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Clinical Measurement of Problem Solving in Children with Autism

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CLINICAL MEASUREMENT OF PROBLEM SOLVING IN CHILDREN WITH AUTISM

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CLINICAL MEASUREMENT OF PROBLEM SOLVING IN CHILDREN WITH AUTISM

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"Aim at heaven and you will get earth thrown in. Aim at earth and you get neither."

– C.S. Lewis

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CLINICAL MEASUREMENT OF PROBLEM SOLVING IN CHILDREN WITH AUTISM

Megan Martin May 2018 48 Pages

Directed by: Drs. Jo Shackelford, Janice Smith, and Lauren Bland

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The current study examined verbal and non-verbal problem skills in twenty-seven male children 10-16 years of age, twelve with autism and fifteen children who were neurotypical. The goal of this study was to assess problem solving abilities of children with autism when compared to gender and age matched peers. The twenty-seven participants completed two assessments of the Rapid Assessment of Problem Solving and one online assessment of Raven's Standard Progressive Matrices. Results of this study showed a .92 reliability of the RAPS for all twenty-seven participants. Correlation between the RAPS and RPM was .419 for all participants. The results of this study indicate a decreased ability to problem solve in children with autism when compared to their neurotypical age and gender matched peers. This study also indicated an increase from verbal problem solving to non-verbal problem solving in children with autism, indicating difficulty with the cognitive load required to solve problems verbally.

INTRODUCTION

Background

From the time we begin to comprehend the world, we see options our world presents us. When we begin to crawl, we can choose any direction. When we are being fed, we see something else that looks more appetizing and reach for that food. Soon, our parents begin giving us more options. Parents ask which outfit we want to wear, what shoes we would like to own, what backpack we want for school. We are faced daily with multiple situations which force us to make decisions and solve problems. At first, we begin to make choices based on what we like. As we grow, we begin to develop the ability to process information and consider a variety of circumstances that influence our decision. Eventually, we become adept at making choices to solve problems we face. Once we have mastered this skill, we have the ability to reach outside of ourselves and create. Philip Seymour Hoffman stated, "creating something is all about problem-solving" (n.d.). To make something out of nothing, we must use our ability to problem solve.

Problem solving is a cognitive executive function. Executive processes "develop throughout childhood and adolescence, and play an important role in a child's cognitive functioning, behavior, emotional control, and social interaction" (Anderson, 2002). For neurotypical children, executive functions develop as they grow. For children with autism, these executive functions develop differently. Executive dysfunction (EDF) has been a prominent theory to explain symptoms presented by people with the diagnosis of autism (Griffith, 1999). EDF is defined by Anderson as

> "deficits in one or more elements of EF…In children, cognitive deficits that may be associated with EDF include poor impulse control, difficulties monitoring or

> regulating performance, planning and organizational problems, poor reasoning ability, difficulties generating and/or implementing strategies, perseveration and mental inflexibility, poor utilization of feedback, and reduced working memory" (2002).

There is no known cause of autism or EDF, but there is a connection between them.

Many definitions exist to describe autism. Dawson, Gernsbacher, Mottron, and Soulieres (2007), state that autism is "defined by atypical communication, social interaction, interests, and body mannerisms." The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) defines Autism Spectrum Disorder as "persistent deficits in social communication and social interaction across multiple contexts…" (American Psychiatric Association, 2013). At the basis of the diagnosis, autism is defined by difficulties with social interactions. Social interactions require a person to be able to assess a situation, consider options, and choose the best way to react in actions and with words. People with autism have difficulty with the executive functions that are required in order to successfully navigate social interactions. In order to be successful in social settings, people with autism must be able to utilize cognitive abilities, including problem solving, which currently does not have an assessment available for this population. This study assessed problem solving abilities of children with and without autism. Both verbal and non-verbal problem solving skills were assessed, to consider the cognitive load required for verbal problem solving.

In order to assess both verbal and non-verbal problem solving, two assessments were utilized. The Rapid Assessment of Problem Solving (RAPS) was chosen to assess verbal problem solving and strategy. The Raven's Progressive Matrices (RPM) was chosen to assess non-verbal problem solving. Prior to this study, there was no normative data on the RAPS for children with autism. A main objective of this study was to expand

the normative database for the RAPS to include children with autism. The RAPS has been used successfully with typically developing children from age 7 years to 17 years/11 months (Smith, 2015). Additionally, a small, exploratory study found that 17 children from ages 7 to 15 years/3 months with autism were able to successfully complete the RAPS (Smith, Page, & Marshall, 2013). Another objective was to assess the validity and reliability of the RAPS with children with autism by comparing their results to scores from typically developing children and scores on the RPM.

This descriptive study had two primary goals. The first goal was to compare the strategies used by both children with and without autism on the RAPS. The second goal was to determine if children with and without autism perform differently on the RAPS and the RPM. It was expected that that children who are typically developing would score higher on both the RAPS and the RPM than children with autism. Lastly, it was expected that the RAPS scores for both child groups would correlate strongly with scores on the RPM.

Research Questions

This descriptive study examined the performance of early-adolescent and adolescent children with autism and typically developing children on the Rapid Assessment of Problem Solving (RAPS) and the Raven's Progressive Matrices (RPM) and sought to answer the following general research questions:

1. Do early-adolescent and adolescent children with autism use different strategies than typically developing age-matched peers to solve problems on the RAPS?

2. Do early-adolescent and adolescent children with autism perform differently than typically developing age-matched peers on the RAPS and RPM?

REVIEW OF THE LITERATURE

This chapter examines the current literature related to (a) problem solving and autism; (b) background information on the RAPS; (c) materials, administration, scoring, and other aspects of the RAPS; (d) research carried out with the RAPS; (e) background information on the RPM; (f) materials, administration, scoring, and other aspects of the RPM; (g) and research carried out with the RPM.

Problem Solving and Autism

The theory of executive dysfunction is a widely-accepted theory of the connection between problem solving difficulties and autism. This theory links frontal lobe failure in analogy with neuropsychological patients who have damaged frontal lobes and subsequent impaired executive functions. Executive dysfunction underlies multiple characteristics of autism, including social and non-social domains. This theory addresses behavior problems such as rigidity and perseveration, which is explained by lack of initiation in new non-routine activities and tendency to be stuck in a certain task (Hill, 2004).

Ben Alderson-Day stated "children with autism spectrum disorders show a range of problems with executive function. The executive functions are higher-cognitive processes that are involved in maintaining information on-line when attempting goal-directed tasks, such as planning, cognitive flexibility, response inhibition, and working memory" (2011). Hill stated that executive functions are typically impaired when developmental disorders occur in a child (2014). People on the autism spectrum disorder additionally struggle with cognitive flexibility, which is the ability to switch tasks. Marshall (2008) stated that executive functioning is necessary to solve problems, which

requires identifying problems, goal setting, strategic thinking, and generating alternative solutions. People with autism especially struggle with verbal problem solving, which requires spontaneous planning and the ability to generate new plans.

Currently, there are no assessments created to specifically assess problem solving in children with autism. There are, however, clinical assessments to assess problem solving in adults who have suffered brain injuries, which result in similar executive dysfunction as people with autism.

Background of the RAPS

The Rapid Assessment of Problem Solving (RAPS) was created by Dr. Robert Marshall to assess problem solving in brain injured adults. The RAPS was created from Mosher and Hornsby's 20Q task (Mosher, 1966). This included one page of 42 watercolor drawings of common objections. To administer this assessment, the examiner would place the page in front of the examinee and give the following instructions:

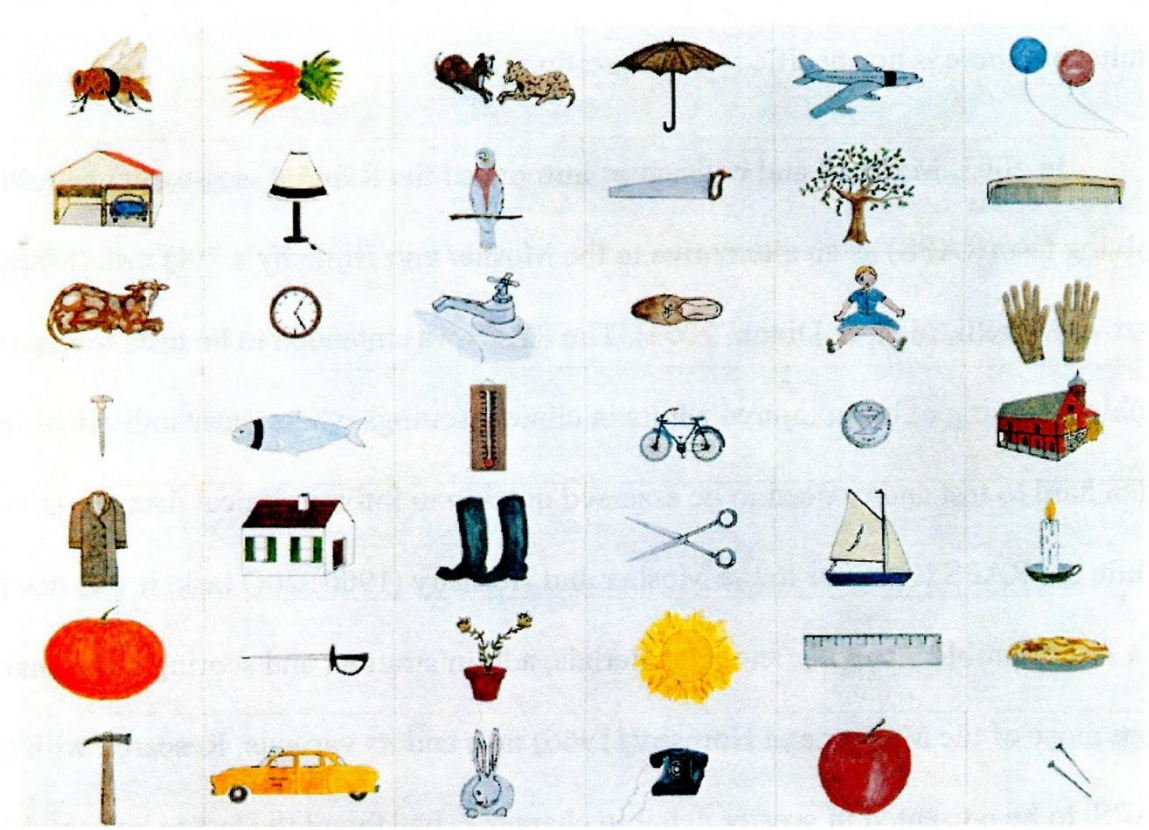
> "Now we're going to play a question-asking game. I'm thinking of one of these pictures and your job is to find out which one it is that I have in mind. To do this you can ask any questions at all that I can answer by saying "yes" or "no," but I can't give any other answer but "yes" or "no." You can have as many questions as you need, but try to find out with as few questions as possible" (Denney, 1985).

The 20Q task classified the various questions asked as constraint-seeking (CS), hypothesis-scanning (HS), or pseudoconstraint questions (PC). CS questions eliminated more than one object. HS and PC were two types of guesses that either eliminated one picture (when answered with a "no") or solved the answer (when answered with a "yes"). The difference in hypothesis-scanning and pseudoconstraint questions is that the hypothesis-scanning questions named the targeted picture (e.g., Is it an apple?), while PC

questions targeted only one picture but were framed in such a way that the object was not named (e.g. Is it a red fruit that grows on a tree?).

Originally, the 20Q task was used to investigate the strategies used by six, eight, and eleven year-old boys to seek information (Mosher, 1966). It was found that children through this age range decreased their use of HS questions from close to 100% to 10%, increased their use of CS questions, and marginally increase their use of PC questions. A study conducted on elderly adults (mean age 82.5 years) showed they used more HT questions and fewer CS questions than middle-aged adults (mean 38.2 years), (Denney & Denney, 1973). Further research additionally suggested that as adults age, their use of CS questions decrease (Denney, 1982; Denney & Palmer, 1981). Additionally, the 20Q task has been used in people with cognitive-communicative disabilities. Barton (1988) conducted a study that found boys with learning disabilities completed the 20Q task with lower efficiency than the neurotypical controls. A variety of additional studies have investigated the problem solving skills of stroke survivors, adults with a history of alcohol abuse, those who are deaf and hard of hearing, and those suffering from traumatic brain injuries (Laine & Butters, 1982; Levin, et al., 1997; Marschark & Everhart, 1999; Marshall, Harvey, Freed, & Phillips, 1996).

Figure 2.1 The Twenty Questions Task by Mosher and Hornsby (1966)



Both the 20Q task and the RAPS present problems that require general sequential reasoning, a part of fluent intelligence (ability to solve new problems, use logic in new situations, and identify patterns) and executive functioning (Horn & Cattell, 1967). Marshall and Karow (2008) show that the most efficient way to identify the target picture is to ask constraint questions in order to strategically reduce possible targets. This would result in the examinee having high efficiency scores.

Differences in the 20Q task and the RAPS

The RAPS is similar to the 20Q task, however, there are multiple differences in the newer RAPS. Differences exist in the areas of screening, procedures, and picture stimuli. Table 2.1 (Smith, 2015) shows a summary of differences between the Twenty Questions Task (Mosher & Hornsby, 1966) and the RAPS (Marshall et al., 2003).

Table 2.1 Summary of Differences between Twenty Questions Task (Mosher & Hornsby, 1966) and the RAPS (Marshall et al., 2003) created by Smith, 2015

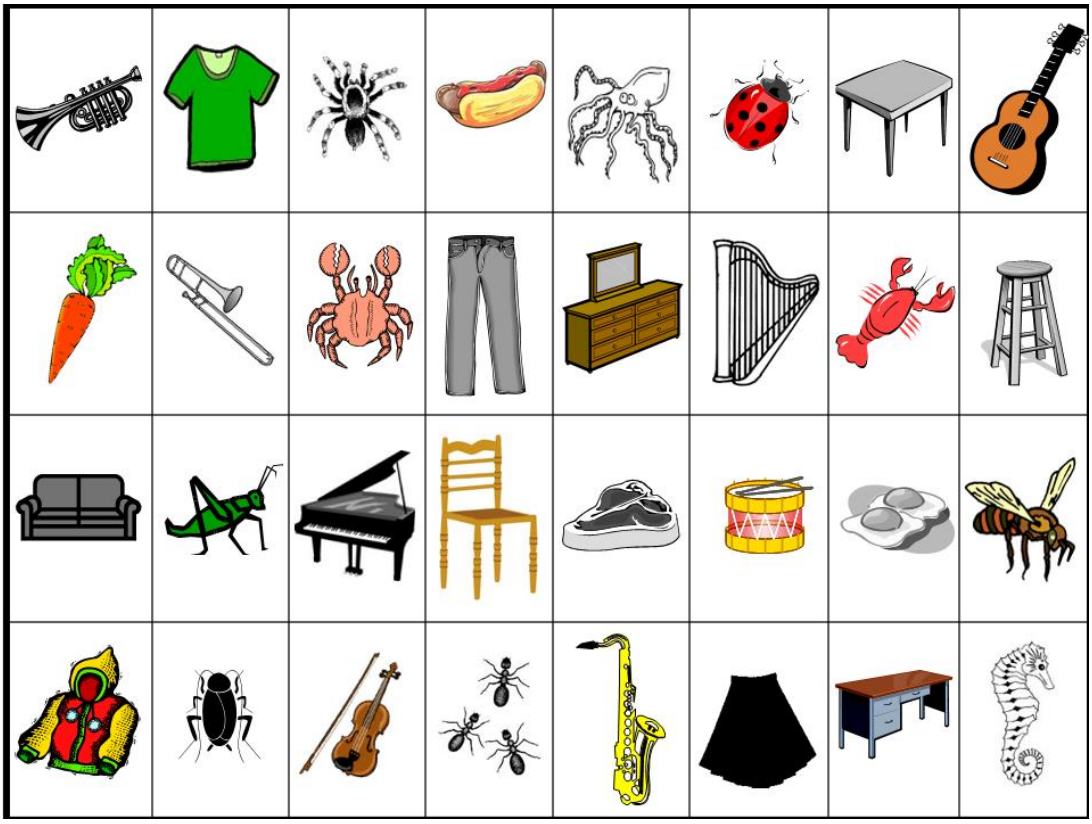
Feature	Twenty Questions	RAPS
Picture Stimuli	42 pictures in a 7 x 6 matrix	32 pictures in a 4 x 8 matrix
Picture features	Black and white line drawings	16 colored and 16 black and white pictures; slightly larger pictures
Picture categories	No control of number of pictures specified	Number of pictures in categories is controlled
Instructions	No modifications for disabled populations	Contains modifications for disabled populations; directs attention to problem solving board; stress on the word *few*
Screening	No screening for oral naming or picture recognition deficits; no practice on task	Screening for oral naming and picture recognition deficits; practice in yes/no question asking
Procedures	Does not cover pictures eliminated by questions	Covers pictures eliminated by questions
Repeat administration	Uses same 42-item picture repeatedly	Nine unique problem solving boards
Scoring	Number of questions needed to solve problem; % of constraint seeking questions	Adds question-asking efficiency scores; adds integration planning score

Materials for the RAPS

The RAPS contains nine problem solving boards similar to the example shown in Figure 2.2. Each of these boards are made up of 32 pictures of common objects derived from 18 common semantic categories including the following: animals, birds, desserts, food, clothing, body parts, furniture, gardening equipment, insects, kitchen items, musical instruments, medical equipment, plants, sea creatures, toys, tools, sports balls, and transportation. Each board has 32 pictures arranged on a 4x8 grid. Half of these pictures are colored and half are black and white. Each board contains pictures from 6 of the 18

semantic categories with one category of 8, two categories of 6, and three categories containing 4 pictures. The pictures from these categories are arranged so that no two pictures from the same category appear adjacently. The pictures are also arranged so that the black and white pictures are alternated with the pictures in color. Each board has a specific recording form on which to record the examinee's questions and other important information. A problem solving board is shown in Figure 2.2.

Figure 2.2 RAPS Board 2



Administration of the RAPS

For a RAPS assessment, the examinee completes three problems. For each problem, the examiner presents a board to the examinee and selects a target picture. The examinee asks yes/no questions until they identify the target picture. When the examiner presents the first problem solving board, they give the following directions:

> "We are going to play a question-asking game. I am thinking of one of these pictures (examiner gestures to the pictures) and your job is to figure out which one it is. The way to do this is to ask me questions that I can answer "yes" or "no." You can ask me any question you want so long as I can answer it "yes" or "no." Try to ask as *few* questions as possible. When you are ready, go ahead and ask your first question."

Once the examinee asks a yes/no question, the examiner responds either "yes" or "no" and covers the pictures eliminated by that question before proceeding. Once the examinee's questions have reduced the available options to two or three, the problem is solved. The examiner then presents two different problems to be solved in the same manner. There is no time limit for the examinee, however, if the examinee's questions are exclusively guesses, the task is terminated with a "yes" response. The administration guidelines for the RAPS (Marshall, et al., 2003a) specify additional directions for certain, unexpected situations.

Scores for the RAPS

Performance on the RAPS has been quantified with four types of scores. The examinee's scores are an average for the three problems. The scores used are as follows: (a) number of questions utilized to solve the problem, (b) percentage of constraint seeking questions asked, (c) efficiency scores, and (d) integration planning scores. A RAPS problem is solved when the examinee's questions have narrowed down the options to two or three pictures, and the questions asked to that point are totaled. Constraint seeking questions are those which eliminate more than one picture from the board. The percentage of these questions asked is determined by dividing the number of CS questions used to solve all three of the problems by the total number of questions used. Efficiency scores are calculated based on the first four questions asked in each of the

three problems. Lastly, integration planning scores (IPS) are assigned to the first question asked for each problem based on the number of pictures targeted by that first question.

Question Categorization of the RAPS

How people see the information in front of them determines how they will assess the situation and how they will approach reaching a solution. Marshall and Karow (2008) stated that after administering the RAPS to 373 neurotypical adults, all participants had a strategy, although the types of strategies varied greatly. Following this study, Marshall and Karow defined categories for the various types of questions. They used these definitions to categorize all 4,842 questions that their 373 participants asked. These categories are as follows: novel, category-focused, narrowing, inefficient constraint questions, or guesses.

Novel questions target nine or more of the pictures, or have efficiency scores of 50% or more. Category-focused questions are questions that target one semantic category. The RAPS has a variety of picture categories on each board, typically with 4, 6, or 8 pictures in each category. These category-focused questions may target all of the pictures in one category, or they will target the remainder of the category if some pictures from that category have previously been eliminated.

Narrowing questions are constraint questions that are used as follow-up questions once the examinee has correctly identified the category of the target picture. The narrowing questions target more than one picture in the category. Narrowing questions continue to reduce the number of pictures possible while keeping the number of questions asked to a minimum.

Inefficient constraint questions are questions with efficiency scores of less than 50%, as long as they are not category-focused, novel, or narrowing but still qualify as constraint questions. This category exists due to the possibility of asking constraint questions that are not efficient.

Guesses are those questions that target one possible picture. If answered with a "yes," they solve the problem, and if answered with a "no," they make little progress in solving the problem. Frank guesses are when one picture is targeted directly (i.e. Is it the horse?). Psuedo-constraint guesses are when only one item is targeted but the question is posed in a non-direct way (i.e. Is it a four legged animal that cowboys ride with a saddle?).

Research with the RAPS

The RAPS was introduced as a clinical measurement of problem-solving in people who are difficult to test (Marshall, 2003a). The RAPS is based on the 20Q task, and in 2003 Marshall provided research that was conducted on 70 neurotypical adults and three adults with traumatic brain injury. This study showed that performance levels on this assessment are largely related to planning and shifting set, which are two components of problem solving. It also showed variability in the performance levels of neurotypical adults; however, there was a trend that adults asked mostly constraint questions and preferred category-limited questions which focused on semantic categories or features.

Marshall also researched the use of the RAPS to compare twenty-one adults with traumatic brain injury (TBI) alongside twenty-one neurologically intact age and gender matched peers (Marshall, et al., 2003b). Question efficiency scores were higher for the neurologically intact adults, whereas the adults with TBI utilized a larger percentage of

guesses. Marshall, et al. (2006) utilized the RAPS to assess problem solving abilities of forty-seven people with and without severe mental illness (SMI). The adults with SMI tended to make more guesses than the controls, and they solved fewer problems. Ferguson, Marshall, and Olson (2012) compared three groups of participants including soldiers with blast injuries, adults suffering from TBI, and age-matched controls. The controls yielded statistically significant higher scores. Additionally, the study found that the soldiers with blast injuries achieved higher IPS scores.

Marshall and Karow published a RAPS update in 2008. This update included research on 373 adults spread across the lifespan from 18-87 years of age. This study found good test-retest stability and a significant correlation between the efficiency score for the RAPS and scores on a non-verbal measure of problem solving, the Raven Colored Progressive Matrices (RCPM) (Marshall and Karow, 2008).

In 2013, Marshall and Karow developed a rubric to score the RAPS. The rubric included six different component elements including the following: planning, strategy choice, strategy execution, awareness of category size, use of narrowing questions, and number of questions. Each element was scored with a 0, 1, or 2. Research was completed that compared sensitivity (probability of identifying abnormal functioning in an impaired individual) and specificity (probability of identifying normal functioning in a healthy individual with the test in question). This research was conducted for groups of neurologically intact (NI) and neurologically compromised (NC) subjects who were matched for age, gender, and education. The rubric successfully identified 87% of the NC subjects, whereas traditional scoring did not identify as many. The RAPS specificity did not show any change with the scoring rubric. Use of the rubric decreased the

administration and scoring time. This research showed that using the rubric for scoring balances clinical observation and measurement and may help time-conscious clinicians develop more efficient ways to quantify performance on multi-component executive function tasks such as the RAPS.

In 2015, Smith conducted a cross sectional study that assessed 229 neurotypical children using the RAPS. This study examined differences in problem solving skills of children aged 7-17. It primarily focused on the cognitive function of planning. It was found that younger children guessed 18.7% of the time on their first and second question, whereas the adolescent children guessed 3.4% on their first and 6.5% on their second (Smith, 2015). The Mean Integration Planning Scores (MIPS) also showed statistically different improvement in the older age range of participants. The youngest age group also had a statistically significant lower overall RAPS efficiency score. This study revealed several age-related differences in problem solving ability and strategy. It also found that "adults and children differ in their ability to integrate and use information available to them to plan, select and execute strategies, and make the necessary strategy shifts to solve problems on the RAPS" (Smith, 2015).

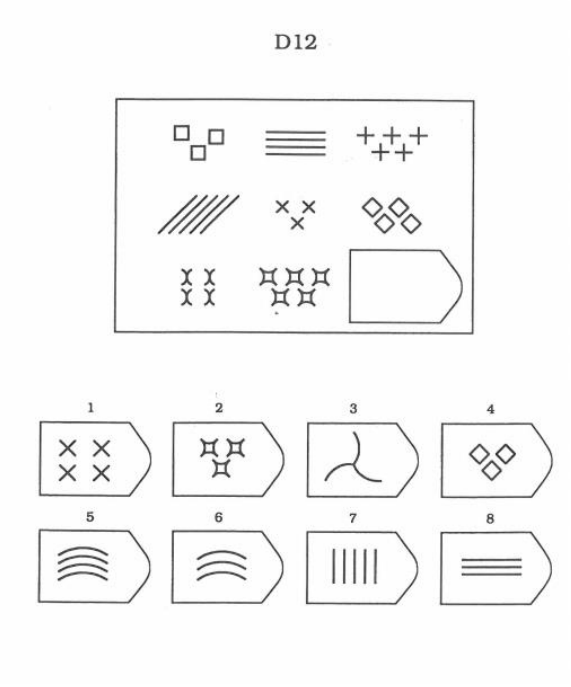
In summary, the RAPS has been used multiple times to test the problem solving ability of neurotypical adult subjects across the lifespan, compare problem solving in neurotypical and neurologically compromised adults, and assess the effects of various problem solving interventions used with adults. In 2015, Smith conducted research that provided norms for the RAPS on 229 neurotypical children.

Background of RPM

The Raven's Progressive Matrices (RPM) directly measures two main components of general intelligence: educative ability and reproductive ability (Raven, 2000). Educative ability is the ability to make meaning from confusion, or the ability to generate high-level, often nonverbal, schemata which allows us to handle complexity. Reproductive ability is what allows us to absorb, recall, and reproduce information that has been made explicit and communicated from one person to another (Raven, 2000).

The Standard Progressive Matrices (SPM) was standardized on 1,407 children in Ipswich, England (Raven, 2000) and normed in many countries. The RPM was created as a book assessment for an examinee to fill out independently. The current study used an online version of the RPM that allowed the examinees to complete the assessment independently on an iPad which has been shown to be an acceptable alternative (Calvert, 1982).

Figure 2.3 Example Problem from the RPM



Materials and Administration for the RPM

The Raven's Progressive Matrices consists of 30 diagrams and three trial items. It is made up of a series of diagrams with one part that is missing. The test taker must determine the correct part needed to complete the designs from options provided. An example problem is provided in Figure 2.3. Many versions of this test have been created including the Advanced Progressive Matrices and the Coloured Progressive Matrices. The current study used the Standard Progressive Matrices test, which was administered electronically via an iPad. Once the participant was ready to begin the assessment, they were given an iPad with the following directions as their first screen:

> "The SPM measures observation skills and clear-thinking ability. For each item, there is a piece missing in the pattern. Your task is to click on the piece that correctly completes the pattern. To solve the items, look across each row and down each column of the pattern to find the missing piece. The correct answer matches the pattern going across the row and down the column. There are three (3) practice items. You can complete and review the practice items before you begin Part 1 of the test."

Once the assessment starts, the participants are given no time limit to complete three trial items. After completing each individual item, the participants are told the correct answer and given a small paragraph describing the reasoning behind the answer. Once this is completed, participants are prompted to begin Set 1. Set 1 contains 28 items and allows the participants forty-five minutes to complete them. Set 2 allows participants two minutes to complete two items. After the completion of Set 2, the participants are shown a page confirming they had completed the assessment.

Scores for the RPM

The RPM provides raw scores and percentile scores for a variety of different norm groups, (such as employed adults, managers, sales representatives, etc.), and an

automatic report. The automatic report yields information regarding the norm group chosen, score interpretation, and skills and abilities assessed. The SPM measures observation skills, clear thinking ability, intellectual capacity and efficiency while minimizing the impact of language skills on performance of the assessment.

Research with the RPM

The Standard Progressive Matrices (SPM) was standardized by J.C. Raven in Ipswich, England with 1,407 children. In 1979, the standardization of the SPM was conducted in multiple areas of Great Britain. Combined, this standardization included 3,250 children ranging in age from 6 to 16 years of age. Standardization in the United States occurred between 1983-1989 through over fifty studies including 60,000 students ranging in age from 5-18 years old (Raven, 2000). The norms provided by these studies revealed a marked difference across school districts and between socioeconomic and ethnic groups. Across the variety of research that has been conducted to standardize the SPM, there was considerable similarity in the norms across societies with a tradition of literacy. The research displays a continuous increase in the scores at all levels of abilities over time (Raven, 2000).

The RPM was also standardized for the adult population. In the 1940s it was normed on a variety of groups of adults in the United Kingdom (Raven, 2000). In 1992 it was standardized in Dumfries, Scotland, and in 1993 it was standardized in Des Moines, Iowa. This study was significant because Des Moines is one of four cities considered to have demographic compositions approximating the United States as a whole. Additional studies were conducted in the 1980s that confirmed the norms for Des Moines approximate those for the United States (Raven, 2000). In 1998 the Raven's Advanced

Progressive Matrices was normed on five hundred and six first year university students at the University of Toronto at Scarborough (Bors and Stokes).

In 2007, Dawson and associates utilized the RPM in a study regarding the level and nature of autistic intelligence. They compared participants' scores on the RPM to their scores on the Wechsler scales of intelligence. This study revealed a discrepancy between these two scores by the 38 participants with autism which was not shown in their participants who were neurotypical. This study indicated that children with autism may be intellectually underestimated when assessed solely on intelligence (Dawson, 2007).

In Iceland, a study was conducted which used an online version of the RPM that allowed the examinees to complete the assessment independently on an iPad. E.J. Calvert (1982) completed a study comparing the results of 83 people on RPM. The examinees were divided with some completing the assessment via the conventional book and other utilizing new automated equipment. The group was then retested and the participants completed the opposite version of the test. This study revealed that the "automated presentation of the matrices is an acceptable alternative to the standard form" (Calvert, 1982) demonstrating use of automated administration can be interpreted as consistent with results from the conventional paper presentation of the RPM.

METHODS

This descriptive study examined the performance of children with autism and typically developing children on the Rapid Assessment of Problem Solving test (RAPS; Marshall et al., 2003) and Raven's Progressive Matrices. The study was approved by the Western Kentucky University Institutional Review Board (IRB #17-442).

Participants

Twelve male children with autism and fifteen male children who were typically developing participated in this study. Their ages ranged from 10-16 years of age and they came from a variety of races including Caucasian and African American. There were no reported coexisting disorders.

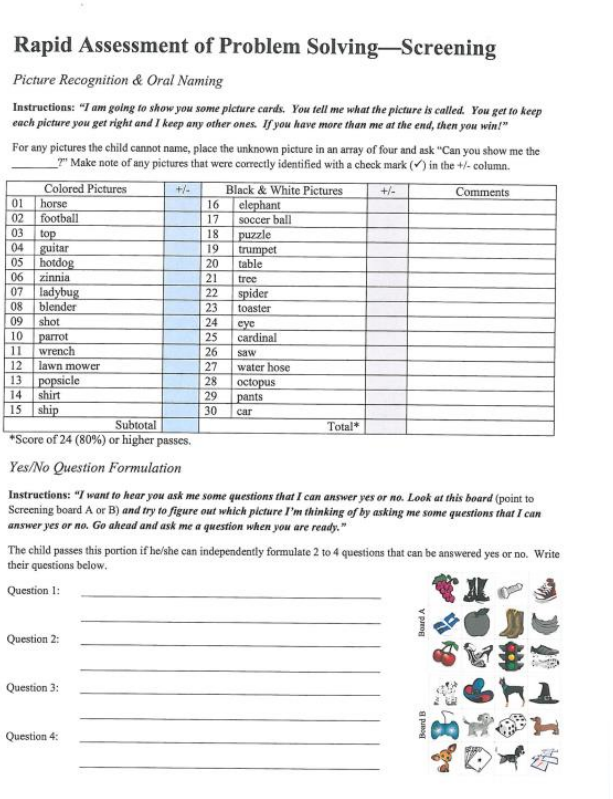
Screening Tasks

Before administration of the RAPS, each child successfully completed two screening tasks. The first screening task, designed to ensure the child's familiarity with stimuli from the RAPS, required the child to orally name or identify 30 of the 126 pictures on the RAPS. The pictures (see Figure 3.1) were selected randomly by choosing one or two pictures from each of the 18 picture categories from the RAPS. Each child completed this task with the same set of pictures. Naming responses were scored correct or incorrect. Alternative responses which indicated the child recognized the picture were considered correct. These included categorical names (e.g., tool for "wrench"), semantically related responses (e.g., cone for "ice cream cone"), and descriptive responses (e.g., yellow flower for "zinnia"). If a child misidentified a picture, picture recognition was assessed with a word-to-picture matching task. The researcher presented the misidentified picture in a row of four pictures and asked the child to point to the

misidentified picture (e.g., “point to the zinnia”). The child passed this screening test if they recognized or named 80% (24/30) of the pictures presented.

The second screening task was designed to ensure the child was able to ask yes/no questions. Two 12-picture problem solving boards, similar to the larger 32-item boards of the RAPS, were shown to the child. The pictures included were not from the RAPS. Six pictures were black and white and six pictures were in color. Three categories (e.g., shoes, fruit, and dogs) were represented. Each board had one category of 6, 4, and 2 pictures respectively with no two pictures from the same category appearing in adjacent positions. The child was given the following directions: “I am thinking of one of these pictures. I want to hear you ask me some questions that I can answer “yes” or “no” to try to figure out the picture I’m thinking of.” If the child asked a yes/no question, it was answered “yes” or “no,” then the child was encouraged to ask another question. If the child did not ask a yes/no question, the child was provided additional instruction such as “You need to ask a question that I can answer yes or no; try again.” The child passed the screening test when they asked two consecutive yes/no questions. All participants passed both screening tests.

Figure 3.1 RAPS Screening Protocol for Children



Rapid Assessment of Problem Solving—Screening

Picture Recognition & Oral Naming

Instructions: ***"I am going to show you some picture cards. You tell me what the picture is called. You get to keep each picture you get right and I keep any other ones. If you have more than me at the end, then you win!"***

For any pictures the child cannot name, place the unknown picture in an array of four and ask "Can you show me the _____?" Make note of any pictures that were correctly identified with a check mark (✓) in the +/- column.

	Colored Pictures	+/-		Black & White Pictures	+/-	Comments
01	horse		16	elephant		
02	football		17	soccer ball		
03	top		18	puzzle		
04	guitar		19	trumpet		
05	hotdog		20	table		
06	zinnia		21	tree		
07	ladybug		22	spider		
08	blender		23	toaster		
09	shot		24	eye		
10	parrot		25	cardinal		
11	wrench		26	saw		
12	lawn mower		27	water hose		
13	popsicle		28	octopus		
14	shirt		29	pants		
15	ship		30	car		
	Subtotal			Total*		

*Score of 24 (80%) or higher passes.

Yes/No Question Formulation

Instructions: ***"I want to hear you ask me some questions that I can answer yes or no. Look at this board*** (point to Screening board A or B) ***and try to figure out which picture I'm thinking of by asking me some questions that I can answer yes or no. Go ahead and ask me a question when you are ready."***

The child passes this portion if he/she can independently formulate 2 to 4 questions that can be answered yes or no. Write their questions below.

Question 1: _____

Question 2: _____

Question 3: _____

Question 4: _____

Board A

Board B

Procedures

Children with autism were recruited through the Western Kentucky University Kelly Autism Program. Typically developing children were recruited through the families of children with autism and social media. Graduate and undergraduate students performed the screening tests and administration of the RAPS and the RPM.

Training

Before performing any tasks with participants, the student researchers completed two modules of the Collaborative Institutional Training Initiative (CITI) required of entry level investigators and participated in two training sessions. The first training session required the students to practice administering the screening task and RAPS assessment. The students practiced giving the test to each other and recording the necessary

information on the recording forms for the RAPS to score the test. This training was carried out under the direction of the investigator. Students were provided feedback of their administration, recording of responses, and scoring. Student questions were addressed as they came up throughout the length of the training.

Administration of the RAPS

The 27 child participants were assessed in the fall of 2017. Student researchers met with children in a quiet classroom of the Kelly Autism Program and the Academic Complex on Western Kentucky University's campus. After ensuring the child met the inclusion criteria, the student researcher had the participant sign an assent form. Half of the participants were administered the RAPS twice, followed by the RPM. The other half of the participants were administered the RPM, followed by the RAPS twice. Breaks were given between each test.

All 27 children were administered the RAPS and RPM individually in single sessions. The RAPS was administered twice, in order to ensure test-retest stability. When administering the RAPS, the student researchers followed guidelines proposed by Marshall et al. (2003b) and described in Chapter 2. To begin the test, the student researcher placed the first problem solving board on the table in front of the child and gave the following instructions:

> "We are going to play a question-asking game. I am thinking of one of these pictures (tester gestures to the pictures) and your job is to figure out which one it is. The way to do this is to ask me questions that I can answer "yes" or "no." You can ask me any question you want so long as I can answer it "yes" or "no." Try to ask as *few* questions as possible. When you are ready, go ahead and ask your first question."

After the participant asked a question, the researcher recorded the question and covered the pictures eliminated by the question. This process was repeated until the

child's questions had reduced the 32-item board to two or three items, at which point the problem was solved. The participant solved six RAPS boards following these procedures. The participant then completed the RPM according to standard procedures described in the Manual (Raven, Raven, & Court, 2003). Upon completion, the child was given a novelty item. The researcher then concluded the session and provided the participant with general praise and encouragement.

Administration of the RPM

The twenty-seven child participants who completed the RAPS also completed the RPM. The RPM was administered electronically on an iPad. The participants were provided directions as described above and then were presented three practice items with no time limit. They were then given 45 minutes to complete 28 problems in Set 1, and then two minutes to complete two problems for Set 2.

Follow-up Activities

Upon completion of the testing, the student researchers met and reviewed the information on the recording forms of the RAPS for accuracy. They reviewed the questions students asked to ensure the correct label had been assigned to each question.

After review of the twenty-seven assessments given, the student researchers completed calculations to score the remaining tests. This required student researchers to (1) count the number of questions asked to solve each problem, (2) count the number of CS questions asked, and (3) calculate QES for the first four questions in each problem. Each question was additionally labeled novel, category-limited, inefficient constraint question, a frank guess, or a pseudo-constraint guess.

Scoring

Scoring of the RPM was calculated electronically and provided in a report. The report provided the raw score which indicated how many assessment items the participant got correct. The raw scores were then taken and a percentage correct was reached by dividing the raw score with the total number of problems (twenty-eight for this assessment). The current study used this percentage as the best alternative to a standard score.

Figure 3.2 RAPS Recording Form

Rapid Assessment of Problem Solving—Recording Form

BOARD 2

Name:_____ **Date of Testing:**_____

Ethnicity: (Please check one box.) ❒ Arab ❒ Asian/Pacific Islander ❒ Black ❒ Caucasian/White ❒ Hispanic ❒ Latino ❒Native American ❒ Multiracial ❒ Other

Gender M F **D.O.B.** _____ **Age** (yrs:mos) ___:___ **Problem:** ☐ 1 ☑ 2 ☐ 3

Question Asked (Write each question in the space provided below.)	Y N	Question Type	# Pictures Considered	# Pictures Targeted	# Pictures Eliminated	Question* Efficiency
1. Does it have color?	N	NOV	32	16	16	1.0
2. Is it alive?	N	CF	16	5	5	0.63
3. Is it a musical instrument?	N	CF	11	4	4	0.73
4. Is it a piece of furniture?	Y	CF	7	3	4	0.86
5. Is it used for eating?	N	PCG	3	1	1	0.67
6. Is it soft?	Y	PCG	2	1	1	1.0
7. Is it the couch?	Y	PCG	1	1	1	
8.						
9.						
10.						

**QE is calculated by dividing either Pictures Targeted OR Pictures Eliminated (whichever is smaller) by Pictures Considered. Then, multiply the answer by 2. The QE could be as high as 1.0 or as low as 0.06.*

RAPS Scores	Total Constraints 4: Category Limited	Narrowing	Novel	Inefficient Constraint	Total Guesses 0: Frank Guess	Pseudo-Constraint	Total Questions
Types of Questions	3	0	1	0	0	0	4

		IP Score
Integration Planning Score	**FIRST question** targeted 1 pic = IP of 1; 2-3 pics = 2; 4-5 pics = 3; 6-7 pics = 4; 8 pics = 5; & 9+ pics = 6	6

	QE for Question # 1	2	3	4	QAE
Question Asking Efficiency Score* **Add QE for questions 1+2+3+4. Divide total by 4 to calculate QAE.*	1.0	0.63	0.73	0.86	0.81

Information for Board 2

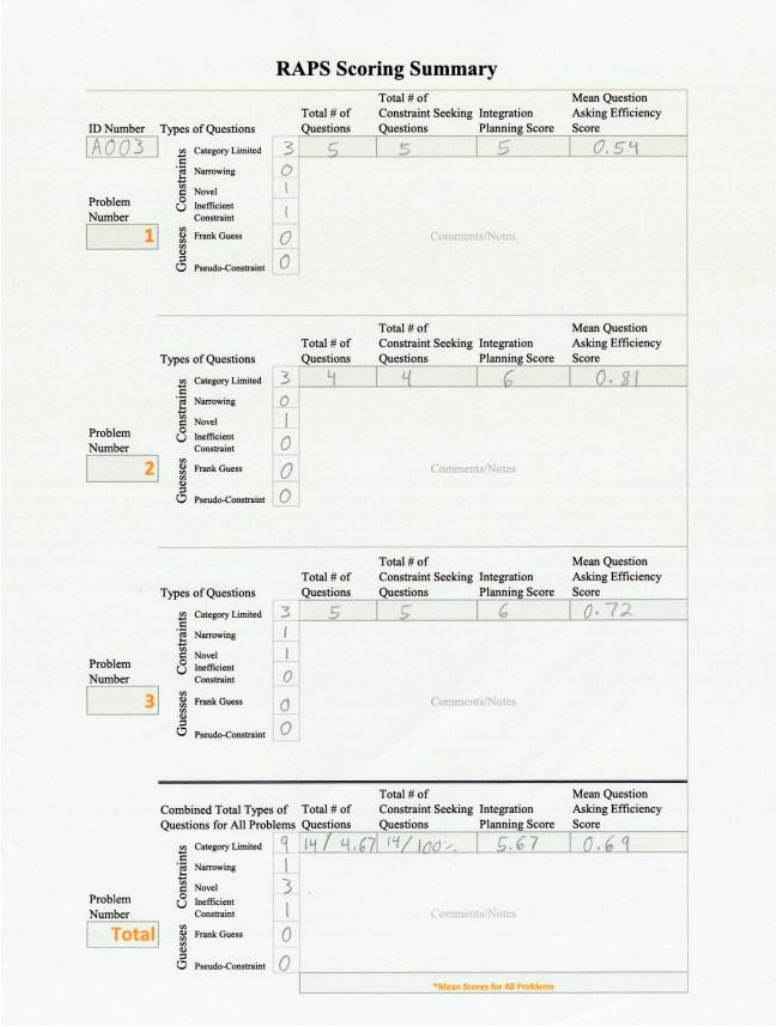
# of ITEMS	CATEGORY	BLACK & WHITE	COLOR
4	Clothing	Pants, Skirt	Shirt, Jacket
4	Food	Steak, Eggs	Hot dog, Carrot
4	Sea Creatures	Seahorse, Octopus	Crab, Lobster
6	Insects	Spider, Ants, Roach	Bee, Ladybug, Grasshopper
6	Furniture	Table, Couch, Stool	Desk, Dresser, Chair
8	Musical Instruments	Harp, Trombone, Piano, Trumpet	Guitar, Saxophone, Violin, Drum

©2001 Marshall & Lewis. Rapid Assessment of Problem Solving (RAPS)

Scoring of the RAPS was completed by the student researchers as described above. This required student researchers to calculate and average scores for each

problem, which yielded mean scores for each participant. For explanation purposes, a completed RAPS test from a participant and the corresponding scoring summary (Figure 3.2 and Figure 3.3, respectively) was included. This recording form shows (a) the questions the participants asked, (b) whether the answer was yes (Y) or no (N), (c) whether the question was a constraint-seeking or guess, (d) the number of pictures targeted by the question, and (e) the number of pictures eliminated by each question.

Figure 3.3 RAPS Scoring Summary Sheet



RAPS Scoring Summary

ID Number: A003

Problem Number	Types of Questions			Total # of Questions	Total # of Constraint Seeking Questions	Integration Planning Score	Mean Question Asking Efficiency Score
1	Constraints	Category Limited	3	5	5	5	0.54
		Narrowing	0				
		Novel	1				
		Inefficient Constraint	1				
	Guesses	Frank Guess	0				
		Pseudo-Constraint	0				
2	Constraints	Category Limited	3	4	4	6	0.81
		Narrowing	0				
		Novel	1				
		Inefficient Constraint	0				
	Guesses	Frank Guess	0				
		Pseudo-Constraint	0				
3	Constraints	Category Limited	3	5	5	6	0.72
		Narrowing	1				
		Novel	1				
		Inefficient Constraint	0				
	Guesses	Frank Guess	0				
		Pseudo-Constraint	0				
Total	Constraints	Category Limited	9	14 / 4.67	14 / 100%	5.67	0.69
		Narrowing	1				
		Novel	3				
		Inefficient Constraint	1				
	Guesses	Frank Guess	0				
		Pseudo-Constraint	0				

Combined Total Types of Questions for All Problems

Comments/Notes

*Mean Scores for All Problems

Mean number of questions (M#Q)

This score was reached by finding the average of the number of questions asked to solve each problem. Figure 3.3 showed that the participant asked 5, 4, and 5 questions to solve problems 1, 2, and 3, respectively. This yielded a M#Q socre of 4.67 (5 + 4 + 5 = 14/3).

Percentage of constraint seeking questions (%CS)

This score is representative of the number of CS questions asked to solve all three of the problems. The score is determined by dividing the number of CS questions by the total number of questions. Figure 3.3 shows the participant used 14 questions to solve the three problems, 14 of which were CS questions. The %CS for this participant is 100%.

Mean integration planning score (MIPS)

The integration planning score (IPS) was derived from the first question asked in each problem. This score is based off the amount of pictures targeted by the first question. The key is as follows: 1 = one picture, 2 = two or three pictures, 3 = four or five pictures, 4 = six or seven pictures. 5 = eight pictures, and 6 = nine or more pictures. The example shows that the first question for problems 1, 2, and 3 received IPS of 5, 6, and 6, respectively. The average of these IPS scores was 5.67 (5 + 6 + 6 / 3).

Efficiency scores

Question-asking-efficiency scores (QAE) were determined from the first four questions of each problem. The efficiency was reached by dividing the smaller of the two numerators: either the pictures targeted or pictures eliminated, by the number of pictures available when the question was asked, then multiplying that by two. Figure 3.2 shows the QAE score for this board: 1.0, 0.63, 0.73, and 0.86. These are averaged for a QAE

score of 0.81 on board 2. The RAPS Scoring Summary (Figure 3.3) shows the QAE scores from each board (1, 2, and 3) of this problem. Those three scores were averaged to reach the Mean QAE score for this assessment, which was 0.69.

RESULTS

The twenty-seven participants solved two RAPS assessments and completed the RPM. Half the participants (six participants with autism and eight neurotypical participants) completed the RPM, were given a break, completed one RAPS assessment, were given a break, and then completed a different RAPS assessment. The other half of the participants (six with autism and seven neurotypical participants) completed one RAPS assessment, had a break, completed a different RAPS assessment, were given a break, and then completed the RPM.

Reliability Analysis

Prior to this study there was no reliability data for use of the RAPS with children. The children who participated were given the RAPS assessment twice, with a small break between testing. The QAE scores from both assessments were used to run reliability measures on SPSS to reach the Chronbach's Alpha number.

Table 4.1 Reliability of RAPS

Total Reliability	Reliability for Neuro-typical Children	Reliability for Children with Autism
.92	.65	.92

The reliability for all twenty-seven participants was at .92, which shows high reliability of the RAPS. The reliability for children with autism was also .92. The reliability for neurotypical children was low at .65. This low score could be attributed to the small sample size, fatigue throughout testing, or boredom with activity.

Section 1: Strategy

Integration Planning Scores

As mentioned previously, the Integration Planning Score (IPS) was created to measure the efficiency of asking as few questions as possible to solve the problem. It measures the number of pictures targeted by the first question in each problem. Values are assigned as follows: target 1 picture = 1; target 2-3 pictures = 2; target 4-5 pictures = 3; target 6-7 pictures = 4; target 8 pictures = 5; and target 9 or more pictures = 6. Upon completion of the assessment (three problems) the IPS scores are averaged to reach a Mean Integration Planning Score.

As a whole of twenty-seven participants, the mean IPS of the first assessment was 4.27. On the second assessment the mean IPS was 4.22.

The group of participants with autism had a mean IPS of 3.08 on the first assessment. On the second assessment they had a mean IPS of 3.25. The participants with autism show a lower mean IPS than the participants who were neurotypical, indicating that they have more difficultly planning problem solving. They do, however, show an increase in the mean IPS of their second assessment which shows improvement over time and practice.

The group of neurotypical participants had a mean IPS of 5.22 with a range of 2.33. On the second assessment they had a mean of 5.00 and a range of 2.67. While their mean IPS scores were higher than the scores of the participants with autism, this group shows a decrease in IPS score from their first assessment to their second. This shows a decrease in planning over time.

Table 4.2 Integration Planning Scores on First RAPS Assessment

Age	Participants with autism	Participants who are Neurotypical
10	2	5.45
11	3.56	5.11
12	5.00	5.49
13	1.00	4.50
15	3.84	5.67
16	5.67	4.33

Figure 4.1 Comparison of IPS scores from the first RAPS assessment of children with autism to children who are neurotypical

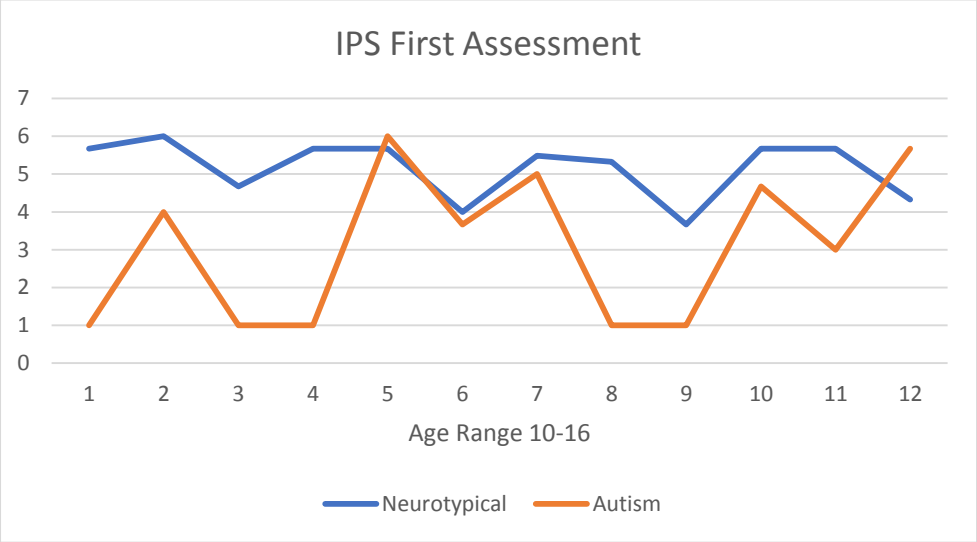


Table 4.3 Ages in Correlation to the X-value on graph 4.1

X Value	1	2	3	4	5	6	7	8	9	10	11	12
Age	10	10	10	11	11	11	12	13	13	15	15	16

Table 4.4 Integration Planning Scores on Second Assessment

Age	Participants with autism	Participants who are Neurotypical
10	2	5.00
11	2.67	4.0
12	3.67	5.34
13	2.17	5.00
15	5.50	5.67
16	6.00	5.33

Figure 4.2 Comparison of IPS scores from the second RAPS assessment of children with autism to children who are neurotypical

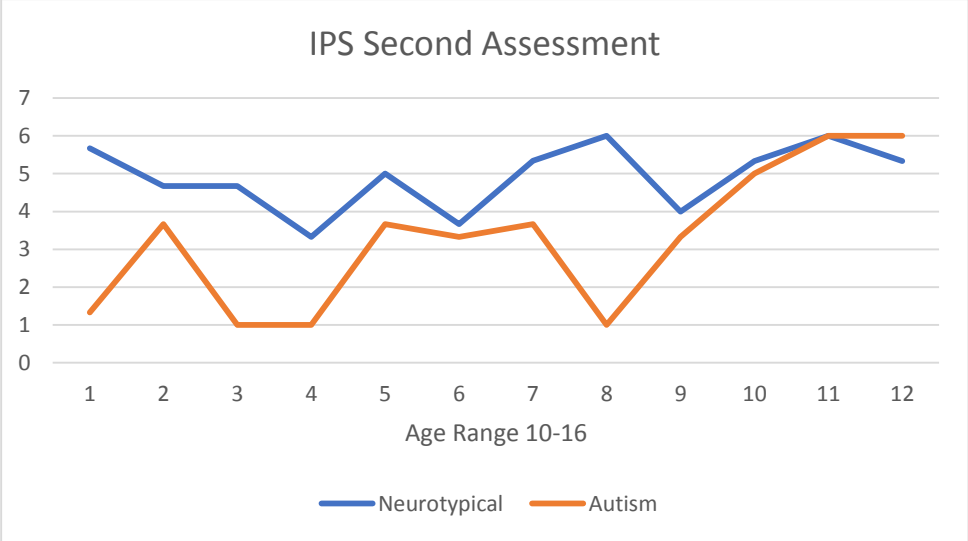


Table 4.5 Ages in Correlation to the X-value on graph 4.2

X Value	1	2	3	4	5	6	7	8	9	10	11	12
Age	10	10	10	11	11	11	12	13	13	15	15	16

RAPS Problem Solving Strategies

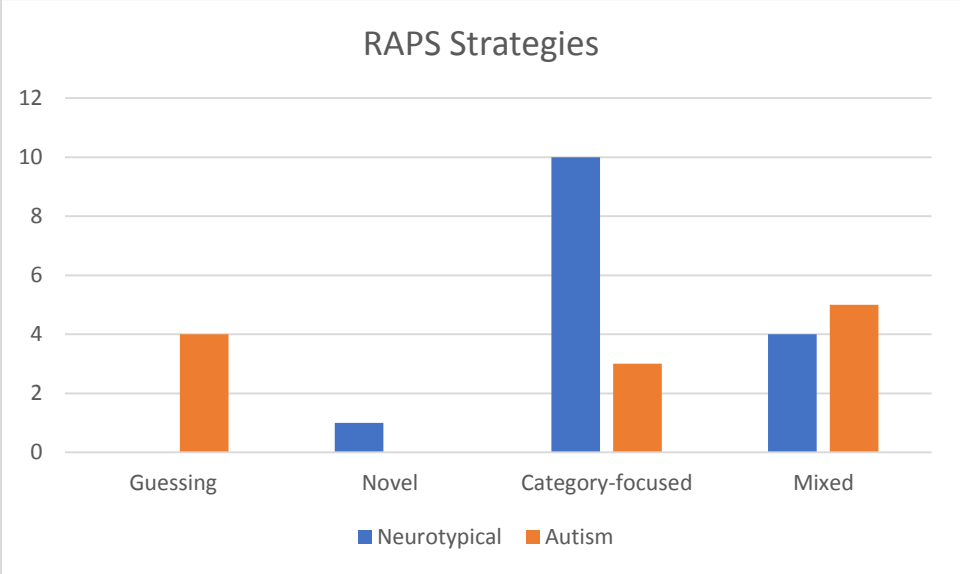
To solve the RAPS, there are four strategies. The first strategy is guessing, where the participant utilizes mostly frank or pseudo-constraint guesses. The next is the novel strategy where a participant utilizes novel questions. Third, there is the category-focused strategy where the participant focuses on categories to narrow the board. Lastly, there is a mixed strategy where participants utilize different types of questions equally. A visual analysis was completed to determine the strategy used by each participant. For this study, the different strategies were coded as follows: .00 = guessing, .01 = novel, .02 = category-focused, and .03 = mixed.

Of the twenty-seven participants, 4 utilized a guessing strategy, 1 utilized a novel strategy, 13 utilized a category-focused strategy, and 9 utilized a mixed strategy.

As a group, the children with autism used guessing, category focused, and mixed strategies. Three children used a category-focused strategy, 4 children used a guessing strategy, and 5 children used a mixed strategy. This indicates that the strategy used by children with autism was varied across the population assessed.

As a collective group, the children who were neurotypical used a mostly category-focused strategy. Of the fifteen neurotypical participants, 10 used a category-focused strategy. Four used a mixed strategy, and 1 used a novel strategy. This indicates that the children who were neurotypical mostly processed information according to categories.

Figure 4.3 RAPS strategies utilized by group with autism and group who was neurotypical



Section 2: Performance on the RAPS and RPM

Raw Scores and Percentages for RPM

For all twenty-seven participants, the mean raw score on the RPM was 12.52 with a range of 16.0. The mean percentage was 44.71 with a range of 57.14.

For the group of children with autism the mean raw score was 9.58 with a range of 16.0. The mean percentage was 34.23 with a range of 57.14. The group of children who are neuro-typical reached a mean raw score of 14.87 with a range of 15. Their mean percentage was 53.09 with a range of 53.57. These results reveal that the children with autism scored lower on the RPM than the group who was neurotypical. For Table 4.6 and Table 4.8 the participants in each age group were averaged for a complete age-to-age comparison.

Table 4.6 RPM Mean Raw scores by Age

Age	Participants with autism	Participants who are Neurotypical
10	7.33	9.00
11	11.00	14.67
12	5.00	14.00
13	8.50	19.00
15	8.50	19.00
16	21.00	20.00

Figure 4.4 Comparison of RPM Raw Scores matched by Age

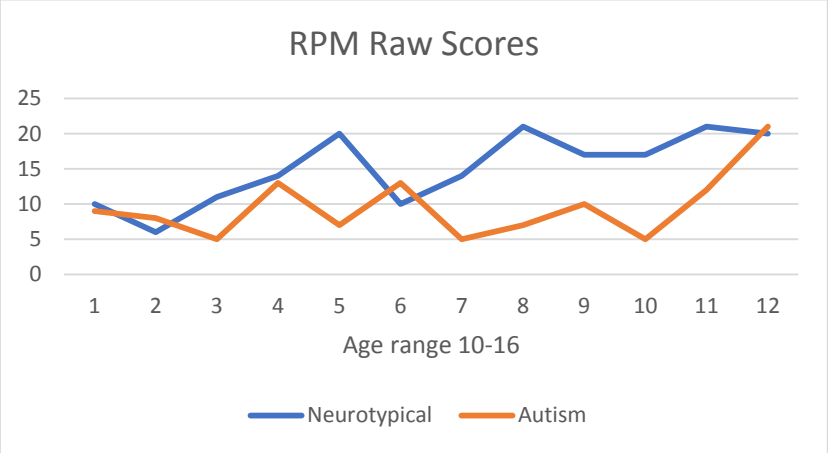


Table 4.7 Ages in Correlation to the X-value on Graph 4.4

X Value	1	2	3	4	5	6	7	8	9	10	11	12
Age	10	10	10	11	11	11	12	13	13	15	15	16

Table 4.8 RPM Mean Percentages by Age

Age	Participants with autism	Participants who are Neurotypical
10	26.19	32.14
11	39.29	52.38
12	17.86	50.00
13	30.36	67.86
15	30.36	67.86
16	75.00	71.43

Figure 4.5 Comparison of groups' RPM percentages

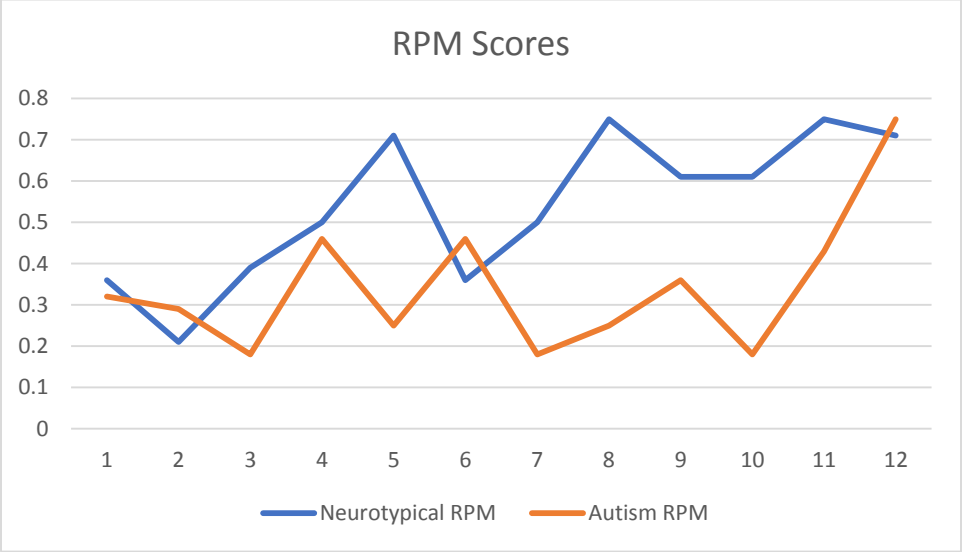


Table 4.9 Ages in Correlation to the X-value on Graph 4.5

X Value	1	2	3	4	5	6	7	8	9	10	11	12
Age	10	10	10	11	11	11	12	13	13	15	15	16

RAPS QAE results

As a combined group of all participants, the mean on the RAPS QAE on the first assessment was .54 and on the second assessment it was .54. The range for the first assessment was .76, and the range for the second assessment was .88.

As a group, the participants with autism had a QAE mean of .35 on the first assessment and .38 on the second assessment. The group of participants who were neurotypical had a mean QAE of .70 with a range of .31. On the second assessment they had a mean of .67 with a range of .47.

Table 4.10 Mean QAE Scores on First Assessment by Age

Age	Participants with autism	Participants who are Neurotypical
10	.24	.69
11	.40	.64
12	.65	.75
13	.07	.65
15	.38	.72
16	.69	.74

Figure 4.6 Comparison of QAE for RAPS First Assessment

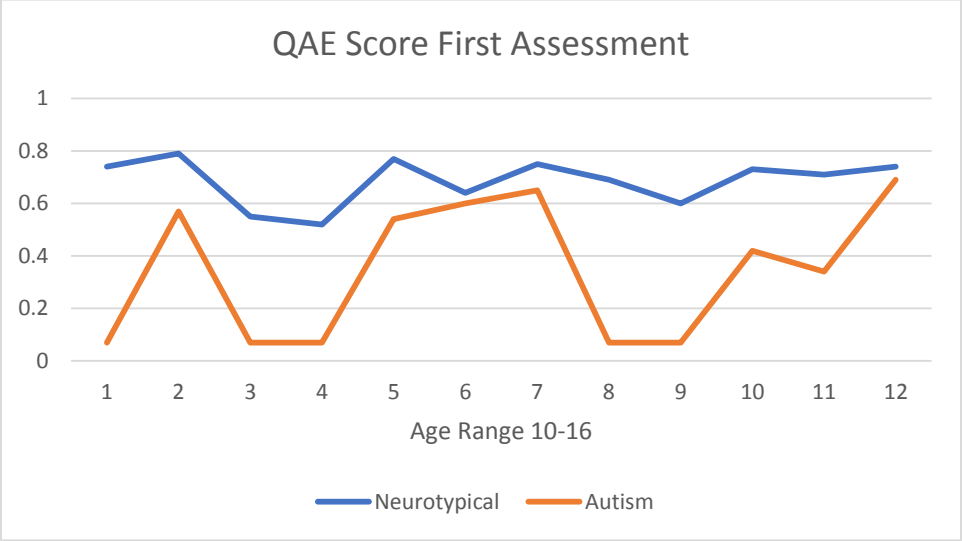
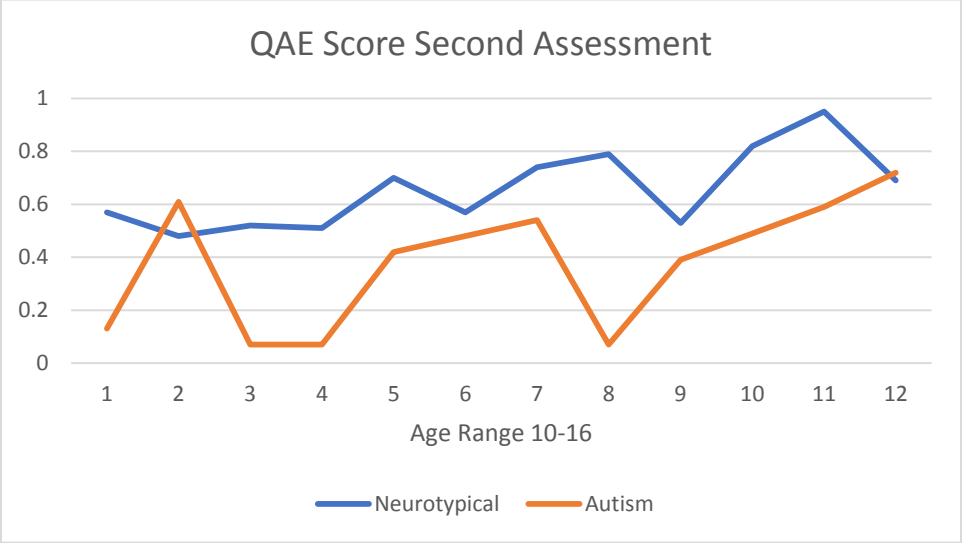


Table 4.11 Mean QAE Scores on Second Assessment by Age

Age	Participants with autism	Participants who are Neurotypical
10	.27	.52
11	.32	.58
12	.54	.74
13	.23	.66
15	.54	.89
16	.72	.69

Graph 4.7 Comparison of QAE scores for Second RAPS Assessment



The participants QAEs for both the first and second assessment were averaged. The data was then used to create this graph.

Figure 4.8 Comparison of mean QAE from both RAPS assessments

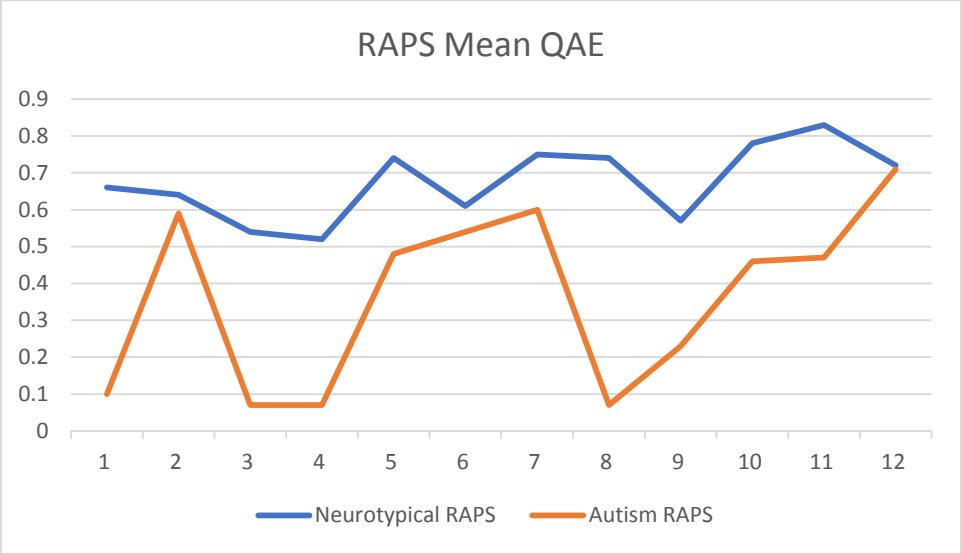


Table 4.12 Ages in correlation to the X-value on graph 4.8

X Value	1	2	3	4	5	6	7	8	9	10	11	12
Age	10	10	10	11	11	11	12	13	13	15	15	16

Correlation

A group analysis was completed to see if a correlation exists between the RAPS mean QAE and the RPM percentage. A Spearman's rho correlation was run between the RPM percentage and mean QAE of the RAPS for each group and all participants combined. The correlation coefficient for the twenty-seven participants as a group was .61. This indicates a statistically significant positive correlation between the RAPS and the RPM. The correlation for the group of participants with autism was .19 which is a weak correlation. Lastly, the group of children who are neurotypical had a weak positive correlation with a coefficient of .419.

DISCUSSION

This study assessed verbal and non-verbal problem solving in twenty-seven children with and without autism ages ten to sixteen. One trained graduate student and three trained undergraduate students administered the RAPS and RPM. Upon completion of the assessments, the trained research assistants calculated the question asking efficiency scores. The investigators completed score summaries for each of the RAPS assessment completed (a total of fifty-four assessments).

Reliability Analysis of the RAPS

The high reliability of the RAPS at .92 for all participants and also for the children with autism shows that the assessment measure what it purports to measure. The low reliability of .65 for children with autism was unexpected. Prior research conducted by Dr. Marshall used the RAPS in neurotypical adults and found test-retest stability was adequate for short term (2008), making the findings of low reliability in typical children in the study unexpected. Reliability in this study could have been influenced by the small sample size, fatigue throughout testing, or boredom with the activity.

Integration Planning Scores

As discussed previously, the Integration Planning Score (IPS) was created to measure the efficiency and ability to ask as few questions as possible to solve a problem. It measures the number of pictures targeted by the first question in each problem. Upon completion of the assessment (three problems) the IPS scores are averaged to reach a Mean Integration Planning Score.

The mean IPS for the group of twenty-seven participants of 4.27 on the first assessment and 4.22 on the second assessment shows that the participants' planning

decreased slightly over time. This could be due to a number of factors including overconfidence, fatigue, or boredom.

Contrary to the group as a whole, the group of participants with autism showed an increase in IPS over time. The group mean IPS of 3.08 which improved to 3.25 on the second assessment indicates that the participants learned over time how to target more pictures with the first question, which would lead to solving the problem faster. Participants who are neurotypical had a mean IPS of 5.22 which decreased to 5.0, showing that these participants decreased in their ability to begin problem solving with a strategy that would delete as many options as possible. This decrease in scores over time could be due to fatigue over time or boredom with the assessment.

RAPS Problem Solving Strategies

At the conclusion of data collection, the data was reviewed and a problem solving strategy was assigned. The first strategy was guessing, where the participant only chose to ask frank or pseudo-constraint guesses until the answer was reached; four participants with autism chose this approach. Novel strategy was one in which the participant asked a majority of novel questions, and one participant who was neurotypical utilized this strategy. Category-focused strategy is where the participant asked mostly category-focused questions; three children with autism and ten children who were neurotypical utilized this strategy. Lastly, there was a category for mixed strategy. These participants, five with autism and four without autism, utilized all types of questions including novel, category-focused, and narrowing.

These results reveal a difference in how children with autism approach problem solving as compared to peers who are neurotypical. The participants with autism were

fairly evenly divided across three groups: guessing, category-focused, and mixed. Four participants had no planning strategy and simply guessed, which shows a decreased ability to understand and approach problems. Three participants were able to split the information into groups and solve the problem by taking one group at a time. Five participants were able to utilize multiple strategies in order to decrease the options and solve the problem. This reveals that each individual with autism processes information in different ways.

RPM Raw Scores and Percentages

The RPM provided a raw score, the total number of problems they got correct out of 28 problems solved. This raw score was then taken and converted into a percentage for a 0-100% score. For all twenty-seven participants, the mean raw score on the RPM was 12.52 with a range of 16.0, with the mean percentage being 44.71 with a range of 57.14. These numbers reveal that there was a wide range, which is the difference in the lowest score and the highest score, indicating the participants had a wide variety in their problem solving abilities.

The group of children with autism had mean raw score of 9.58, range of 16.0 and a mean percentage of 34.23 with a range of 57.14. Results show the percentage score for the children with autism was slightly over 10 points below the average of the participants as a whole, indicating a decreased ability in non-verbal problem solving.

The group of children who are neuro-typical reached a mean raw score of 14.87, range of 15, and a mean percentage of 53.09, range of 53.57, showing that they displayed increased ability to solve problems non-verbally than the participants with autism, as a group. It should be noted that the participant with autism at age 16 scored a percentage of

75, compared to the 16-year-old participant who was neurotypical who scored a 71.43. This was the only age where the participant with autism scored higher than their typical age-matched peer.

RAPS QAE Results

The RAPS QAE shows the participant's ability to effectively ask questions in order to solve the problem as quickly as possible. All participants combined had a mean score of .54 on both the first and second assessments. The range for the first assessment was .76, and the range for the second assessment was .88. The QAE remaining the same on both assessments shows a consistency across time, however, the range difference indicates fluctuation in the scores.

As a group, the participants with autism had a QAE mean score of .35 on the first assessment which improved to a .38 on the second assessment, showing that the participants with autism improved over time in their ability to ask fewer questions. The group of participants who were neurotypical had a mean QAE of .70, which decreased to .67, showing a decrease in scores over time. This could be attributed to boredom, overconfidence, or inattention. The participants who were neurotypical scored higher as a group when compared to their age-matched peers on the RAPS QAE, indicating participants with autism display a decreased ability to verbally problem solve quickly and efficiently as compared to neurotypical peers.

Correlation between RAPS and RPM

The group analysis for the group of twenty-seven participants showed a statistically significant positive correlation was reached at .61, indicating performances on these two assessments are comparable. The correlation for the group of children with

autism was weak at .19. The correlation for the group of children who are neurotypical was a weak positive correlation at .42, which is not statistically significant. These weak results could be related to small sample size and indicate that further research is needed to establish a better correlation.

On the RAPS, the children with autism scored 30% below the children who were neurotypical, which was decreased to 20% on the RPM. This difference between the scores indicate that the children with autism perform better on the assessment of nonverbal problem solving. This shows that the cognitive load required to verbalize their problem solving negatively impacted the scores of children with autism.

Other Considerations

Limitations

One limitation to this study was the small sample size, with only 27 children participating, which limits generalizability of results. Another limitation was that the study only had male participants. The population of children with autism is dominated by males; however, inclusion of female participants would have provided a stronger sample for this study.

Clinical Implications

Previous research has provided RAPS assessment normative data for children who are neurotypical. Additionally, this study provided reliability information of the RAPS for children who are neurotypical and for children with a diagnosis of autism, as well as information on the RPM and correlation between the RPM and RAPS in children with and without autism. This study also indicated a difference in the verbal and non-

verbal problem solving abilities of children with autism, indicating an increase in ability when the cognitive load of communication is not required.

Future Research

As previously mentioned, the RAPS was created to assess adults. It is suggested a new version of the RAPS be created to appeal to children. Currently, there is a project in the planning stages that will create new, more kid-friendly images for the RAPS. This will make the RAPS assessment more relevant to the early-adolescent and adolescent population targeted by this current study. Additionally, it is suggested that this current study be replicated to improve the size of this study and include female participants.

To facilitate future research, is also suggested a version of the RAPS be developed for online administration. This would increase appeal for many populations as well as decreasing time required for scoring the assessment. It is also suggested that further research gather more data on the reliability of the RAPS with children, both with and without autism, due to the unexpected result of low reliability of for children without autism. Lastly, it is suggested that research continue to research the difference cognitive load has on children with autism and their ability to problem solve. Further research into problem solving abilities in children with autism will lead to a deeper understanding of information integration in social situations. Upon entering a room, where do we go? Who do we talk to? Who do we want to start friendships with? From picking out our outfit to picking out our lifelong friends, problem solving is a skill we utilize every day to create the world where we want to live.

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