive outcomes following contemporary treatment without cranial irradiation for childhood acute lymphoblastic leukemia. *Journal of the National Cancer Institute, 104*(18), 1386-1395.

Conklin, H. M., Ogg, R. J., Ashford, J. M., Scoggins, M. A., Zou, P., Clark, K. N., . . . Zhang, H. (2015). Computerized cognitive training for amelioration of cognitive late effects among childhood cancer survivors: A randomized controlled trial. *Journal of Clinical Oncology, 33*, 3894-3902.

Copeland, D. R., Dowell, R. E., Fletcher, J. M., Sullivan, M. P., Jaffe, N., Cangir, A., . . . Judd, B. W. (1988). Neuropsychological test performance of pediatric cancer patients at diagnosis and one year later. *Journal of Pediatric Psychology, 13*(2), 183-196.

Copeland, D. R., Fletcher, J. M., Pfefferbaum-Levine, B., Jaffe, N., Ried, H., & Maor, M. (1985). Neuropsychological sequelae of childhood cancer in long-term survivors. *Pediatrics, 75*, 745-753.

Cousens, P., Ungerer, J. A., Crawford, J. A., & Stevens, M. M. (1991). Cognitive effects of childhood leukemia therapy: A case for four specific deficits. *Journal of Pediatric Psychology, 16*(4), 475-488.

de Ruiter, M. A. (2016). Impact of a pediatric brain tumor: Research into neurocognitive late effects and psychosocial consequences and the evaluation of a potential intervention.

de Ruiter, M. A., Grootenhuis, M. A., van Mourik, R., Maurice-Stam, H., Breteler, M. H., Gidding, C., . . . Oosterlaan, J. (2015). Timed performance weaknesses on computerized tasks in pediatric brain tumor survivors: A comparison with sibling controls. *Child Neuropsychology, 23*(2), 208-227. doi:10.1080/09297049.2015.1108395

de Ruiter, M. A., Oosterlaan, J., Schouten-van Meeteren, A. Y., Maurice-Stam, H., van Vuurden, D. G., Gidding, C., . . . Grootenhuis, M. A. (2016). Neurofeedback ineffective in paediatric brain tumour survivors: Results of a double-blind randomised placebo-controlled trial. *European Journal of Cancer, 64*, 62-73.

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Appendix G. List of Eligible Epilepsy/Seizure Articles

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Berl, M. M., Terwilliger, V., Scheller, A., Sepeta, L., Walkowiak, J., & Gaillard, W. D. (2015). Speed and complexity characterize attention problems in children with localization-related epilepsy. *Epilepsia, 56*(6), 833-840.

Bhise, V. V., Burack, G. D., & Mandelbaum, D. E. (2010). Baseline cognition, behavior, and motor skills in children with new-onset, idiopathic epilepsy. *Developmental Medicine & Child Neurology, 52*(1), 22-26.

Bioh, R. (2015). *Neuropsychological deficits in children with seizure disorders in Ghana: A study at Korle-Bu teaching hospital.*

Bolender, V. (2008). *New onset benign rolandic epilepsy: An integrated examination of cognition, behavioral adjustment, MRI volumes, and clinical seizure correlates.*

Bongiolatti, S. R. (2008). *Attention and learning in children with epilepsy and co-morbid sleep disturbance.*

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Appendix H. List of Articles, Measures, and *g* Values

Study	n	M_{age}	$\%_{Female}$	$\%_{Minority}$	Measures	*g*
Diabetes						
Berg, Hughes, et al. (2014)	252	12.49	54	6	Brief Self-Control Scale[1]	-0.124
Berg, Wiebe, et al. (2014)	110	17.78	62	16	Behavior Rating Inventory of Executive Function (BRIEF)[2]	-0.229
Bjorgaas et al. (1997)	56	-	-	-	Trail Making Test, Part B (TMT-B)[3]	0.104
					Children's Checking Task Test (CCTT)[4]	
Caruso et al. (2014)	85	11.66	46	0	BRIEF[2]	-0.321
Conant et al. (2010)	45	8.39	71	4	Tower of London (ToL)[5]	-0.266
					Wisconsin Card Sorting Task (WCST)[6]	
					Gordon Diagnostic System (GDS)[7]	
					Child Behavior Checklist (CBCL)[8]	
Duke et al. (2014)	50	15.10	-	-	BRIEF[2]	0.838
Fitzgerald (2013)	84	14.27	46	13	BRIEF[2]	-0.026
					WCST[6]	
					Delis-Kaplan Executive Functioning System (D-KEFS)[9]	
Graziano et al. (2011)	109	15.23	54	28	BRIEF[2]	1.646
Hannonen et al. (2003)	31	9.33	55	-	NEPSY[10]	-0.310
Hershey et al. (2003)	82	11.62	-	-	Sustain[11]	-0.064
Holmes et al. (1992)	192	12.60	55	0	Wechsler Intelligence Scale for Children – Revised (WISC-R)[12]	-0.005

Hughes et al. (2012)	137	13.48	54	5	Self-Control Scale[1]	0.036
Jyothi et al. (1993)	61	-	48	-	Leiter[13]	-2.697
Mauras et al. (2015)	216	6.97	46	17	BRIEF[2]	-0.207
McNally et al. (2010)	235	10.54	54	-	BRIEF[2]	-0.206
Northam et al. (1992)	85	15.50	53	-	WISC-R[12]	-0.632
					WCST[6]	
					Rey-Osterrieth Complex Figure Test (ROCFT)[14]	
Northam et al. (1995)	253	8.94	50	-	WISC-R[12]	-0.060
					ROCFT[14]	
Northam et al. (2001)	174	-	-	-	ToL[5]	-3.314
					Contingency Naming Test (CNT)[15]	
					Rey Auditory Verbal Learning Test (RAVLT)[16]	
					Test of Language Competence[17]	
Ohmann et al. (2010)	90	14.85	53	-	Wechsler Intelligence Scale for Children – 3rd Edition (WISC-III)[18]	-0.384
					Stroop Color-Word Task (S-CWT)[19]	
Parent et al. (2009)	190	11.95	52	23	ADHD Rating Scale – 4th Edition (ADHD-RS-IV)[20]	-0.230
Perantie et al. (2008)	175	11.87	46	-	Go/No-Go (GNG)[21]	0.098
Reich et al. (1990)	38	11.21	55	-	TMT[3]	-0.490
					WISC-R[12]	
Rovet et al. (1990)	103	7.65	-	-	WISC-R[12]	-0.600
Ryan et al. (1984)	80	15.50	53	0	WISC-R[12]	-0.327

					Wechsler Adult Intelligence Scale (WAIS)[22]	
Schwartz et al. (2014)	147	10.40	54	39	TMT[3]	-0.137
					Wechsler Intelligence Scale for Children – 4th Edition (WISC-IV)[23]	
					Wechsler Adult Intelligence Scale – 4th Edition (WAIS-IV)[24]	
Semenkovich et al. (2015)	99	11.90	44	-	GNG[21]	-0.287
Strudwick et al. (2005)	84	10.15	51	-	Children's Memory Scale (CMS)[25]	0.312
Stupiansky et al. (2013)	204	18.25	56	7	Self-Regulation Questionnaire (SRQ)[26]	0.239
Suchy et al. (2016)	196	17.74	64	12	BRIEF[2]	-0.260
					D-KEFS[9]	
Topitsch et al. (1998)	38	12.30	42	-	Test of Variables of Attention (TOVA™)[27]	-0.167
Tupola et al. (2004)	20	-	-	-	WISC-R[12]	-0.699
Wysocki et al. (2003)	142	11.60	44	14	Das-Naglieri Cognitive Assessment System (DN-CAS)[28]	0.395
Cancer/Tumor						
Aarsen et al. (2009)	61	11.00	54	-	TMT[3]	-0.450
					WCST[6]	
					ROCFT[14]	
Anderson et al. (2008)	36	-	-	-	Conners' Continuous Performance Test – 2nd Edition (CPT-II)[29]	-0.348
Anderson et al. (2004)	89	13.30	48	-	TMT[3]	-0.356

					CNT[15] Continuous Performance Task (CPTa)[30]	
Antonini et al. (2017)	39	13.28	36	36	CPT-II[29] D-KEFS[9]	-0.130
Appleton et al. (1990)	25	11.00	52	24	WISC-R[12]	-0.713
Araujo et al. (2017)	335	11.05	41	12	Test of Everyday Attention for Children (TEA-Ch)[31]	-0.206
Ashford et al. (2010)	97	10.84	43	27	WISC-III[18]	-1.408
Bava et al. (2018)	62	10.80	50	100	Conners' Continuous Performance Test – 3rd Edition (CPT-3)[32] D-KEFS[9] BRIEF[2] Behavior Assessment System for Children – 2nd Edition (BASC-2)[33]	-0.014
Briere et al. (2008)	18	-	33	-	WISC-III[18]	-0.923
Brown et al. (1992)	48	8.22	42	23	Detroit Test of Learning Aptitude – 2nd Edition (DTLA-2)[34]	-0.430
Buizer et al. (2005)	185	10.84	51	-	Amsterdam Neuropsychological Tasks (ANTa)[35]	-0.380
Bull et al. (2014)	110	10.30	53	-	BRIEF[2]	-0.411
Bull et al. (2015)	104	10.34	53	-	BRIEF[2]	-0.529
Butler et al. (2008)	161	-	35	36	WISC-III[18] CPT-II[29]	-0.621
Butler et al. (1994)	120	12.76	-	-	WCST[6]	-0.115
Callu et al. (2009)	39	8.84	49	-	WISC-III[18] ROCFT[14]	-0.801

Carey et al. (2001)	15	10.31	40	13	NEPSY[10]	-0.665
Caron et al. (2009)	88	-	59	-	BRIEF[2]	-0.072
					Behavior Assessment System for Children (BASC)[36]	
Cheung et al. (2016)	190	12.86	49	26	BRIEF[2]	-0.167
					D-KEFS[9]	
					WISC-IV[23]	
					ROCFT[14]	
					CPT-3[32]	
Christie et al. (1994)	14	13.28	29	-	WISC-R[12]	-1.065
Christie et al. (1995)	82	11.34	43	-	WISC-R[12]	-0.402
Conklin et al. (2017)	68	12.02	47	22	WISC-IV[23]	-0.539
					BRIEF[2]	
					CPT-II[29]	
					Conners' Rating Scales – 3rd Edition (Conners 3)[37]	
Conklin, Ashford, et al. (2012)	130	13.11	50	6	WISC-IV[23]	-0.190
					BRIEF[2]	
					Self-Ordered Search (SOS)[38]	
Conklin, Krull, et al. (2012)	156	-	46	20	Conners' Continuous Performance Task (CPTb)[39]	-1.008
Conklin et al. (2015)	68	12.02	47	22	WISC-IV [23]	-0.613
					BRIEF[2]	
					CPT-II[29]	
					Conners 3[37]	
Copeland et al. (1988)	38	10.31	50	45	TMT[3]	-0.472

Copeland et al. (1985)	49	12.70	53	40	TMT[3]	-0.528
Cousens et al. (1991)	43	9.37	53	-	WISC-R[12]	-0.442
de Ruiter (2016)	125	13.99	54	-	BRIEF[2]	-0.285
de Ruiter et al. (2015)	125	13.99	54	-	WISC-III[18]	-0.193
					Wechsler Adult Intelligence Scale – 3rd Edition (WAIS-III)[40]	
					Stop Signal Task (SSTa)[41]	
					Attention Network Task (ANTb)[42]	
de Ruiter et al. (2016)	71	13.93	51	-	BRIEF[2]	-0.183
De Smet et al. (2009)	8	9.75	25	-	WISC-III[18]	-0.576
					WCST[6]	
Delone (2014)	79	5.76	48	28	Silly Sounds Task (SSTb)[43]	-0.035
Desjardins et al. (2017)	32	10.79	38	41	WISC-IV[23]	-0.584
					BRIEF[2]	
					CBCL[8]	
ElAlfy et al. (2014)	122	10.47	48	-	TMT[3]	-1.016
Faber et al. (2014)	11	10.65	73	-	WCST[6]	-0.550
					Comprehensive Trail-Making Test (CTMT)[44]	
FitzGerald (2007)	26	13.03	58	0	BRIEF[2]	-0.532
					WAIS-III[40]	
					WISC-IV[23]	
Garcia-Perez et al. (1993)	50	-	-	-	ROCFT[14]	-0.295
Garrison (2012)	19	14.66	26	21	BRIEF[2]	-0.793
					D-KEFS[9]	
Giralt et al. (1992)	100	11.19	40	-	Sorting Task[45]	-0.428

Gomes et al. (2012)	20	8.45	70	-	WISC-III[18]	-0.971
					WCST[6]	
Gordon (2016)	32	11.25	-	-	TOVA™; [27]	-0.144
					ROCFT[14]	
					BRIEF[2]	
Grill et al. (1999)	31	11.40	23	-	WISC-III[18]	-1.137
Hardy et al. (2008)	35	11.67	43	14	WISC-III[18]	-0.714
Hardy et al. (2013)	20	12.00	40	-	Conners 3[37]	-0.731
					Wide Range Assessment of Memory and Learning – 2nd Edition (WRAML-2)[46]	
Hardy et al. (2011)	9	13.30	44	-	WISC-IV[23]	-0.484
Hardy et al. (2015)	70	11.55	44	16	WISC-IV[23]	-0.311
Hazin et al. (2010)	20	10.20	55	-	WISC-III[18]	-0.475
Hile (2012)	50	12.00	44	68	WISC-IV[23]	-0.409
					TMT[3]	
Hile (2015)	61	10.72	64	75	National Institutes of Health Executive Abilities Measures and Instruments for Neurobehavioral Evaluation and Research (NIH EXAMINER)[47]	0.334
Irestorm et al. (2018)	101	9.40	46	-	NEPSY[10]	-0.302
					WISC-IV[23]	
					WAIS-IV[24]	
					Wechsler Preschool and Primary Scale of Intelligence – 4th Edition (WPPSI-IV)[48]	
Irish (2015)	44	11.90	52	68	BRIEF[2]	-0.169

					California Verbal Learning Test – Children's Version (CVLT-C)[49]	
Iuvone et al. (2011)	83	8.60	36	-	ROCFT[14]	-0.569
					ToL[5]	
Jacola et al. (2014)	50	13.14	50	8	WISC-III[18]	-0.177
					WISC-IV[23]	
					BRIEF[2]	
					Wechsler Abbreviated Scale of Intelligence (WASI)[50]	
Jain et al. (2009)	103	11.43	49	-	TMT[3]	-0.427
					GDS[7]	
					WISC-III[18]	
Jain et al. (1993)	55	9.30	31	-	Malin's Intelligence Scale for Indian Children (MISIC)[51]	-1.385
Jansen et al. (2005)	79	-	48	-	WCST[6]	0.083
					ROCFT[14]	
					Bourdon-Vos Test[52]	
Judd-Glossy (2013)	11	-	18	37	BRIEF[2]	-0.673
Kadan-Lottick et al. (2009)	92	-	45	16	CPT-II[29]	0.274
					WISC-IV[23]	
Kaemingk et al. (2004)	30	12.30	40	-	WISC-III[18]	-0.774
Kahalley et al. (2011)	100	15.00	50	15	CPT-II[29]	-0.186
					Conners 3[37]	
Kahalley et al. (2016)	57	12.50	30	49	WISC-IV[23]	-0.685
Kamdar et al. (2011)	72	12.10	33	42	DIgit span, VERbal fluency, Grooved pegboard, Trail making test (DIVERGT)[53]	-0.044

Kesler et al. (2016)	70	11.56	46	49	WISC-IV[23]	-0.320
Kesler et al. (2010)	59	12.16	46	31	WISC-IV[23]	-0.544
					Wechsler Preschool and Primary Scale of Intelligence – 3rd Edition (WPPSI-III)[54]	
					Children's Category Test (CCT)[55]	
					Woodcock-Johnson Tests of Cognitive Abilities – 3rd Edition (WJ-CA-III)[56]	
Kim et al. (2015)	84	10.50	40	-	S-CWT[19]	-0.238
					Korean Educational Development Institute – Wechsler Intelligence Scale (KEDI-WISC)[57]	
					Children's Color Trails Test (CCTT)[58]	
					Attention Deficit Hyperactivity Disorder Diagnostic System (ADS)[59]	
Kingma et al. (1993)	35	11.40	46	-	WISC-R[12]	-1.137
Kobritz	32	10.80	35	38	WISC-IV[23]	-0.511
					BRIEF[2]	
					CBCL[8]	
Krull et al. (2016)	408	13.80	49	26	D-KEFS[9]	-0.189
					WASI[50]	
					ROCFT[14]	
					CPT-II[29]	
Krull et al. (2008)	240	12.60	40	43	DIVERGT[53]	-0.186
Kunin-Batson et al. (2014)	263	13.10	46	19	WISC-IV[23]	-0.086
					CPT-II[29]	

Lacaze et al. (2003)	21	-	59	-	WISC-III[18]	-0.067
Laffond et al. (2012)	29	-	48	-	BRIEF[2]	-0.223
Law et al. (2011)	67	10.93	51	-	WISC-IV[23]	-0.766
Lesnik et al. (1998)	20	-	60	-	TMT[3]	-1.121
					ROCFT[14]	
Levisohn et al. (2000)	19	10.00	-	-	WISC-R[12]	-0.360
					WISC-III[18]	
					Wechsler Preschool and Primary Scales of Intelligence – Revised (WPPSI-R)[60]	
Liu et al. (2015)	64	13.15	47	-	WISC-IV[23]	-1.081
Livesay (2008)	15	14.29	-	25	BRIEF[2]	-0.959
					WISC-IV[23]	
					D-KEFS[9]	
Lockwood et al. (1999)	28	12.02	32	54	ROCFT[14]	-0.116
					CVLT-C[49]	
					TMT[3]	
					WCST[6]	
					WISC-III[18]	
					TOVA™; [27]	
Lofstad et al. (2009)	70	11.55	51	-	WISC-III[18]	-0.234
Mabbott et al. (2008)	70	11.31	-	-	CPT-II[29]	-0.202
					WISC-III[18]	
					WJ-CA-III[56]	
Moore et al. (1994)	14	10.18	43	29	WISC-III[18]	0.200
Moyer et al. (2012)	469	12.10	44	15	Conners' Rating Scales – Revised (Conners-R)[61]	-0.527
Mulhern et al. (1987)	40	-	50	-	WISC-R[12]	-0.865

Mulhern et al. (1988)	40	10.65	58	-	CBCL[8]	-0.853
Mulhern et al. (2004)	37	-	46	-	CPTb[39]	-0.598
Nassar et al. (2017)	57	8.26	32	26	CPT-II[29]	-0.846
					Conners-R[61]	
Nelson (2012)	17	8.91	41	65	BASC-2[33]	-0.123
Ottensmeier et al. (2015)	57	-	39	-	CPTa[30]	-1.562
Patel et al. (2009)	12	11.75	50	67	CPTb[39]	-0.786
					WISC-III[18]	
					CVLT-C[49]	
Patel et al. (2011)	70	11.19	-	-	TMT[3]	-0.072
					WISC-III[18]	
Perez (2008)	20	12.84	45	60	D-KEFS[9]	-0.407
					WCST[6]	
					WISC-IV[23]	
					BRIEF[2]	
					BASC-2[33]	
Peterson (2017)	39	9.61	38	-	WISC-IV[23]	-0.057
Poggi et al. (2005)	76	11.90	38	-	CBCL[8]	-0.855
Prince (2014)	37	12.70	57	-	TEA-Ch[31]	-0.820
					WISC-IV[23]	
					TMT[3]	
					BRIEF[2]	
Quillen et al. (2011)	20	12.53	35	-	WISC-IV[23]	-0.225
Raghubar et al. (2017)	27	12.35	22	-	WISC-IV[23]	-0.104
Raiker et al. (2015)	77	11.40	47	45	WISC-IV[23]	-0.411
Raymond-Speden et al. (2000)	62	10.87	40	-	WISC-R[12]	-0.863
Reddick et al. (2006)	112	10.13	44	8	CPTb[39]	-1.066
Reddick et al. (2014)	450	-	45	-	CPTb[39]	0.013

Reeves et al. (2006)	38	10.31	40	24	CVLT-C[49]	-0.716
					CPTb[39]	
Reinfjell et al. (2007)	82	11.80	51	-	WISC-III[18]	-0.988
Riva et al. (2002)	42	-	-	-	WISC-R[12]	-0.939
					TMT[3]	
Riva et al. (2009)	8	7.44	-	-	WISC-R[12]	-0.145
					TMT[3]	
Robinson et al. (2010)	15	14.29	53	-	D-KEFS[9]	-1.241
					WISC-IV[23]	
Robinson et al. (2014)	32	12.74	59	19	BRIEF[2]	-0.890
					WISC-IV[23]	
					D-KEFS[9]	
					n-back[62]	
Ross et al. (2013)	9	-	44	-	ROCFT[14]	0.713
					D-KEFS[9]	
					BRIEF[2]	
Said et al. (1989)	151	10.07	41	-	WISC-R[12]	-0.545
					ROCFT[14]	
					TMT[3]	
Saury & Emanuelson (2011)	8	10.60	-	-	WISC-III[18]	-1.730
Scott et al. (2001)	7	7.01	29	-	WISC-III[18]	-1.132
Shortman et al. (2014)	68	-	51	-	TEA-Ch[31]	-0.413
Stargatt et al. (2007)	35	9.47	60	-	CPTb[39]	-0.390
Taylor et al. (2007)	20	13.20	50	35	Conners-R[61]	-0.809
Thigpen et al. (2016)	49	7.92	41	-	BRIEF[2]	-0.538
Thompson et al. (2001)	32	-	50	-	CPTb[39]	-0.888
Vaquero et al. (2008)	33	11.94	61	-	WCST[6]	-0.244
					ROCFT[14]	

					WISC-R[12]	
					S-CWT[19]	
Varela et al. (2011)	32	9.56	44	-	CBCL[8]	-0.872
Ventura et al. (2017)	65	12.40	56	8	WISC-IV[23]	0.298
					CPT-II[29]	
					BASC-2[33]	
					BRIEF[2]	
Waber et al. (1994)	51	-	-	-	ROCFT[14]	-1.103
Waber et al. (1992)	51	-	-	-	WISC-R[12]	-0.524
Whitaker (2015)	20	13.99	35	100	ROCFT[14]	-0.950
					D-KEFS[9]	
Willard et al. (2016)	80	15.00	49	15	Conners-3[37]	-0.196
					CPT-II[29]	
Willard et al. (2017)	98	5.17	46	33	WPPSI-IV[48]	-0.809
					Stanford-Binet Intelligence Scales – 5th Edition (SB-5)[63]	
Wochos et al. (2014)	62	12.02	52	-	BRIEF[2]	-0.444
Wolfe et al. (2013)	24	-	54	17	BRIEF[2]	-0.306
					Tasks of Executive Control (TEC)[64]	
Wymer	40	12.28	48	25	BRIEF[2]	-0.778
					D-KEFS[9]	
					n-back[62]	
Zou et al. (2012)	14	12.02	-	-	Conners-R[61]	-1.812
Epilepsy/Seizure						
Aldenkamp & Arends (2004)	152	10.08	43	-	FePsy[65]	-0.454
Aldenkamp et al. (1993)	166	12.70	43	-	FePsy[65]	-0.168
Aldenkamp et al. (2000)	90	9.33	49	-	FePsy[65]	-0.320

Ay et al. (2009)	51	10.02	-	-	S-CWT	-0.462
					Dichotic Listening Test [66]	
Ayaz et al. (2013)	62	10.17	42	-	WISC-R[12]	-0.077
					WCST[6]	
					S-CWT[19]	
Baglietto et al. (2001)	18	-	44	-	TMT[3]	-0.799
					S-CWT[19]	
					WISC-R[12]	
					Corsi's Block Tapping Test (Corsi)[67]	
Banaskiwitz et al. (2017)	58	10.30	45	-	ToL	-0.207
					S-CWT	
					Modified Card Sorting Task (MCST)[68]	
Bawden et al. (1999)	41	10.21	44	-	WISC-R[12]	-0.436
Bechtel et al. (2012)	32	11.52	0	-	Conners-R[61]	-2.441
Bender (2007)	60	11.91	63	23	ROCFT[14]	-1.096
					TMT[3]	
					WASI[50]	
					WISC-III[18]	
					WISC-IV[23]	
Bender et al. (2007)	19	-	42	-	NEPSY[10]	-0.724
Berg et al. (2008)	286	15.30	53	-	CPT-II[29]	-0.114
Berl et al. (2015)	150	10.11	50	-	TEA-Ch[31]	-0.332
Bhise et al. (2010)	57	10.08	74	-	TOVA™; [27]	-0.788
					TMT[3]	
Bioh (2015)	72	11.75	44	-	WISC-IV[23]	0.941
Bolender (2008)	30	10.35	40	-	BRIEF[2]	-0.558

Bongiolatti (2008)	19	9.85	58	16	TEA-Ch[31] CPT-II[29] TMT[3]	-0.412
Bonilha et al (2014)	39	13.17	51	-	D-KEFS[9]	-0.213
Borgatti et al. (2004)	19	10.30	37	-	CPTb[39]	-0.321
Braakman et al. (2012)	71	10.75	35	-	FePsy[65] ROCFT[14]	-1.001
Braakman et al. (2015)	75	10.77	48	-	WISC-III[18] S-CWT[19]	-0.637
Byars et al (2007)	249	9.60	51	18	WCST[6]	0.062
Campiglia et al. (2014)	53	11.85	47	-	BRIEF[2]	-0.488
Cerminara et al. (2013)	48	-	50	-	A Computerized Assessment of Attention Deficits[69]	-0.387
Cerminara et al. (2010)	42	9.86	43	-	A Computerized Assessment of Attention Deficits[69]	-0.532
Chambers et al. (2014)	66	9.55	33	-	NEPSY[10] WISC-R[12] TEA-Ch[31] Corsi[67]	-0.098
Chang et al. (2000)	174	7.10	42	-	Taiwanese Computerized Non-Verbal Assessment of Attention in Children[70]	0.650
Cheng et al. (2017)	154	9.61	53	-	WCST[6]	-0.934
Conant et al. (2010)	45	8.39	71	4	ToL[5] WCST[6] GDS[7] CBCL[8]	-0.266
Costa et al. (2015)	73	11.30	39	-	WISC-III[18]	-0.031

					Test of Visual Attention (TAVIS)[71]	
					Swanson, Nolan, Pelham Questionnaire – 4th Edition (SNAP-IV)[72]	
Coulehan (2015)	70	10.37	47	22	WISC-IV[23]	-0.814
					TMT[3]	
					ToL[5]	
					CPT-II[29]	
					BRIEF[2]	
Croona et al. (1999)	34	12.50	-	-	TMT[3]	-0.723
					ROCFT[14]	
					ToL[5]	
Culhane-Shelburne et al. (2002)	27	12.28	44	30	TOVA™; [27]	-2.203
Cunningham (2008)	271	9.70	52	16	WCST[6]	-0.050
D'Agati et al. (2012)	30	11.05	47	-	ToL[5]	-0.746
					WISC-III[18]	
					TMT[3]	
					Corsi[67]	
D'Alessandro et al. (1990)	53	-	-	-	TMT[3]	-1.410
					S-CWT[19]	
Danielsson & Petermann (2009)	50	5.10	56	-	Kindergarten Non-Verbal Assessment Battery (KET-KID)[73]	-0.067
Datta et al. (2013)	46	10.31	41	-	WISC-IV[23]	0.064
					Corsi[67]	
Deltour, Barathon, et al. (2007)	54	9.27	33	-	Attentional Capture Task (ACT)*	-0.218
Deltour, Quaglino, et al. (2007)	29	8.70	55	-	CPT-II[29]	-0.431
Drewel et al. (2009)	173	11.74	49	9	CCT[55]	-0.431

Ekinci et al. (2017)	87	10.56	40	-	Conners-R[61]	0.144
					Turgay DSM-IV Disruptive Behavior Disorders Rating Scale (T-DSM-IV-S)[74]	
Ewen et al. (2011)	6	10.30	50	-	TOVA™; [27]	-0.668
					ROCFT[14]	
Fay-McClymont et al. (2012)	13	-	54	-	BRIEF[2]	-1.555
					ROCFT[14]	
Felix (2009)	60	11.92	42	48	WISC-IV[23]	-1.243
					BRIEF[2]	
					D-KEFS[9]	
					NEPSY[10]	
Filippini et al. (2016)	30	9.00	47	-	ROCFT[14]	-0.642
					Five Point Task[75]	
					Alpha Span Task[75]	
Gascoigne et al. (2017)	101	11.63	53	-	TEA-Ch[31]	-0.451
					CBCL[8]	
Gelziniene et al. (2011)	118	15.50	60	-	TMT[3]	-0.380
					S-CWT[19]	
Gencpinar et al. (2016)	38	11.71	39	-	WCST[6]	-0.495
					S-CWT[19]	
Goldberg-Stern et al. (2010)	51	10.02	-	-	WISC-R[12]	-0.429
					ROCFT[14]	
					Corsi[67]	
Gonzalez-Garrido et al. (2000)	78	10.29	-	-	Continuous Performance Task*	-1.001
Granader (2012)	122	11.20	48	-	BRIEF[2]	-0.759
Griffiths et al. (2006)	289	-	-	-	CVLT-C[49]	1.537

Guimaraes et al. (2007)	50	-	-	-	WISC-III[18]	-0.674
					WCST[6]	
					TMT[3]	
Gulgonen et al. (2000)	42	9.90	36	-	WISC-R[12]	-0.480
					CCT[55]	
Henkin et al. (2005)	44	14.37	59	-	WISC-R[12]	-0.419
					ROCFT[14]	
Hermann et al. (2006)	103	12.70	48	-	D-KEFS[9]	-0.341
					CPTb[39]	
Hernandez et al. (2003)	32	11.57	38	-	WISC-III[18]	-1.368
					ROCFT[14]	
Hernandez et al. (2002)	32	11.57	38	-	WCST[6]	-0.370
					ToL[5]	
Hochsztein (2014)	80	12.38	46	31	ToL[5]	-0.955
					BRIEF[2]	
Hoie et al. (2006)	272	10.25	41	-	WCST[6]	0.014
Holtmann et al. (2006)	32	9.55	13	-	CBCL[8]	-0.791
					S-CWT[19]	
					Continuous Performance Task*	
Hrabok et al. (2014)	104	10.88	48	30	WISC-IV[23]	-1.459
Hwang et al. (2015)	33	8.20	42	-	CBCL[8]	0.258
					WCST[6]	
Igarashi et al. (2002)	7	13.70	29	-	WCST[6]	-0.837
Japaridze et al. (2014)	33	12.66	36	-	TMT[3]	-0.639
Kang et al. (2015)	149	10.00	49	-	Comprehensive Attention Test (CAT)[76]	-0.251
Kavanaugh et al. (2015)	152	10.69	54	37	BRIEF[2]	-0.982
Kernan et al. (2012)	133	9.77	51	52	S-CWT[19]	-0.298

					WCST[6]	
					WISC-III[18]	
Kerr & Fayed (2017)	76	10.90	-	-	TEA-Ch[31]	-1.375
					WISC-IV Integrated[77]	
					Attentional Capacity Test (ACT)[78]	
Killory et al. (2011)	48	12.00	58	-	CPTb[39]	-0.541
Kim et al. (2014)	44	10.53	43	-	WISC-III[18]	-0.540
					TMT[3]	
					S-CWT[19]	
Kolk et al. (2001)	44	6.57	50	-	NEPSY[10]	-0.910
Koop et al. (2005)	95	10.41	48	6	CPTb[39]	0.780
					ACT[78]	
Kral et al. (2016)	204	11.23	47	-	WISC-IV[23]	-1.192
					WAIS-IV[24]	
					CPT-II[29]	
					BASC-2[33]	
					BRIEF[2]	
Kral et al. (2017)	20	8.26	50	-	Conners 3[37]	-2.996
Lee et al. (2018)	40	7.70	75	-	Advanced Test of Attention (ATA)[79]	-0.535
					ADHD Rating Scale (ARS)[20]	
Lee et al. (2015)	55	10.77	47	-	WISC-III[18]	-0.318
					S-CWT[19]	
					TMT[3]	
Levan (2015)	28	11.79	50	36	BRIEF[2]	-1.172
Lima et al. (2014)	62	10.40	-	-	WISC-III[18]	-0.246
					WCST[6]	

Lima et al. (2017)	60	11.52	58	-	WISC-III[18] WISC-IV[23] TMT[3] WCST[6]	-0.383
Lin et al. (2012)	67	12.62	52	-	D-KEFS[9] BRIEF[2]	-0.722
Liu et al. (2011)	122	10.18	38	-	WISC-III[18] CPT-II[29]	-0.182
Lopes et al. (2013)	120	9.99	53	-	WISC-III[18]	-1.029
Lordo et al. (2017)	207	10.60	45	19	BASC-2[33] Children's Memory Scale (CMS)[80]	-0.789
Love et al. (2016)	54	11.59	48	30	BRIEF[2] WISC-IV[23] Wechsler Abbreviated Scale of Intelligence – 2nd Edition (WASI-II)[81]	-0.928
Lundmark (2010)	42	12.65	57	-	BRIEF[2]	-0.577
Luton et al. (2010)	40	12.55	35	42	D-KEFS[9] BRIEF[2]	-1.443
MacAllister et al. (2012)	90	12.36	46	-	ToL[5] BRIEF[2]	-0.831
Mankinen et al. (2014)	42	11.70	52	-	WISC-III[18]	0.000
Masur et al. (2013)	446	-	-	-	WISC-IV[23] WCST[6]	-0.339
Modi et al. (2017)	11	15.17	73	-	BRIEF[2]	-0.262
Modi et al. (2018)	38	15.30	71	13	BRIEF[2] D-KEFS[9] TEA-CH[31]	-0.013

					CBCL[8]	
					WAIS-IV[24]	
					Wechsler Intelligence Scale for Childre – 5th Edition (WISC-V)[82]	
					National Institutes of Health Toolbox (NIH Toolbox)[83]	
Myatchin & Lagae (2011)	62	9.90	-	-	Backmatching*	-0.286
Neri et al. (2012)	53	10.69	43	-	WCST[6]	-0.909
Nicolai et al. (2012)	229	10.11	45	-	FePsy[65]	-0.365
Nissenkorn et al. (2017)	34	6.24	59	-	WISC-IV[23]	-0.124
					CPT-II[29]	
Northcott et al. (2005)	42	8.50	38	-	WISC-III[18]	-0.336
					ROCFT[14]	
					TMT[3]	
					Wide Range Assessment of Memory and Learning (WRAML)[84]	
Ofer et al. (2018)	10	9.76	40	-	WISC-IV[23]	0.325
O'Leary et al. (1983)	106	12.44	-	-	CCT[55]	0.048
					TMT[3]	
Oostrom et al. (2002)	99	10.00	-	-	CCTT[58]	-0.171
Papazoglou (2009)	62	11.64	-	-	BRIEF[2]	-0.723
Parisi et al. (2012)	32	11.60	44	-	WISC-III[18]	-1.069
					NEPSY – 2nd Edition (NEPSY-2)[85]	
Parrish et al. (2007)	103	12.70	48	-	BRIEF[2]	-0.618
					D-KEFS[9]	
Piccinelli et al. (2010)	43	10.40	51	-	WCST[6]	-0.144

Pinton et al. (2006)	18	6.67	39	-	Battery for Rapid Evaluation of Cognitive Functions (BREV)[86]	-0.558
Posar et al. (2014)	10	10.67	60	-	WISC-R[12]	-1.598
					ROCFT[14]	
					FePsy[65]	
Pulsipher et al. (2009)	83	13.33	53	-	BRIEF[2]	-0.281
Rantanen et al. (2010)	26	4.98	54	-	NEPSY[10]	-0.676
Raud et al. (2015)	65	10.37	55	-	NEPSY[10]	-0.735
Riccio et al. (2015)	28	12.88	29	32	WCST[6]	-0.296
					ROCFT[14]	
					CMS[80]	
Riva & Devoti (1999)	7	13.67	-	-	WISC-R[12]	-0.667
Riva et al. (2002)	8	-	63	-	WCST[6]	-0.893
					CVLT-C[49]	
Riva et al. (2007)	40	9.65	33	-	WISC-R[12]	-0.640
Rzezak et al. (2012)	64	11.86	41	-	WISC-III[18]	-0.506
					TMT[3]	
					WCST[6]	
					WRAML[84]	
Sarhan et al. (2015)	50	8.70	36	-	CBCL[8]	-3.158
Sart et al. (2006)	60	10.80	30	-	WISC-R[12]	-0.637
Schmidt et al. (2015)	15	13.10	53	-	WISC-IV[23]	-0.964
					ROCFT[14]	
Schoenfeld et al. (1999)	84	11.07	62	-	TMT[3]	-0.140
					S-CWT[19]	
Schouten et al. (2002)	135	9.10	53	-	Word Span*	-0.400
Schouten et al. (2000)	64	7.20	-	-	Sorting Task for Children (STC)*	-0.575

Schouten et al. (2009)	62	9.48	45	-	ROCFT[14]	-0.896
Schraegle & Titus (2016)	130	11.50	44	38	BRIEF[2]	-1.065
Scott (2013)	15	8.67	47	-	WISC-IV[23]	-0.106
Seidel & Mitchell (1999)	10	9.70	40	-	CAT[76]	-0.695
					TMT[3]	
Seidenberg et al. (1988)	48	12.14	52	-	TMT[3]	0.050
					Wechsler Memory Scale (WMS)[87]	
Selassie et al. (2008)	20	6.50	70	-	NEPSY[10]	-0.119
Sepeta et al. (2017)	140	10.25	43	-	WISC-IV[23]	-0.367
					BRIEF[2]	
					CVLT-C[49]	
Sherman et al. (2010)	208	11.30	-	-	ADHD-RS-IV[20]	-0.501
Sherman et al. (2012)	212	11.00	57	32	WISC-IV[23]	-1.073
Sibilia et al. (2017)	45	8.84	-	-	ROCFT[14]	-0.756
Singhi et al. (1992)	80	9.96	36	-	WISC-R[12]	-0.805
Smith et al. (2012)	24	11.06	42	-	Integrated Continuous Performance Task*	0.147
Smith et al. (2004)	51	13.22	49	-	WISC-III[18]	-0.209
					GDS[7]	
Srnka et al. (2018)	226	12.02	53	-	CPT-II[29]	-0.297
Stefanatos (2015)	51	11.92	29	-	BRIEF[2]	-1.240
					WISC-IV[18]	
					CBCL[7]	
Tian et al. (2010)	74	11.40	47	-	ANTb[42]	-0.158
Triplett & Asato (2015)	38	12.40	50	18	CNS Vital Signs (CNSVS)[88]	-0.584
Tsai et al. (2013)	183	9.86	38	-	CBCL[8]	-0.573
					SNAP-IV[72]	

Tsai et al. (2015)	101	8.41	-	-	WISC-IV[23] CPT-II[29]	-0.371
Vago et al. (2008)	40	9.65	33	-	CVLT-C[49]	-0.798
van Mil et al. (2008)	68	10.25	41	-	FePsy[65] ROCFT[14]	-0.193
Veenstra et al. (2016)	52	12.62	58	69	WISC-IV[23] TMT[3]	-1.035
Vermeulen et al. (1994)	165	10.12	47	-	WISC-R[12] FePsy[65]	-0.312
Verrotti et al. (2013)	35	7.75	43	-	WISC-IV[23] NEPSY-2[85]	-1.439
Vintan et al. (2012)	36	8.55	-	-	Computerized Battery Tests (CANTAB)*	-0.073
Wannag et al. (2010)	46	10.70	-	-	Conners-R[61]	-1.323
Weglage et al. (1997)	80	8.50	43	-	CBCL[8]	-0.415
Williams et al. (2002)	42	10.33	52	76	Attention Deficit Disorders Evaluation Scale – Home Version (ADDES-HV)[89]	-0.496
Williams et al. (1996)	84	10.08	50	19	WISC-R[12]	-0.567
Wirrell et al. (2008)	6	9.10	17	-	WISC-III[18] BRIEF[2]	-0.811
Yang et al. (2015)	180	8.48	37	-	ANTb[42]	-0.096
Zeng (2017)	209	10.72	47	-	WISC-IV[23] D-KEFS[9] NEPSY-2[85]	-0.710
Zilli et al. (2015)	23	9.80	48	-	NEPSY-2[85]	-0.441

Note. Age is represented in years; measures listed are only those included in the analyses; full name for measures are used the first time they are listed in the table, acronyms are used thereafter; not all subtests of test batteries were always included in publications or entered in analyses, but only the main measure names are listed in the table for brevity; *g* values based on mixed model, with all measurements for each study combined; references for the measures are listed below; *see source publication for description of measure.

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