

Refining best practices for the diagnosis of autism: A comparison between individual healthcare practitioner diagnosis and transdisciplinary assessment.

Jessica Rae Stewart, M.S., CCC-SLP, Ph.D.
Candidate, 775-784-4887,
jstewart@medicine.nevada.edu

Debra C. Vigil, Ph.D., CCC-SLP, Associate
Professor, University of Nevada Reno

Erika Ryst, M.D., Associate Professor, University of
Nevada Reno

Wei Yang, M.D., Ph.D., Professor, University of
Nevada Reno

Abstract

The purpose of this study is to compare the diagnostic decision-making of individual healthcare practitioners against that of a transdisciplinary team. Despite national recognition of transdisciplinary assessment as the gold standard diagnostic approach, autism is most frequently diagnosed by individuals working independently in a variety of disciplines. The current study examined how closely these individual practitioners make diagnoses matching that of a transdisciplinary team. Twenty professionals from five different disciplines viewed videotape clips of fifteen children previously assessed by a transdisciplinary team. Results confirmed that individual healthcare practitioners matched the transdisciplinary team diagnosis on average only 65.6% of the time. Pediatricians were the least accurate diagnosticians compared to the transdisciplinary team with an accuracy rate of only 59.8%. Implications of these results are discussed with respect to the ways in which team transdisciplinary assessments overcome the limitations of individual practitioner diagnosis.

Key words: autism, diagnosis,
multidisciplinary/transdisciplinary, accuracy.

Introduction

Current prevalence rates for Autism Spectrum Disorder (ASD) as reported by the Centers for Disease Control and Prevention(CDC) is one child in every 88 (males: 1:54; females: 1:252) (CDC, 2012). When compared to the estimated prevalence rate reported by Kanner in 1943 (4 per 10,000) the increase in prevalence is exponential. As a result of the increase in prevalence, knowledge regarding etiology, diagnosis, and treatment of autism has expanded (Heidgerken, Geffken, Modi, &

Frakey, 2005). This increased awareness has resulted in a demand for the improvement of diagnostic procedures and sensitivity when diagnosing the disorder (Wing & Potter, 2002). Further, despite this increased knowledge, the diagnosis of autism spectrum disorder is given on average when a child is 4.5 years of age even though it can be reliably identified at 2 years of age (CDC, 2012; Kleinman et al., 2008).

As a way to combat the difficulties associated with autism diagnosis, an increasing number of professional organizations are recommending the implementation of a transdisciplinary approach. Such an approach overcomes the limitations of any one specialty, and pools professional knowledge in a synthesized and integrated practice (Beatson & Prelock, 2002). Due to the inherent advantages of diagnosing autism in this manner, the National Research Council (NRC) recommended in 2001 that a multidisciplinary or transdisciplinary group including speech language pathologists, clinical psychologists, pediatricians, school psychologists and other healthcare professionals work together to diagnose autism (NRC, 2001). Despite recognition of transdisciplinary assessment as the optimum diagnostic approach, the reality is that autism today continues to be identified and diagnosed in a variety of settings by a variety of healthcare practitioners (Heidgerken et al., 2005). Pediatricians, psychologists, medical specialists, psychiatrists, and school psychologists all make the autism diagnosis, and the heterogeneity of approaches across these disciplines results in ‘diagnostic confusion’ and a lack of uniform assessment practice (Farber & Capute, 1984; Heidgerken et al., 2005). Children pay the price for this lack of healthcare integration, as studies indicate that when the diagnosis involves contact with multiple healthcare practitioners acting independently, the time between initial evaluation and diagnosis and treatment lengthens considerably (Stone, 1987). Given the importance of early intervention in autism, such delays affect ultimate prognosis and outcome (Heidgerken et al., 2005). This raises the question as to how practicing healthcare professionals view these children and whether or not they refer for further assessment.

Children with autism also present unique issues for clinical assessment (Klin, Saulnier, Tsatsanis, & Volkmar, 2005). This includes variability in a wide range of areas such as intelligence, language and functional skills. The settings in which a child is observed and tested also tend to vary in terms of familiarity, degree of structure, and intrusion adopted by the examiner—all factors which can influence the child’s presentation

(Klin et al., 2005). Other influential factors include the time of day and the state of the individual at the time of assessment (Klin et al., 2005). It is vital that the assessment builds an accurate portrait of the child's strengths and deficits, otherwise discrepant views of the child may surface leading to conflicted impressions and inaccurate diagnosis. To counteract these potential pitfalls of diagnosis, the involvement of practitioners with different areas of expertise is essential (Klin et al., 2005). A transdisciplinary team format encourages discussion among the clinicians involved and provides the 'beneficial effect' of creating a more complex and accurate view of the child, which ultimately leads to appropriate diagnosis (Klin et al., 2005).

Despite the call for transdisciplinary assessment, many practitioners continue to work in isolation within their own individual settings. Considering that practitioners from different backgrounds can hold various views about autism, it would be useful to know how accurate individual disciplines are in independently diagnosing autism, and what factors influence these individual decisions to give a diagnosis of autism or not.

The current study is a pilot and serves to highlight the importance of transdisciplinary assessment compared to individual disciplinary practice in the diagnosis of autism. Specifically, this study compares diagnoses made by a transdisciplinary team of healthcare practitioners to diagnoses made by individual practitioners on the same set of children. Through this comparison, the study will assess whether transdisciplinary team diagnoses truly differs from diagnoses performed by individual practitioners; additionally, it will allow examination of specific individual specialties (speech language pathologists, occupational therapists, pediatricians, and school psychologists) to determine whether any one specialty more closely approaches the diagnostic results of a transdisciplinary team. Finally, it assesses the association of several different variables (years of experience, comfort level of the practitioner, specific diagnostic tools used, and percentage of daily interaction with autism disorders) and the accuracy of individual diagnosis compared to the gold standard of a transdisciplinary team diagnosis. It is hypothesized that:

1. When compared to a transdisciplinary group of healthcare practitioners, individual healthcare practitioners will be less specific, sensitive, and accurate in the identification of autism.
2. Individual healthcare practitioners with more years of experience will be more accurate at identifying autism in accordance with a transdisciplinary team of healthcare practitioners.

3. An individual healthcare practitioner with a greater reported comfort level in identification of autism will be more accurate in identifying autism in accordance with a transdisciplinary team of healthcare practitioners.
4. Those individual practitioners who use a standardized autism diagnostic tool will be more accurate in identifying autism in accordance with a transdisciplinary team of healthcare practitioners.
5. An individual healthcare practitioner who more frequently interacts with children with autism will be more accurate in identifying autism in accordance with a transdisciplinary team of healthcare practitioners.

Method

Participants

Twenty healthcare practitioners participated in this study. Criteria for inclusion in the study for the healthcare practitioners included experience in working with children with autism and other neurodevelopmental disorders. The desired professions for the study included: pediatrics, child psychiatry, school and/or child psychology, speech-language pathology, and occupational therapy.

Recruitment procedures included emailing supervisors of practitioners asking them to email a flyer explaining the study to their constituents. Emails were also sent to listserves of individual healthcare professions with a flyer explaining the study asking for participation. Additionally, a flyer was posted in school district offices. Both the e-mails and fliers included a brief description of the study and potential participants were invited to contact the investigators if interested. Interested participants contacted the investigators and indicated their desire to participate through a phone call or email. The investigators then discussed requirements of participation, a study summary was re-sent to each potential participant, and a time was scheduled for the potential participant to review the Consent to Participate form and obtain written consent. Recruitment closed after the desired number of subjects (five from each health care discipline) was obtained.

We received responses from pediatricians, speech-language pathologists, occupational therapists, and school psychologists. We did not get responses from child psychiatry or child psychology. Participants in the study included: five speech-language pathologists, five occupational therapists, five school psychologists, and five pediatricians. Although occupational therapists and speech language pathologists do not diagnose autism, they were included in the study due to the nature of the

discipline being related to specific criteria related to autism, i.e. disordered/delayed language and hypo- and hypersensitivity to sensory input. Further, the National Research Council (2001) recommends that speech-language pathologists and school psychologists be part of a multidisciplinary team to diagnose children with autism. Occupational therapists were included as the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) includes sensory sensitivity to

environmental input (American Psychiatric Association, 2013). The speech-language pathologists and school psychologists primarily worked in a school district setting. The occupational therapists worked in schools and in private practice. The pediatricians worked in private practice. Participants were located in different towns and cities. Years of experience are outlined in table 1. All subjects provided informed consent prior to participation.

Table 1: Years of experience of healthcare practitioners

Years of Practice	Pediatricians	Speech Language Pathologists	Occupational Therapists	School Psychologists
0-5	2	1	1	1
5-10	1	2	1	2
10-15	1	1		2
15+	1	1	3	

Participants were assigned an identification number and password that would allow them entry onto a secure website for participation in the study.

Stimulus Material

Videos

Videotapes of 15 children were obtained from an existing database of children who had been previously evaluated by a transdisciplinary team of practitioners. The team is comprised of a group of healthcare practitioners that conducts transdisciplinary assessment of children with suspected autism and other neurodevelopmental disorders. Practitioners include the following disciplines: developmental pediatrics, child psychiatry, child and school psychology, speech-language pathology, occupational therapy, special education, and social work. The videotapes were chosen as standardized stimuli to present to the study participants for the purpose of determining the presence or absence of an autism diagnosis. Since all fifteen children had been previously diagnosed by the team, the team's diagnosis provided a standard of comparison for the diagnoses made by study participants on these 15 children. Parental consent and patient assent (when appropriate) for the use of the videotapes for research purposes was obtained at the time of the initial evaluation.

Videotape stimuli of the 15 children included clips of the administration of critical portions of the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999). The Autism Diagnostic Observation Schedule (ADOS) is a standardized play and activity based assessment that assesses social behavior, communication, play, and restricted and repetitive behaviors in individuals suspected of having a possible autism spectrum disorder (LeCouteur,

Haden, Hammal, & McConachie, 2008). The ADOS is currently the most recognized instrument to diagnose autism (Matson & Sipes, 2010). It is based on the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) diagnostic criteria for autism spectrum disorders and used in a substantial number of empirical studies (Matson & Sipes, 2010).

Videotapes of children were chosen based on diagnosis to provide an equal number of cases from three diagnostic categories. Five of the children were diagnosed with autism, five were diagnosed as not autistic, and five were diagnosed with other emotional/behavioral disorders such as Attention Deficit Hyperactivity Disorder, Language Disorder, Reactive Attachment Disorder, and Oppositional Defiance Disorder. The age of the children ranged from 3 years, 2 months to 10 years, 6 months (Mean=6.43, SD=2.64). A continuous fifteen minute video taped segment of each child's ADOS evaluation was selected for use and posted on a secure internet website. All identifying information was edited out of the fifteen-minute video taped segments.

Professional practice questions

A professional practice survey was developed in order to gain more information about the practitioner's scope of practice and experience working with children with ASD. As this was a pilot study, the professional practice questions were not validated. The survey consisted of twelve questions. Question content addressed individual practitioner discipline, years of experience, preferred diagnostic tool, comfort level with autism, and frequency of interaction with children with autism. Some of the questions were presented as fill in the blank, while

other questions provided answers from which the participants would select the one that best fit.

The rationale to ask for years in practice was based on the proposition that becoming a better diagnostician is a long-term process of learning from experience, during which time the clinician adjusts his/her diagnostic schema for the patient by comparing expected outcomes with observed actual outcomes, whereas individuals just beginning to practice operate on a 'no news is good news' mode, believing that unless they hear about a problem, the diagnosis they made must be correct (Rudolph & Morrison, 2008). For frequency of contact, the literature suggests that clinicians are better at diagnosing particular disorders when they have had more experience in diagnosing them (Rudolph & Morrison, 2008). Regarding use of a diagnostic tool, extensive research has been conducted regarding the validity of using standardized tools in the assessment of autism (Gilliam, 2006; Lord et al., 1999) and for comfort level in diagnosing autism, Rudolph and Morrison (2008) suggest that comfort level plays a key role in the diagnostic process. They suggested that confidence level is a feedback loop and that an under confident clinician will seek updated information to increase their diagnostic skills. As confidence levels increase, the need for updating decreases, creating a feedback loop ultimately effecting diagnostic skills. Appendix A shows the professional practice questions.

Characteristic questionnaire

In order to evaluate the critical reasoning process underlying the ability to identify autism, a questionnaire was prepared to present to the participants after they viewed each child. Twenty characteristics were selected from the Diagnostic and Statistical Manual of Mental Disorders , 4th Edition, Text Revision (American Psychiatric Association, 2002), the ADOS (Lord et al., 1999), and the Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood (DC0-3R; Zero to Three, 1994).Each characteristic represented one of the following disorders: autism spectrum disorder, oppositional defiant disorder, attention deficit hyperactivity disorder, obsessive compulsive disorder, post traumatic stress disorder, anxiety disorder, reactive attachment disorder, and language disorder. Characteristics from these disorders were chosen due to the symptom overlap that occurs between these disorders and ASD, which can increase the risk of misdiagnosis (American Psychiatric Association, 2000). Appendix B lists the twenty characteristics, the disorder that each characteristic represents, and the diagnostic manual from which they were obtained.

Procedure

A secure internet website was used to present study stimuli to the participants. By conducting this study through the means of a secure internet website, the participants were able to log on and off at their leisure over the course of 60 days to view the video tapes and answer subsequent questions. The total time commitment for the study participants was 6 hours and 30 minutes.

To access the location of the videotapes, participants were given a specific URL. Once this URL was entered, the participants were prompted to enter their assigned user name and password. Participants were presented a tutorial, and subsequently the professional practice survey. After completion of the professional practice questionnaire, all fifteen videos were presented on the screen, identifiable only by randomly assigned three-digit numbers. Only one video could be viewed at a time and participants were able to select any of the fifteen videos in a random manner. Directly after viewing each video in its entirety, the participants were asked several questions regarding characteristics and whether or not they thought child had autism. They were then asked to choose the three characteristics from the characteristic questionnaire that they felt most represented the child's behavior. Once a participant had chosen a diagnosis, they were directed to questions regarding their diagnostic choice, and no longer were able to return to the videotape. Appendix C contains the procedures, questions and possible answers presented to the participants to determine their diagnosis and associated reasoning for each case.

After completion of viewing all 15 videos, the participants no longer had access to the website. In addition, the website only allowed the participants sixty days to complete all fifteen videos and each video could only be viewed one time.

Research Design

The design used for this study was a quantitative, descriptive study with four independent variables and three dependent variables. The independent variables were: 1) years in practice, 2) percentage of daily interaction with autism, 3) comfort level in diagnosing autism, and 4) the preferred diagnostic tool used to diagnose autism. The dependent variables are as follows: 1) percentage of children diagnosed with autism by the transdisciplinary team who were also diagnosed with autism by the participant (sensitivity), 2) percentage of children not given a diagnosis of autism by the transdisciplinary team and not given a diagnosis of autism by the participant (specificity), and 3) the percentage of children given the same diagnosis by

the transdisciplinary team and the participant (accuracy).

Results

Sensitivity, Specificity, and Accuracy Calculations

Due to the low number of participants in each individual group, a binary diagnostic test was chosen using calculations of mean sensitivity, specificity, and accuracy for each participant, as well as each healthcare professional group. Appendix D presents data for each individual participant's sensitivity, specificity, and accuracy for all 15 assessments.

None of the four discipline groups achieved rates of sensitivity, specificity or accuracy of greater than 76%. As a whole (all health care practitioners combined), the range of sensitivity was 40.00-100.00, with a mean of 71.00 and a standard deviation of 13.73. For specificity, the range was 30.00-90.00, with a mean of 63.5 and a standard deviation of 17.55. For accuracy, the range was 40.00-80.00, with a mean of 65.55 and a standard deviation of 11.93.

Though none of the independent professional groups matched the transdisciplinary team diagnosis very closely, the occupational therapist group did the best. For the occupational therapist group, the range for sensitivity was 60.00-100.00 with a mean of 76.00 and a standard deviation of 16.73. For specificity, the range was 30.00-90.00 with a mean of 62.00 and a standard deviation of 25.88. The range for accuracy was 40.00-87.00 with a mean of 65.20 and a standard deviation of 18.58.

School psychologists as a group were found to have lower sensitivity, specificity, and accuracy when compared to the transdisciplinary team. Their range for sensitivity was 60.00-80.00 with a mean of 72.00 and a standard deviation of 10.95. For specificity their range was 40.00-90.00 with a mean of 68.00 and a standard deviation of 17.89. Finally, their range for accuracy was 53.00-80.00 with a mean of 69.20 and a standard deviation of 10.16.

Speech and language pathologists and pediatricians scored the lowest on sensitivity, with pediatricians having the lowest scores on specificity and accuracy. For speech language pathologists as a group, the range for sensitivity was 60.00-80.00 with a mean of 68.00 and a standard deviation of 10.95. For specificity, the range was 50.00-80.00 with a mean of 68.00 and a standard deviation of 10.95. The range for accuracy was 53.00-80.00 with a mean of 68.00 and a standard deviation of 9.95. For pediatricians as a group, the range of sensitivity was 40.00-80.00 with a mean of 68.00 and a standard deviation of 17.89. For specificity, the range was 40.00-80.00 with a mean of 56.00 and a standard deviation of 15.17. The range for accuracy was 53.00-73.00 with a mean of 59.80 and a standard deviation of 8.17. Sensitivity, specificity, and accuracy were treated as continuous variables and an ANOVA analysis was conducted. Results of the ANOVA analysis indicated that none of the differences between individual group scores on sensitivity, specificity or accuracy were significant. Results for sensitivity, specificity and accuracy for each of the professional groups are listed in Table 2.

Table 2: Sensitivity, Specificity and accuracy of each healthcare professional group as a whole

Healthcare professional group	Sensitivity Mean and Range	Specificity Mean and Range	Accuracy Mean and Range
School psychologist	0.72; 0.60-0.80	0.68; 0.40-0.90	0.692; 0.53-0.80
Occupational therapist	0.76; 0.60-1.00	0.62; 0.30-0.90	0.652; 0.40-0.87
Pediatrician	0.68; 0.40-0.80	0.56; 0.40-0.80	0.598; 0.53-0.73
Speech Language Pathologist	0.68; 0.60-0.80	0.68; 0.50-0.80	0.68; 0.53-0.80

Binary Logistic Regression

A binary variable was created based on an 80% criterion (sensitivity, specificity, and accuracy above or below 80%). Plante and Vance (1994) recommended that 80% sensitivity, specificity, and accuracy is fair; and when these are lower than 80%, it is considered poor. Binary logistic regression model was conducted to determine if participant's years in practice, percentage of daily interaction with autism, use of a standardized tool to diagnose autism, and the participants comfort level in diagnosing autism (independent variables) had any relationship with participant's sensitivity, specificity, and/or

accuracy of diagnosing autism (dependent variables). The accuracy of the rate of diagnosis was in fact found to be significantly related to the percentage of daily interaction participants had with children on the spectrum ($p=0.024$); and the sensitivity of diagnosis of autism was found to be marginally related to the percentage of daily interaction with autism ($p=0.0837$). All other independent variables had no statistically significant relationship to the dependent variables. The p-values obtained for each independent variable's interaction with the dependent variable are presented in the Table 3.

Table 3: P-values associated with professional practice questions.

	Sensitivity	Specificity	Accuracy
Years in practice	p=0.9846	p=0.1411	p=0.2400
Percentage of daily interaction with autism	p=0.0837†	p=0.1500	p=0.0244*
Preferred diagnostic tool used to diagnose autism	p=0.9481	p=0.5084	p=0.4077
Participants comfort level in diagnosing autism	p=0.1409	p=0.8928	p=0.5602

*p<.05; †p<.10

Discussion

The present pilot study examined whether diagnoses of autism made by independent healthcare practitioners match those made by a transdisciplinary team. As a whole, the group of healthcare practitioners acting independently was less accurate in diagnosing the presence or absence of autism when compared to the transdisciplinary group of healthcare practitioners. That is, on average the individual healthcare practitioners' diagnoses matched that of the interdisciplinary team 65.55% of the time. Put another way, the individual practitioners only identified autism correctly 71% of the time (sensitivity) and correctly ruled out autism only 63.5% of the time (specificity). This indicates that in 29% of cases autism was missed, and in 36.5% of the cases, autism was falsely diagnosed by the independent practitioners.

Overall, the above results indicate that individual practitioners do not make the same diagnoses as a transdisciplinary team when evaluating children with complex developmental disorders. Of even more interest is the fact that individual practitioners erred both in missing the diagnosis of autism when present, and incorrectly labeling children as having autism when they did not. The lack of consistency in these error patterns suggest an overall confusion about appropriate diagnosis of autism, which may stem from the complexity of neurodevelopmental disorders, the overlapping characteristics between different disorders, and the lack of consensus between practitioners about appropriate diagnosis of autism.

Given the widely disseminated recommendation of transdisciplinary team assessment as the most accurate mode of autism diagnosis, this discrepancy in diagnosis rates by individual practitioners represents a patently unacceptable error rate. These study results indicate that a high percentage of children are either not identified as having autism, or are incorrectly labeled with autism when it is not present. The end result of such statistics is that many children are either receiving no intervention, or inappropriate intervention for the developmental problems that they have, ultimately affecting long-term functional outcomes.

Possibly of most concern is the finding that the individual practitioner group with the most discrepant diagnoses was the pediatricians. Since pediatricians are the most likely to come in first contact with children who exhibit developmental problems, they represent a critical gateway towards appropriate referral, assessment and intervention. The results show that pediatricians are inaccurate in diagnosing autism more than forty percent of the time, meaning that forty percent of children are not getting the help that they need. Multiple factors likely impact this finding, including lack of advanced training on complex neurodevelopmental disorders, limited time availability for full assessments, and frequent overlap of symptoms in different developmental disorders.

Results from the professional practice questionnaire indicate that in fact there is at least one individual variable, which can increase accuracy of an individual practitioner's diagnosis of autism. Specifically, we found that individual participants who more frequently interact with children with autism make more diagnoses that match that of a "gold standard" transdisciplinary team. Intuitively it makes sense that those whose practices include the greatest number of autistic children demonstrate the most expertise in diagnosing autism. However, this finding further highlights the problems of accurately screening and diagnosing children within a primary care setting, as clinicians in these settings are unlikely to have extensive experience with autism.

All other individual professional characteristics measured (number of years in practice, greater reported comfort level, and using a standardized diagnostic tool) were not found to have a relationship with the accuracy of diagnosis. Perhaps the most interesting of these negative findings is that the practitioner's "comfort level" in diagnosing autism did not predict accurate diagnosis. This finding correlates with other research on diagnostic problem solving (Rudolph & Morrison, 2008). Investigators have found that over time, if doctors do not get feedback on the accuracy of their diagnoses, they may get overconfident in their skills. Professionals working in isolation are at particular risk of not getting necessary feedback and are therefore more likely to consistently and unknowingly make diagnostic errors.

Diagnostic Implications

Although further research is required due to a limited sample size, these results support the need for a transdisciplinary team to diagnose autism. On the whole, individual practitioners do not make the same diagnoses as a transdisciplinary diagnostic team. Only those individuals with expertise in autism (that is, who see a significant percentage of children with autism in their practice) approach the same accuracy of diagnosis as compared to a transdisciplinary team. This indicates the importance of the transdisciplinary approach in diagnosing autism, both because the team approach is more likely to yield a more appropriate diagnosis, and because it provides a format for individual practitioners to gain increased expertise in autism which they can then import to their individual practices.

Limitations of the Present Study

Certain limitations should be considered when interpreting the results of the present study. The sample size was small, which limited the ability to make stronger conclusions based on our statistical analyses.

Additionally, due to time constraints the participants were only presented with fifteen-minute segments of assessment. Even though this represents only a very short sample of a child's behavior, it does reflect the average amount of time spent by a child in a pediatrician's exam room. Furthermore, the clips were selected to maximize critical diagnostic information. For confidentiality reasons participants also were not privy to information obtained from parent report such as developmental and family history. An argument could be made that with more information and more time, their accuracy rates may have improved.

Another potential criticism of this study is the implicit underlying assumption that transdisciplinary assessment produces more "accurate" diagnosis than practitioners working alone. Unfortunately, no research to date has investigated the actual accuracy of transdisciplinary team diagnosis compared to independent practitioners. In light of this data deficit, we therefore rely on national guidelines and standards, which define transdisciplinary assessment as the gold standard. Furthermore, the complexity of autism and the overlap of autistic symptoms with many different types of disorders implies that the combined expertise of different disciplines is more likely to yield a true diagnosis. Finally, research on diagnostic reasoning indicates that professionals who interact with and receive feedback from other professionals constantly

refine their diagnostic acumen and avoid the potential pitfalls of overconfidence.

Implications for Further Research

The current study represents an initial pilot study to investigate the performance of individual healthcare practitioners in diagnosing autism compared to a transdisciplinary team. Future research should replicate this study with a larger number of participants and should include a wider spectrum of professional disciplines such as family practice doctors, child psychiatrists and pediatric neurologists. This will allow more in-depth analysis of possible individual factors, which influence diagnosis. Further analysis of diagnostic reasoning processes underlying individual diagnostic choices would also help to delineate characteristic diagnostic patterns of individual disciplines. This could help to identify whether characteristic attitudes and beliefs within specific professions lead to consistent diagnostic errors. Results of such studies will help to inform best diagnostic practices as well as additional needed areas of professional education.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: American Psychiatric Publishing.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.
- Beatson J & Prelock P. (2002). The Vermont rural autism project: sharing experiences, shifting attitudes. *Focus on Autism and Other Developmental Disabilities*, 17, 48-54.
- Centers for Disease Control and Prevention. Prevalence of Autism Spectrum Disorders—Autism and Developmental Disabilities Monitoring Network, United States, 2008. March 30, 2012. MMWR 2012; 61 (No. SS03) 1-19.
- Farber J., Capute, A. (1984). Understanding autism. *Clin Pediatr*, 23, 199-202.
- Gilliam, J.E. (2006). *Gilliam autism rating scale* (2nd ed.). Austin, TX: Pro-Ed.
- Heidgerken A, Geffken G, Modi A, Frakey L (2005). A survey of autism knowledge in a healthcare setting. *Journal of Autism and Developmental Disorders*, 35, 323-330.
- Kanner L (1943). Autistic disturbances of affective contact. *Nervous Child*, 2, 217-250.
- Kanner L (1949). Problems of nosology and psychodiagnostics of early infantile autism. *Am J Orthopsychiatry*, 19, 416-426.

- Kleinman, J.M., Ventola, P.E., Pandey, J., Verbalis, A.D., Barton, M., Hodgson, S., Green, J., Dumont-Mathieu, T., Robins, D.L., & Fein, D. (2008). Diagnostic stability in very young children with autism spectrum disorders. *J Autism Dev Disord*, 48(4), 606-615.
- Klin A, Saulnter C, Tsatsanis K, & Volkmar FR. (2005). Clinical evaluation in Autism Spectrum Disorders: Psychological assessment within a transdisciplinary framework. In: FR Volkmar, R Paul, A Klin, D Cohen (eds), *Handbook of autism and pervasive developmental disorders: assessment, interventions, and policy*, 3rd edn. Wiley, NJ, 772-798.
- Le Couteur A, Haden G, Hammal D, & McConachie H. (2008). Diagnosing autism spectrum disorders in preschool children using two standardized assessment instruments: the ADI-R and the ADOS. *Journal of Autism and Developmental Disorders*, 38, 362-371.
- Lord C, Rutter M, DiLavore P, Risi, S (1999). *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services.
- Matson J & Sipes M (2010). Methods of early diagnosis and tracking for autism and pervasive developmental disorder not otherwise specified (PDDNOS). *Journal of developmental and physical disabilities*, 22, 343-358.
- National Research Council (2001). *Educating children with autism*. National Academy Press, Washington, DC.
- Newsom C. (1998). Autistic disorder. In EJ Mash, RA Barkley (eds), *Treatment of childhood disorders* (3rd ed). Guildford, NY, 416-467.
- Plante E & Vance R (1994). Diagnostic accuracy of two tests of preschool language. *American journal of speech language pathology*, 4, 70-76.
- Rudolph J, Morrison J (2008). Sidestepping superstitious learning, ambiguity, and other roadblocks: a feedback model of diagnostic problem solving. *Am J Med*, 121, 534-537.
- Stone W. (1986). Cross-disciplinary perspectives on autism. *Journal of Pediatric Psychology*, 12, 615-630.
- Wing L & Potter D (2002) The epidemiology of autistic spectrum disorders: is the prevalence rising?. *Mental Retardation and Developmental Disabilities Research Reviews*, 8, 151-161.
- Zero to Three. (2005). *Diagnostic classification of mental health and developmental disorders of infancy and early childhood*. Revised edition (DC:0-3). Washington, DC, Zero to Three Press.

Appendix A: Professional practice questionnaire

1. What is your profession?
 - a. Occupational therapist
 - b. Pediatrician
 - c. School Psychologist
 - d. Speech Language Pathologist
 2. How many years have you been in practice
 - a. 0-5
 - b. 5-10
 - c. 10-15
 - d. 15+
 3. What percentage of your practice includes autism or other neurodevelopmental disorders?
 - a. 0-10
 - b. 10-25
 - c. 25-50
 - d. 50+
 4. How often do you interact with clinicians from other disciplines to collaborate on cases
 - a. Daily
 - b. Several times a week
 - c. Weekly
 - d. Monthly
 - e. Less than monthly
 5. Do you participate in a multidisciplinary team in any clinical setting?
 - a. Yes
 - b. No
 6. How do you diagnose autism?
 - a. By clinical interview and knowledge and experience in diagnosing Autism Spectrum Disorder
 - b. Use of diagnostic criteria using formal rating scale such as the DSM-IV
 - c. Initial screening instrument and referral to sub-specialist
 - d. Participation with a multidisciplinary team assessment
 - e. Standardized diagnostic tools specific for diagnosing autism. If so please name the tool in the next question
 7. Please enter the name of the tool specific for diagnosing autism that you use?
 8. Do you do anything differently than the above to diagnose autism?
 - a. Yes
 - b. No
 9. If you answered yes to the previous question, please describe your procedure for diagnosing autism?
 10. Do you feel comfortable diagnosing autism?
 - a. Yes
 - b. No
 11. Do you feel comfortable differentiating between autism and other neurodevelopmental disorders
 - a. Yes
 - b. No
 12. Do you feel adequately prepared by your professional training to diagnose autism?
 - a. Yes
 - b. No
-

Appendix B: Twenty Characteristics of Overlapping Disorders

Disorder	Characteristics	Source
Autism spectrum	<ol style="list-style-type: none"> 1. Showed social interaction difficulties 2. Had a preoccupation with objects and/or topics 3. Showed unusual sensory responsiveness 4. Exhibited a need for sameness and resisted change in routines 5. Limited eye contact 6. Impairment in communication 	DSM-IV-TR; ADOS
Oppositional defiance	<ol style="list-style-type: none"> 1. Defined or refused to comply with adults requests or rules 2. Showed negativism, aggression, and threw temper tantrums 	DSM-IV-TR
Attention deficit hyperactivity	<ol style="list-style-type: none"> 1. Did not seem to listen when spoken to directly 2. Disorganized approach to tasks and activities 3. Was easily distracted by extraneous stimuli 4. Was excessively talkative 	DSM-IV-TR
Obsessive compulsive	<ol style="list-style-type: none"> 1. Repetitive behaviors that the child seemed driven to perform 	DSM-IV-TR
Post traumatic stress	<ol style="list-style-type: none"> 1. Displayed irritability 	DSM-IV-TR
Anxiety	<ol style="list-style-type: none"> 1. Showed marked anxiety in a task 2. Inappropriately high level of activity 3. Showed restlessness 	Zero to Three
Reactive attachment	<ol style="list-style-type: none"> 1. Excessive social inhibition and hypervigilance 	Zero to Three
Language	<ol style="list-style-type: none"> 1. Had difficulty understanding words and/or sentences 2. Limited vocabulary, errors in grammar, or limited sentence production 	DSM-IV-TR

Appendix C: Video survey questions and answers when applicable

1. Have you completed viewing the video recording
 - a. Yes, I have completed viewing the video recording
 - b. No, I was unable to view the video
 2. Please enter your survey identification number
 3. What diagnosis would you give this child?
 - a. Autistic
 - b. PDD-NOS
 - c. Asperger's Syndrome
 - d. Not on the Autistic Spectrum
 4. If you think the child was on the spectrum, please click Save and View Next Question to go on to the next page.
 5. If you thought that the child was NOT autistic, please write in the box below what diagnosis you would give or what you think is happening with this child. Click Save and View Next after completing your response.
 6. Please pick three of the following characteristics that best fit the child you saw on the video. Click Save and View Next after making your selections. Click Finish to complete the survey (see stimulus material section for a list of all characteristics presented here).
 7. Thank you for completing this section of the survey.
 8. Please click Save and View Next and then Finish to submit your survey.
-

Appendix D: Mean sensitivity, specificity and accuracy of each individual participant

Participant	Sensitivity	Specificity	Accuracy
Schpsy 301	0.80	0.70	0.73
Shcpsy 302	0.80	0.70	0.73
Schpsy 303	0.60	0.70	0.67
Schpsy 304	0.80	0.40	0.53
Schpsy 305	0.60	0.90	0.80
Ot 802	0.60	0.90	0.73
Ot 803	1.0	0.80	0.87
Ot 806	0.80	0.40	0.53
Ot 807	0.60	0.30	0.40
Ot 808	0.80	0.70	0.73
Ped 401	0.40	0.60	0.53
Ped 402	0.80	0.50	0.60
Ped 403	0.80	0.40	0.53
Ped 404	0.60	0.80	0.73
Ped 405	0.80	0.50	0.60
Spa 701	0.60	0.50	0.53
Spa 702	0.60	0.70	0.67
Spa 704	0.80	0.80	0.80
Spa 706	0.80	0.70	0.73
Spa 707	0.60	0.70	0.67
Mean for the entire group	71.00%	63.50%	65.50%
Range for the entire group	40.00%-100.00%	30.00%-90.00%	53.00%-80.00%