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# CORRELATING DIRECT AND INDIRECT EXECUTIVE FUNCTIONING MEASURES AND LANGUAGE SKILLS OF CHILDREN WITH AUTISM

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# CORRELATING DIRECT AND INDIRECT EXECUTIVE FUNCTIONING MEASURES AND LANGUAGE SKILLS OF CHILDREN WITH AUTISM

By

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TITLE: CORRELATING DIRECT AND INDIRECT EXECUTIVE FUNCTIONING MEASURES AND LANGUAGE SKILLS OF CHILDREN WITH AUTISM

MAJOR PROFESSOR: Dr. Mark Dixon

Executive functioning usually refers to one's ability to regulate one's behavior, set goals, be mentally flexible, and understand the consequence of one's actions. However, certain neurodevelopmental disabilities such as Autism, often can negatively impact executive function processes. Although applied behavior analytic (ABA) treatment is the most recommended intervention for autism treatment practitioners rarely assess or target executive functioning within their treatment planning. The present study assessed the relationship between direct and indirect executive functioning scores and a language assessment used by ABA providers. Thirty-nine children with autism spectrum disorder were administered a variety of scales including the Behavior Rating Inventory of Executive Functioning (BRIEF 2), Comprehensive Executive Functioning Inventory (CEFI), Tower of London (TOL), and the PEAK Comprehensive Assessment (PCA). Obtained data yielded a moderate, negative relationship between the total BRIEF and total PCA scores (r=-0.521, $p$=.032) and a moderate, positive relationship between CEFI planning and PCA scores (r=0.394, $p$=.017). However, there was a strong correlation between total PCA scores and TOL scores (r=0.708, $p$=.005).

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# DEDICATION

I would like to dedicate this to the memory of Adam Schelske. He was a free spirit and a great friend. He set me on a career path to help people who struggled with mental illness and addiction. I wish I had had a chance to tell him that. If I can help just one person make different decisions than he made, all of this will have been worth it. I miss him greatly every day.

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CHAPTER 1

# INTRODUCTION

## Executive Functioning

Executive functioning is a hypothetical construct designed to describe self-regulation, set goals, be mentally flexible, and understand the consequence of one's actions (Ardila, 2008). The totality of the repertoire described by this broad term is open debate (Liss et al., 2001). As a result, different assessments which contain different sub-domains of executive functioning continue to be developed. For example, Suchy (2009) defines executive functioning as: "forming, maintaining, and shifting mental sets, corresponding to the abilities to reason and generate goals and plans, maintain focus and motivation to follow through with goals and plans, and flexibly alter goals and plans in response to changing contingencies" (p. 106). On the other hand, Etnier and Chang (2009) define it as: "a "higher level" or "meta-" cognitive function that manages other more basic cognitive functions (as sited in: Alvarez & Emory, 2006; Baddeley, 1986; Salthouse, 2007) and the regulation of emotions and attention necessary for purposeful and goal-directed behaviors" (p. 470).Goldstein, Naglieri, Princiotta, and Otero (2014) include 33 more definitions in their book titled "Introduction: A History of Executive Functioning as a Theoretical and Clinical Construct".

Executive functioning abilities are claimed to be developed throughout childhood and even into adulthood through a series of rapid bursts rather than a continuous flow (Anderson, 2002). For example, it develops rapidly between infancy and preschool as the child's brain develops and slows down in adulthood (Anderson and Reidy, 2012). Executive dysfunction is a deficit in the aforementioned skills. Not understanding one's own strengths and weaknesses, being unprepared for assignments, becoming upset in a new situation, and being unaware that

your behavior affects others are examples of executive dysfunction. It can be caused by a variety of factors, such as traumatic brain injury (TBI) or developmental disorders. Being born prematurely can also put one at a higher risk for executive dysfunction (Luu, Ment, Allan, Schneider, and Vohr, 2011). Individuals with Huntington's disease also appear to experience a gradual loss of executive functioning (Rosenblatt, 2007).

There are several assessment tools designed to measure executive functioning. Common options survey-based options include the Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia, Isquith, Guy and Kenworthy, 2000). and the Comprehensive Executive Functioning Inventory (CEFI; Anderson, 2002). Chan, Cheung, Han, Sze, Leung, Man, and To, (2009) found a significant correlational relationship between IQ and BRIEF scores on children with and without ASD. Children with ASD also scored significantly higher on the BRIEF than children without ASD. Indirect assessments, while easy to administer, have been reported to produce inaccuracies by reporters as bias or poor recollection of specific behavioral manifestations tend to occur (Barton-Arwood, Wehby, Gunter, & Lane, 2003). Bodnar, Prahme, Cutting, Denckla, and Mahone (2007). As a result, there remains an effort to either supplement or replace such indirect assessment tools with more direct measures of a client's performance on executive function tasks.

There are also a few direct assessments designed to also evaluate executive functioning. The Tower of London (TOL) (TOL; Culbertson and Zillmer, 2001), Wisconsin Car Scoring Test (WCST) (WCST; Heaton and Staff, 1993), and the Stroop Test (Stroop Test; Hill, 2004). Although these direct measures of executive functioning may be prone to more objective information on the functioning of the client, they typically only target one of the various dimensions of a repertoire that make up the construct of executive functioning. For example, the

TOL measures planning (Culbertson and Zillmer, 2001), the WCST measures mental flexibility (Heaton and Staff, 1993), and the Stoop Test measures inhibition (Hill, 2004).

**Autism Spectrum Disorder and Executive Function**

One clinical population that may demonstrate executive dysfunction are individuals impacted by autism spectrum disorder. Autism Spectrum Disorder is a neurodevelopment disorder that includes a wide range of symptoms. These include a lack of social exchange and repetitive behaviors, activities, or interests (American Psychological Association, 2020). Symptoms of ASD are noticeable at a very young age, usually between infancy and 3 years old. Children with ASD often do not seek out others for attention or comfort. They may also fixate on certain objects, activities, subjects, or shapes. Although there are diagnostic criteria for ASD, no two cases of this disorder are exactly alike (Lord, Cook, Leventhal, and Amaral, 2000). Recently, research has investigated ways to decrease autism symptom severity through targeting individual's deficits in executive functioning. The most common strategy right now to decrease executive dysfunction with students with ASD is to use an Individualized Education Program (IEP) to target deficits. Executive functioning difficulties can cause heightened symptom presence in individuals with ASD. The plan may include the individual learning about their disability, learning to ask for help, asking for breaks or clarity, or asking for modifications for tests and assignments (Ozonoff, and Schetter, 2007). Lack of adaptive behavior is linked to poor outcomes in adulthood including less independence (Granader et al., 2014). Studies have highlighted the importance of targeting executive dysfunction among individuals with ASD, however little conclusive evidence had been found. Rosenthal, Wallace, Lawson Wills, Dixon, Yerys, and Kenworthy (2013) found that individuals with ASD often become more impacted regarding executive functioning when compared to their peers as they become older. However,

how to assess individual's proficiency on executive function has been the of continued concern.

**Behaviorally Based Assessments**

With the extensive literature documenting the success of repertoire development in children with autism using behaviorally based interventions, it remains likely that these gains, if conceptualized through the lens of the executive functioning construct, might imply that ABA interventions do in fact target executive functioning domains. For example, Dixon and Cummings (2001) promoted self-control by extending the amount of time a child was willing to wait for a larger reward. Additionally, adaptive behavior has been shown to be increased, and maladaptive behavior reduced by putting children in an enriched environment in a study done by Horner (1980). The "good behavior game" targets behavior regulation and is frequently used in classrooms. This uses very basic ABA principles (Warner, Miller, Cohen, 1977).

Following the logic that ABA may in fact address the very limitations in repertoire that comprise the construct of executive functioning, it may be possible that an ABA assessment that measures presence and absence of certain language and cognition skills in children with autism, also might align with tests designed specifically for capturing a client's executive functioning. As a result, the purpose of the present study was to compare assessment tools often used to measure executive functioning in children with an ABA assessment designed to measure language and relational abilities of children with autism.

**Purpose of Study**

Currently, there is not much research assessing and targeting executive functioning in children with ASD, particularly in ABA therapy. Executive dysfunction often impacts individuals with ASD but so far there has been no reliable way to target it. The current study examines ways of assessing executive functioning and compares these assessments to an ABA

language assessment, the PCA. At present, there has not been any research assessing the relationship between PEAK and executive functioning, although there has been research suggesting PEAK has a relationship between measures of intelligence, vocabulary, and functions of challenging behavior assessments (Dixon, Belisle, and Stanley, 2018; McKeel, Rowsey, Dixon, and Daar, 2015; Belisle, Stanley, and Dixon, 2017).The purpose of the current study was to assess the relationship between the PCA and measures of executive functioning through the CEFI, BREIF, and TOL. Additionally, the current study also assessed the relationship between indirect and direct measures of executing functioning. Thirty-nine total participants with ASD were assessed using direct and indirect measures. Thirty-six participants were assessed using the PCA, 38 participants were assessed with the CEFI, 18 with the BRIEF, and 15 were assessed with the TOL$^{DX}$.

CHAPTER 2

# METHODOLOGY

## Participants, Setting, and Materials

39 Participants were recruited from a center for autism at a Midwestern university (age between 4-16, *M*=9.7, 10 female, 29 male), and were assessed individually in therapy rooms (2x2m) seated in a chair at a low table. Participant demographics can be found in table 1. Each testing instrument required a unique set of materials that are detailed below for their respective tests.

## Measures and Procedure

### *CEFI*

The CEFI is an indirect measure of executive function that contains 100 questions measuring 9 different components: attention, emotional regulation, flexibility, organizations, planning, self-monitoring, initiation, working memory, and inhibitory control. Caregivers were given the Comprehensive Executive Function Inventory (CEFI) to fill out during their child's therapy session. They were given the inventory and a pen. The room provided was a large area with a couch, lounge chair, table, and chairs. Some caregivers chose to take the assessment home and return it at a later time, and this was allowed. They were asked to read each question and circle if it applied to their child: never (N), rarely (R), sometimes (S), often (O), very often (V), or always (A), which were calculated using the standardized CEFI scoring system, and added together to get component scores and domain scores for each participant. Test time was about 30 minutes.

### *BRIEF*

The BRIEF was comprised of 63 questions measuring three domains of executive

functioning: Behavior Regulation (BRI), Emotional Regulation (ERI), and Cognitive Regulation (CRI). The BRI has two subdomains: Inhibit and Self-Monitor. The ERI also has two subdomains: Shift and Emotional Control. The CRI has 5 subdomains: Initiate, Working Memory, Plan/Organize, Task-Monitor, and Organization of Materials. Global Executive Composite (GEC). Caregivers were given the Behavior Rating Inventory of Executive Function, second edition (BRIEF 2) during their child's therapy session. They were given the inventory and a pen. Similar to the CEFI, caregivers were provided a room to complete the assessment that included large area with a couch, lounge chair, table, and chairs. The parents/caregivers could sit wherever they wished. Similar to the CEFI, some caregivers chose to take the assessment home and return it at a later time, and this was allowed. They were asked to read each question and circle if, in the past 6 months, it applied to their child: never (N), sometimes (S), or often (O). Test time was approximately 15-20 minutes. The totals were added up for each section to obtain subsection scores, section scores, and a total score. T-scores were then obtained from the BRIEF-2 manual using the raw scores obtained and the age of the child. The BRIEF T-Scores were what were used for this study.

***TOL***

The Tower of London Drexel University 2nd Edition ($TOL^{DX}$) is a wooden puzzle test. It includes two boards with three beads each. It has one example problem, two practice problems, and 10 test problems. The goal of each problem is for the examinee to make the same pattern as the examiner making as few moves as possible and moving only one bead at a time. The minimum amount of moves to answer correctly range between 2-7. The maximum moves a participant may make before the test problem is terminated is 20. The moves made, time it takes the participant to move the first bead, time it takes the participant to solve the problem, and total

time is recorded. If a participant tried to put more beads than will fit on a peg, moved more than one bead at a time, or took more than one minute to solve a problem, these are recorded as time or rule violations per the assessment guidelines. If a participant took more than two minutes to solve a problem, the score was marked at 20. A Standard Score (SS) on this test is comprised on correct answers (when a participant makes the minimum amount of moves to solve a problem), move score (moves made over the minimum), time spent on each problem, time spent to start a problem, and time/rule violations. The TOL$^{DX}$ was done directly with the participants during their normal therapy sessions with the primary researcher. The assessment was completed for each participant in approximately 10-15 minutes. The wooden boards were placed parallel to each other. The examinee's board was placed about 10 centimeters from the edge of the table and the examiner's board was placed approximately 5 centimeters from the first board. The tallest peg on the examinee's board was opposite the examinee's right hand. The tallest peg on the examiner's board was placed opposite the examiner's right hand. Participants were asked to make the same design as the therapist with the beads in as few moves as possible, moving only one bead at a time. See Appendix A for a picture of this apparatus.

***PEAK Comprehensive Assessment (PCA)***

The PCA (Dixon, 2019) is a 344-item assessment of language and cognition skills designed for persons with autism spectrum disorders. Rooted within a behavior analytic framework the PCA items range from basic requesting and labeling, to abstract logic induction and deduction. The PCA 60-120 minutes, and was completed through a direct interaction with the participant under rather strict testing conditions of no feedback on performance, only the occasional break, a verbatim script for test items, and limited amounts of time to make a response to test items. For the Direct Training and Generalization subtests of the PCA, if a

subdomain received a score of zero, the testing stopped for that subdomain and the therapist moved on to the next one. For the Equivalence and Transformation sections, if a participant successfully moved past the practice items into the assessment questions, and answered three questions in a row incorrectly in a subdomain, the testing in that subdomain was ended and the therapist moved on to the next one.

**Statistical Analysis**

A Pearson correlation statistical analysis was used. The researcher used this analysis to compare total PCA scores with CEFI total scores, total PCA scores with BRIEF 2 Global Executive Composite T (GEC) scores, total PCA scores with $TOL^{DX}$ Standard Scores (SS), PCA scores with CEFI Planning scores, PCA scores with BRIEF Planning/organizing T scores, $TOL^{DX}$ with CEFI Planning scores, $TOL^{DX}$ with BRIEF Planning/organizing T scores, and CEFI planning scores with BRIEF Planning/organizing T scores. Additionally, each subtest score on the PCA was also assessed across the total score of each assessment.

CHAPTER 3

# RESULTS

## Summary of Scores

CEFI scores were also combined get a composite score. The minimum achievable score on this is 0 and the maximum is 500. The lowest score in this participant pool was 102 and the highest was 377. The planning portion was pulled out to compare as well, because the direct measure used, the TOL$^{DX}$, specifically measures executive functioning of planning. The minimum score achievable on the Planning section on the CEFI is 0 and the highest is 100. The lowest score in this participant pool was 8 and the highest was 42. The scores were combined on the BRIEF 2 to obtain a Global Executive Composite T-score. With the BRIEF, the lower the score is, the higher the executive functioning is determined to be. The lowest achievable score on this is >90 and the highest is 37. The lowest score in this participant pool was 82 and the highest was 45. The Planning/Organizing section was also analyzed because the TOL$^{DX}$ measures specifically planning, and the minimum achievable score is 88 and the highest is 38. The lowest score in this participant pool was 71 and the highest was 50. The Standard Score was used with the TOL$^{DX}$. The minimum achievable score on this assessment is <60 and the highest is 150+. The lowest score in this participant pool was 60 and the highest was 116. PCA scores were combined into a composite score. The minimum score achievable on the PCA is a 0 and the highest is 344. The lowest score in this participant pool was 1 and the highest was 320.

Each section of the PCA was also evaluated. The lowest possible score on the Direct Training (DT) portion is 0 and the highest is 64. The lowest score in this participant pool was 1 and the highest was 64. On the Generalization (G) portion, the lowest possible score is 0, and the highest is 64. The lowest score in this participant pool was 0 and the highest was 63. On the Equivalence

(E) portion, the lowest possible score is a 0 and the highest is 24. The lowest score in this participant pool was 0 and the highest was 24. On the Transformation Receptive (TR) portion the lowest possible score is 0 and the highest is 96. The lowest score in this participant pool was 0 and the highest was 84. On the Transformation Expressive (TE) the lowest possible score is 0 and the highest is 96. The lowest score in this participant pool was 0 and the highest was 86. Pearson correlation was conducted between total PCA scores and total CEFI scores. There was no significant relationship (r=0.293, p=.083). These results are shown in figure 1. Additionally, a Pearson correlation was also conducted between total PCA scores and BRIEF 2 GEC T-scores, with moderate, negative significant relationship (r=-0.521, p=.032) discovered. These results are shown in figure 2. A Pearson correlation was also analyzed between PCA scores and $TOL^{DX}$ standard scores. There was a strong, positive, significant relationship (r=0.708, p=.005). These results can be seen if figure 3. A Pearson correlation was also conducted between total PCA scores and CEFI Planning scores. A moderate, positive, significant relationship was seen (r=0.394, p=.017) These results can be seen if figure 4. A Pearson correlation was conducted between total PCA scores and BRIEF Planning/organizing scores. No significance was seen (r=-0.092, p=0.726). These results can be seen if figure 5.

A Pearson correlation was also run between PCA DT scores and CEFI total scores. No significance was discovered (r=0.238, r=0.169). A Pearson correlation was also conducted between PCA DT scores and BRIEF GEC T-scores. No significance was demonstrated (r=-0.215, p=0.424). A Pearson correlation was run between PCA DT scores and $TOL^{DX}$ standard scores. A strong, positive, significant relationship was found (r=0.803, p=0.003). A Pearson correlation was also analyzed between PCA G scores and CEFI total scores and no significance was seen (r=0.259, r=0.134). There was also no significant discovered between the PCA G

scores and BRIEF GEC T-scores (r=-0.329, p=0.213). A Pearson correlation was also conducted between PCA G scores and TOL$^{DX}$ standard scores. A strong, positive, significant relationship was found (r=0.777, p=0.001).

A Pearson correlation was also run between PCA E scores and CEFI total scores. No significance was seen (r=0.19, r=0.274). A Pearson correlation was analyzed between PCA E scores and BRIEF GEC T-scores. No significance was seen (r=-0.32, p=0.226). A Pearson correlation was conducted between PCA E scores and TOL$^{DX}$ standard scores. A strong, positive, significant relationship was found (r=0.775, p=0.001). Additionally, another Pearson correlation was also run between PCA TR scores and CEFI total score (r=0.15, r=0.389), and BRIEF-GEC T scores (r=-0.281, p=0.293), neither of which showed significance. A Pearson correlation was used between PCA TR scores and TOL$^{DX}$ standard scores. A strong, positive, significant relationship was found (r=0.728, p=0.003). A Pearson correlation was also conducted between PCA TE scores and CEFI total scores (r=0.241, r=0.162) and the BRIEF GEC T scores (r=-0.401, p=0.125). Similar to the receptive test, neither of these were significant. A Pearson correlation was analyzed between PCA TE scores and TOL$^{DX}$ standard scores. A moderate, positive, significant relationship was found (r=0.672, p=0.009), which is consistent with the Receptive component. The correlations tables for all of these analyses can be seen in tables 2 and 4.

Correlational analyses were conducted between the total scores of all assessments. A correlational matrix for these analyses can be seen in Table 2. Table 3 demonstrates the relationship between each PCA subtest with each executive functioning measure. Additional analyses were conducted on the planning portion of each executive functioning assessment along with the total scores for the PCA and TOL$^{DX}$. These results are displayed within a correlational

matrix in Table 4.

**Indirect vs. Direct measures of Executive Functioning**

Pearson correlations were also conducted between measures of executive functioning. A correlational analysis was conducted between CEFI Planning scores and $TOL^{DX}$ standard scores. No significant relationship was found (r=0.271, p=0.394). These results can be seen if figure 6. A Pearson correlation was run between BRIEF Planning/Organizing scores and $TOL^{DX}$ standard scores. The results were not significant (r=-0.321, p=0.349). These results can be seen if figure 7. A Pearson correlation was analyzed between BRIEF Planning/Organizing scores when compared to CEFI Planning scores. No significance was seen (r=-.0246, p=0.34). These results can be seen if figure 8. The correlations tables for these can be seen in table 3.

CHAPTER 4

# DISCUSSION

## Summary

The current data show no significant correlation amongst the various tools used to measure executive functioning. Similar to Bodnar, Prahme, Cutting, Denckla, and Mahone's (2007) study, the direct and indirect results did not significantly correlate. The indirect scores did not significantly correlate to each other either, which is consistent with previous literature with BREIF and CEFI (Chan et al., 2009). Depending on the environment the child is in, a parent may rate them higher or lower because compared to their peers. A caretaker may rate a participant as doing a question item as more or less often when comparing them to a group outside of a typical population. The researcher found this to be true in this case having evaluate Indirect assessments are often used because they are quick and convenient, however they rely on self-reported information or information reported on someone's behalf by a parent or caregiver. The BRIEF and CEFI both rely on information given on a participant's behalf either by a parent or teacher. In many cases, this is effective, but the information is not as reliable or valid as direct assessments (Chan et al., 2009) two different groups of participants that had large variability in autism severity.

The behavioral measure, the PCA, held up to a high correlation with the direct measure used, the TOL$^{DX}$. When broken down, each section of the PCA also had a strong to moderate correlation with the TOLDX. The only other relationships seen were between the PCA and the BRIEF GEC T-scores and the PCA and the CEFI Planning scores. Both of these relationships were moderate. There were no other significant correlations. These results are most likely due to executive functioning being used as a construct for many behavioral repertoire elements

addressed by ABA interventions. Self-control and adaptive behavior are just a few of the areas of executive functioning that have already been targeted by ABA. (Dixon and Cummings, 2001; Horner, 1980; Warner, Miller, and Cohen, 1977), although additional areas should be targeted within future research.

ABA may address the limitations in behavioral repertoires that comprise the construct of executive functioning, and therefore it may be possible that an ABA assessment that measures presence and absence of certain language and cognition skills in children with autism, also might align with tests designed specifically for capturing a client's executive functioning. Self-regulation, set goals, mental flexibility, and understanding the consequence of one's actions (Ardila, 2008) are all areas ABA often targets. While there may not be many studies comparing ABA treatments to EF, the present study may suggest that ABA would help improve on these area and therefore overall EF.

With the PCA being an ABA assessment tool, it is possible that by targeting items across the domains of this assessment, practitioners could concurrently capture EF levels. The PCA and the corresponding curriculum, *PEAK Relational Training System* include many skills that have been demonstrated through research (Rowsey, Belisle, Stanley, Daar, & Dixon, 2017; Dixon, Belisle, Stanley, Speelman, Rowsey, Kime, and Daar, 2017; Dixon, Peach, Daar, and Penrod, 2017; Dixon, Belisle, Stanley, Rowsey, Daar, & Szekely, 2015), many of which fit into the EF skill sets. This might imply that one of the ways to change and not just measure EF is through ABA intervention.

**Limitations**

There were participants in the study who had previous experience with the PEAK program and others who were not. These two populations were not compared to assess if one

group had different responses both on indirect and direct executive functioning measures. Also, due to time constraints, sample sizes varied between assessments. The groups size was much smaller than anticipated and this could skew results. Correlational studies usually use much larger sample sizes, but this could not be done for this study. Another limitation is that the $TOL^{DX}$ was run with children under the age of 7, which is the youngest age it is made for. Scores were still included and calculated in the 7-9 age range category. All the children that participated also came from relatively small, midwestern towns and the population was homogeneous. There was also occasional challenging behavior from participants during the direct measures. Some of the participants would try to escape demands by leaving the room or not paying attention.

The indirect assessments themselves were also a limitation. Caregivers in the current study did not always report accurately about their child. For example, one parent reported that their child never knew when a task was completed, when this behavior had been observed by the researcher several times. Caregivers with children with greater autism severity often rated their child as doing behaviors that had never been seen by the researcher frequently or always. Caregivers with less impacted children often rated their child as doing behaviors rarely or never that had frequently been seen by the researcher. This is a limitation that has been seen before in literature (Barton-Arwood et al.,2003). Parents rate their child's behavior differently depending on the environment they are in and who the child's peers are. If a less impacted child is in a normative classroom, the parent may rate their executive functioning as lower because he or she performs certain behaviors more or less frequently than his or her peers. If a parent has a more impacted child that goes to special education classes, they may rate their executive functioning as higher for the same reason.

**Future Research**

Executive functioning has not been studies extensively in behavior analysis. Other areas of executive functioning should be targeted for improvement by applied behavioral methods. ABA has been shown to work effectively at decreasing symptoms of ASD (Foxx, 2008). It is possible that ABA methods improve executive functioning as well, but it is currently not a common progress measure. The current study provides preliminary evidence to suggest that skills commonly targeted in ABA therapy as measured in the PCA, may be related to areas of executive functioning. Continued research and practice should make use of measures of executive functioning, particularly direct measures, to assess for changes in these skill sets. By incorporating measures of executive functioning, progress using ABA treatment may be disseminated in different fields that use executive functioning as an important measure of progress outcomes.

## EXHIBITS

### Tables

*Table 1*. Participant Demographics

| Characteristics | N | % |
|---|---|---|
| Ages | | |
| 4-6 | 6 | 15 |
| 7-10 | 21 | 54 |
| 11-13 | 10 | 26 |
| 14-16 | 2 | 5 |
| Gender | | |
| Male | 29 | 74 |
| Female | 10 | 26 |

*Table 2*. Correlation Matrix for PCA, BRIEF-T, TOL, and CEFI

| | | PCA | BRIEF-T | TOL | CEFI |
|---|---|---|---|---|---|
| 1 | PCA | - | -0.521* | 0.708* | 0.293 |
| 2 | BRIEF-T | -0.521* | - | - | -0.449 |
| 3 | TOL | 0.708* | -0.332 | - | -0.05 |
| 4 | CEFI | 0.293 | -0.449 | -0.05 | - |

*Correlation is significant at the 0.01 level

*Table 3.* Correlation Matrix for measures of executive functioning with PCA subtests

| | BRIEF | TOL | CEFI |
|---|---|---|---|
| PCA-DT | -0.215 | 0.803 | 0.238 |
| PCA-G | -0.329 | 0.777* | 0.259 |
| PCA-E | -0.32 | 0.775* | 0.19 |
| PCA-TR | -0.281 | 0.728* | 0.15 |
| PCA-TE | -0.401 | 0.672* | 0.241 |

*Correlation is significant at the 0.01 level

*Table 4*. Correlation Matrix for PCA and Executive Functioning Planning Measures

| | | | BRIEF | CEFI | |
|---|---|---|---|---|---|
| | | PCA | Planning | Planning | TOL |
| 1 | PCA | - | -0.092 | 0.394* | 0.708* |
| 2 | BRIEF Planning | -0.092 | - | -02.46 | -0.321 |
| 3 | CEFI Planning | 0.394* | -0.246 | - | 0.271 |
| 4 | TOL | 0.708* | -0.321 | 0.271 | - |

*Correlation is significant at the 0.01 level

## Figures

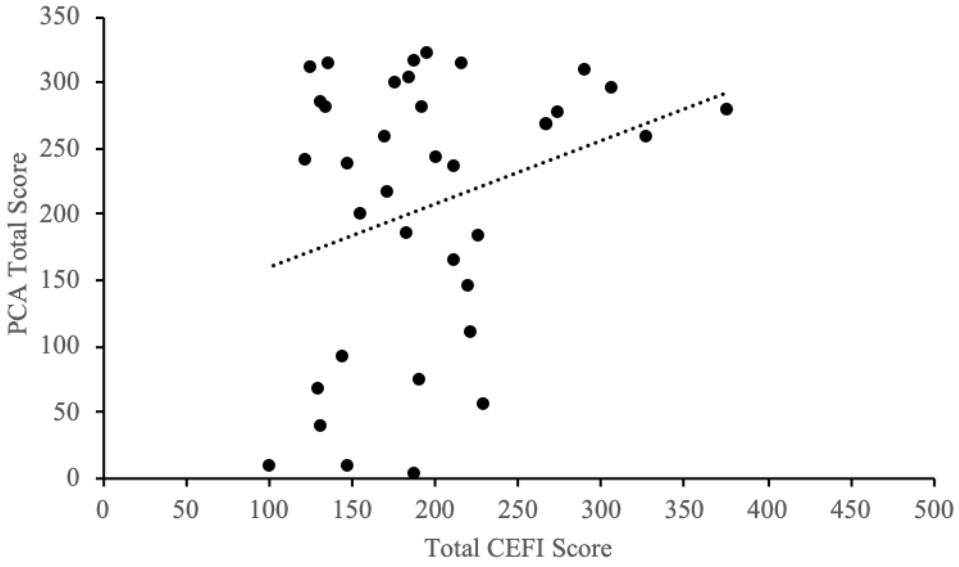


*Figure 1*. The Pearson correlation of the relationship between total scores on the PCA and total CEFI scores (r=0.293, $p$=0.083).

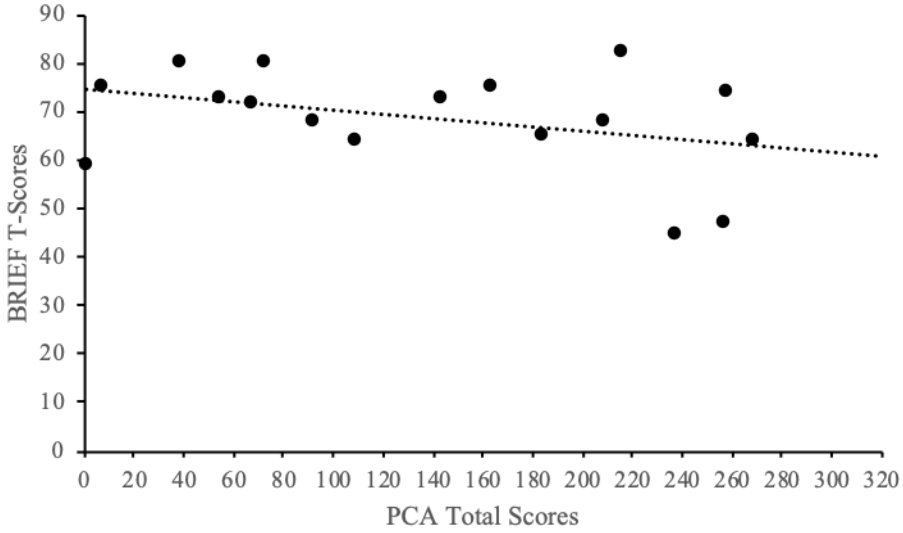


*Figure 2*. The Pearson correlation of the relationship between total scores on the PCA and total BRIEF scores (r=-0.521, $p$=0.032).

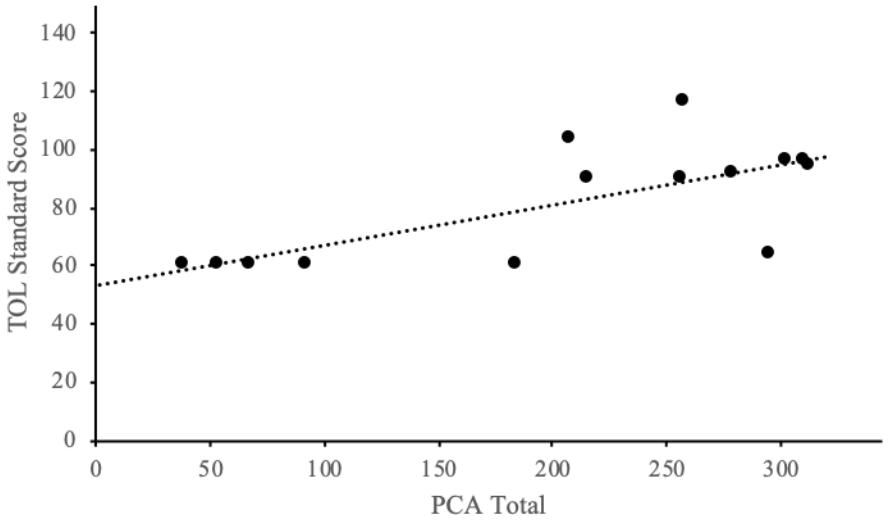


*Figure 3*. The Pearson correlation of the relationship between total scores on the PCA and total $TOL^{DX}$ standard scores (r=0.708, p=0.005).

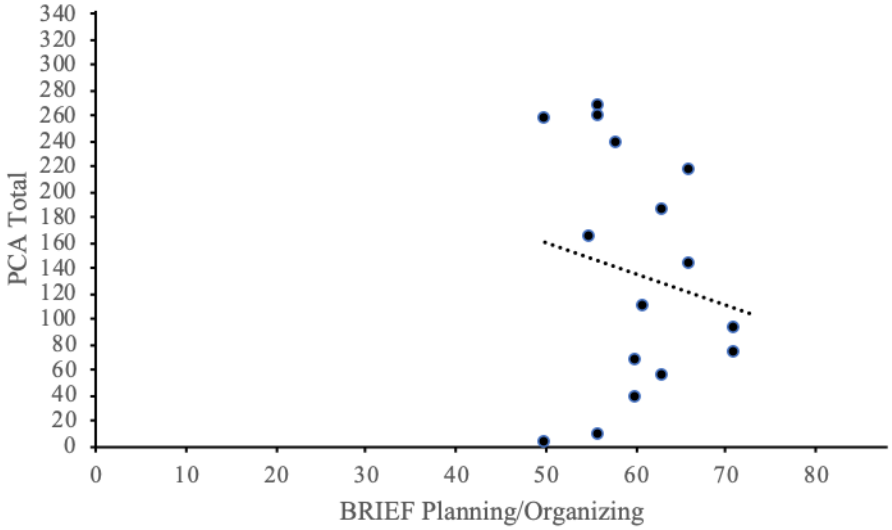


*Figure 4*. The Pearson correlation of the relationship between total scores on the total PCA scores when compared to CEFI Planning scores (r=0.394, *p*=0.017).

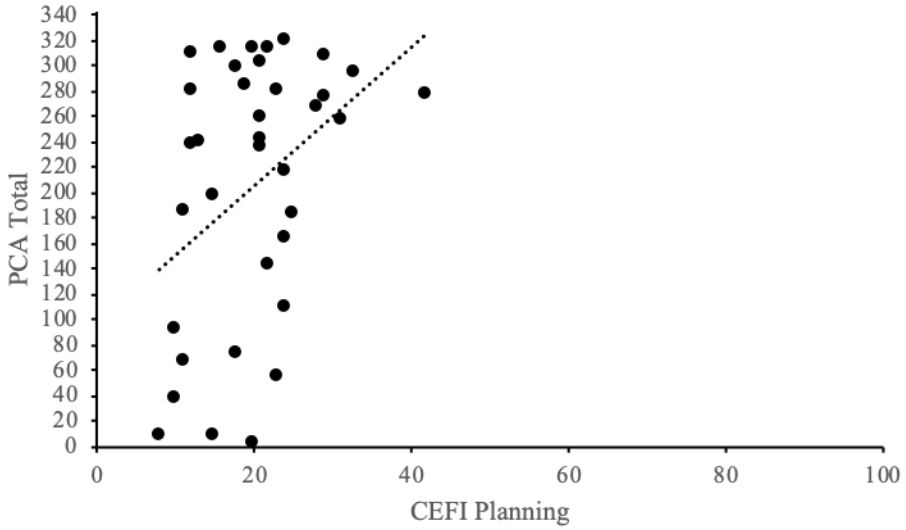


*Figure 5*. The Pearson correlation of the relationship between total scores on the total PCA scores when compared to BRIEF Planning/organizing scores (r=-0.092, $p$=0.726).

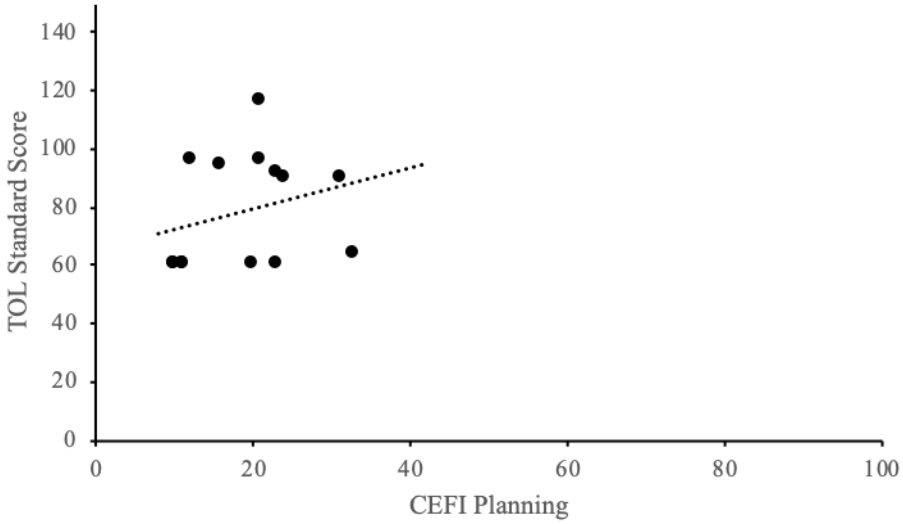


*Figure 6*. The Pearson correlation of the relationship between total scores on the total CEFI Planning scores when compared to TOL$^{DX}$ standard scores (r=0.271, $p$=0.394).

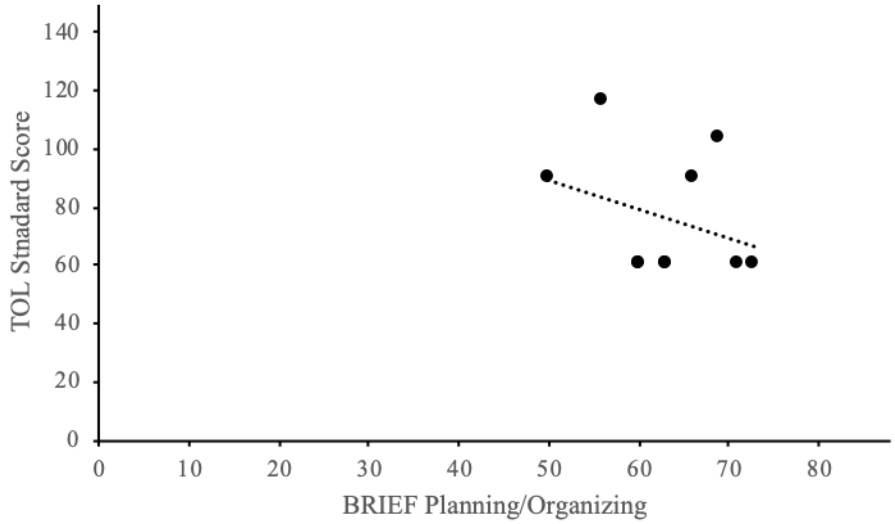


*Figure 7*. The Pearson correlation of the relationship between total scores on the total BRIEF Planning/Organizing scores when compared to TOL$^{DX}$ standard scores (r=-0.321, $p$=0.349).

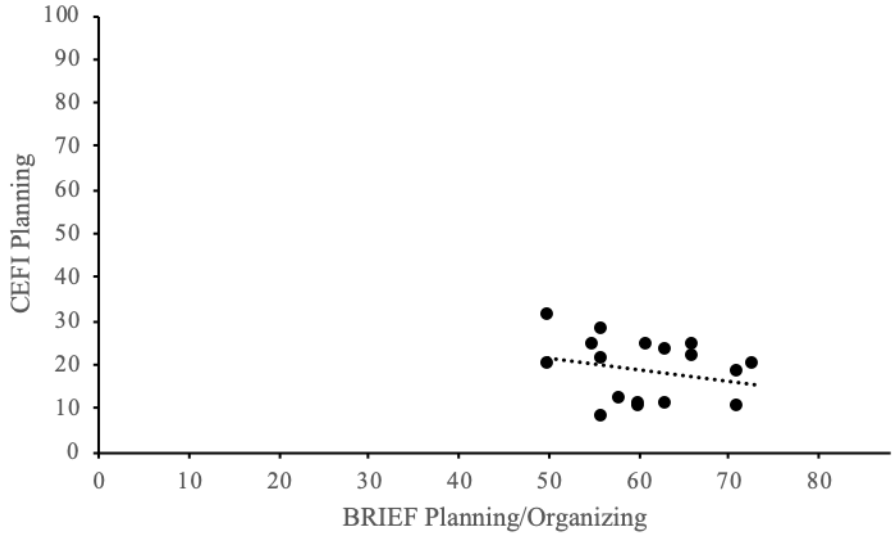


*Figure 8*. The Pearson correlation of the relationship between total scores on the total BRIEF Planning/Organizing scores when compared to CEFI Planning scores (r=-.0246, $p$=0.34).

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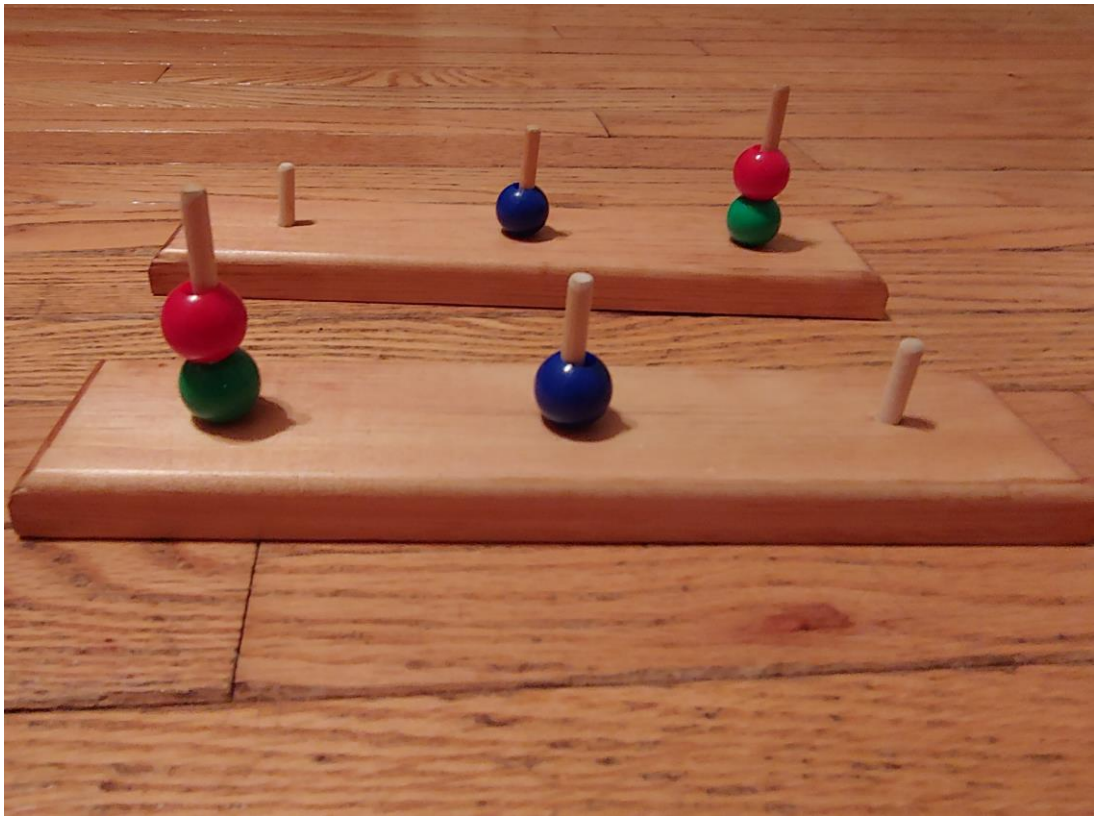
# APPENDICES

APPENDIX A

TOWER OF LONDON PUZZLE BOARD



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Children with Autism

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