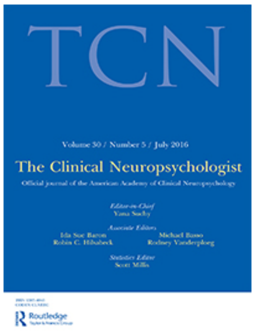

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Outcomes of pediatric neuropsychological services: A systematic review

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ABSTRACT

Objective: The primary aim of this project was to apply systematic review methods to synthesize the literature on outcomes of pediatric neuropsychological services. The secondary aim was to use the results of the systematic review to identify gaps in the extant literature and describe priorities for future research. **Method:** We identified the relevant studies using a rigorous search strategy, collected data on methodological variables, assessed the risk of bias in the studies, summarized findings by topic and subtopic areas, identified strengths and weaknesses of the literature, and provided recommendations for future research. The outcomes measured were satisfaction, changes in resource or strategy utilization, and changes in symptoms or functioning (i.e. changes in child emotional, behavioral, cognitive, or academic problems, parent stress, or family functioning). **Results:** The final sources of data were 26 records, pertaining to a total of 974 children who received neuropsychological services. Parents were generally satisfied with services and reported high clinician empathy and increased level of knowledge, based on the evaluation. However, they reported less often that the neuropsychologist provided actual help. Informal home and school-based strategies were implemented more often than other types of recommendations. The research on changes in child symptoms and functioning was limited, but suggests improvements. **Conclusions:** This is the first systematic review of outcomes of pediatric neuropsychological services. Larger studies involving data collection at multiple time points are needed in order to further clarify mechanisms leading to outcomes and potential targets for improving them.

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Outcomes; satisfaction; recommendations; adherence; pediatric neuropsychology

The role of the pediatric neuropsychologist in clinical settings is to apply knowledge of brain–behavior relationships to ameliorate deficits and promote quality of life among children with developmental or acquired disorders. To that end, the overwhelming majority of research in pediatric neuropsychology has focused on adding to

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the empirical basis of our understanding of those brain–behavior relationships, as well as cognitive development and profiles in a wide range of disorders. This body of research serves as the foundation of evidence-based case conceptualization and diagnosis in pediatric neuropsychology. However, research on the practice of clinical pediatric neuropsychology, and in particular, outcomes of pediatric neuropsychological services, is far more limited.

Bolstering the literature on outcomes in pediatric neuropsychology is a goal of clinical and professional significance. From a clinical standpoint, many pediatric neuropsychologists do not have further contact with patients and their families following an evaluation or consultation, and therefore, receive minimal feedback about the impact of their services. Some patients do return for re-evaluation. However, eliciting feedback from returning patients alone would not provide a complete understanding of outcomes because they are unlikely to be representative of the patient population as a whole. Because of these limitations, opportunities for maximizing one's effectiveness as a clinician based on past experiences are few. This is especially concerning with regard to outcomes that are usually not apparent at the time of the evaluation, such as the parents' long-term adjustment to a child's diagnosis of a disability, the school's and family's degree of success in implementing recommendations, and the impact of supports and treatments recommended by the neuropsychologist on functional outcomes. This information is vital to pediatric neuropsychologists, as it could lead to a multitude of changes in practice, ranging from subtle differences in how findings are worded in reports to restructuring how, when, and to whom we provide information.

From a professional standpoint, several authors have discussed the importance of outcome research for demonstrating the value of neuropsychological services in order to advocate for the profession with healthcare financial gatekeepers (Donders, 2020; Glen et al., 2020; Prigatano & Morrone-Strupinsky, 2010; Prigatano & Pliskin, 2002). This value may be measured via objective or subjective metrics. Objective metrics include indications of the beneficial financial and patient care-related impacts of neuropsychological services, for example, studies showing cost-effectiveness of neuropsychological evaluation through a reduction in the probability of subsequent hospitalizations. Subjective metrics include knowledge of the role of neuropsychologists and esteem for their unique skill sets, particularly among referring providers when the goal is preserving or advancing the position of neuropsychology in the healthcare setting. These professionally-oriented goals are linked to clinically-oriented ones and may ultimately impact insurance reimbursement, affecting the accessibility of neuropsychological services for patients.

Two recent reviews have examined outcomes of neuropsychological services, but both focused primarily on adult populations (Donders, 2020; Watt & Crowe, 2018). Watt and Crowe (2018) found that existing adult studies supported the utility of neuropsychological assessment in diagnostic decision-making and predicting patient outcomes (e.g. cognitive decline) and demonstrated that clients, referrers, and significant others value the service. Donders (2020) reviewed the literature to evaluate the incremental value of neuropsychological assessment above and beyond what can be accounted for on the basis of demographic, medical, and other diagnostic variables. He found that the incremental validity of neuropsychological evaluations was strongly supported in mild cognitive impairment/dementia and traumatic brain injury (TBI), and moderately supported in stroke, epilepsy, multiple sclerosis, and attention-deficit/hyperactivity disorder (ADHD). Five pediatric samples were identified within these two review articles, only two of which are included in the current review.

Individual studies tend to be narrow in the scope of outcomes they examine, and theories regarding the classification of outcome types and relationships among outcomes are lacking. We put forth a simple model in Figure 1, to serve as a starting point. Outcomes in the model are organized ordinally in four levels, according to how proximal or distal they are from the event of the child receiving neuropsychological services. Arrows indicate that relationships among levels are at least partially causal, though some may be bidirectional as well. The Level 1, or most proximal outcomes, are internal experiences of affected people, including satisfaction with the services or changes in knowledge or attitudes on the part of children, parents, teachers, or referring providers. The Level 2 outcomes include actions or behavior change, such as recommendation implementation or changes in adult behavior toward the child. The Level 3 outcomes include changes in symptoms or functioning, which are most often examined in the child, but could also be investigated in the parent or family system (i.e. changes in child emotional, behavioral, cognitive, or academic problems, parent stress, or family functioning). Finally, the Level 4 outcomes include high-level consequences with financial or economic impacts, such as educational and vocational achievement (e.g. the child graduates from high school, successfully maintains competitive employment as a young adult), adherence to pre-existing medical or psychiatric treatment, or long-term healthcare utilization.

In the context of the model, one might expect that a neuropsychologist would have the largest effect on Level 1 outcomes and successively smaller effects on each subsequent level. This pattern of successively smaller effects across levels is explained by the fact that the relative importance of a multitude of other factors increases at each successive level of the model. To provide a concrete example, the neuropsychologist's evaluation may have a large effect on a parent's knowledge about their child's dyslexia, a medium effect on the school's implementation of evidence-based reading interventions, a small effect on changes in the child's reading ability over time, and a very small effect on the child's completion of a college degree. The neuropsychologist's influence on the child's completion of a college degree is limited by factors that are beyond the neuropsychologist's control, including the child's preferences and goals, the child's community/peer group, family resources, parent expectations, and others.

The primary aim of this project was to apply rigorous systematic review methods to synthesize the literature on outcomes of pediatric neuropsychological services. We sought to answer the questions: What are the outcomes of pediatric neuropsychological services? The secondary aim was to apply the results of the systematic review to identify gaps in the extant literature and describe priorities for future research. In order to accomplish these aims, we: 1. Identified the relevant studies. 2. Collected data on methodological variables. 3. Assessed the quality of the studies. 4. Summarized findings by topic and subtopics areas. 5. Identified strengths and weaknesses of the literature. 6. Provided recommendations for future research.

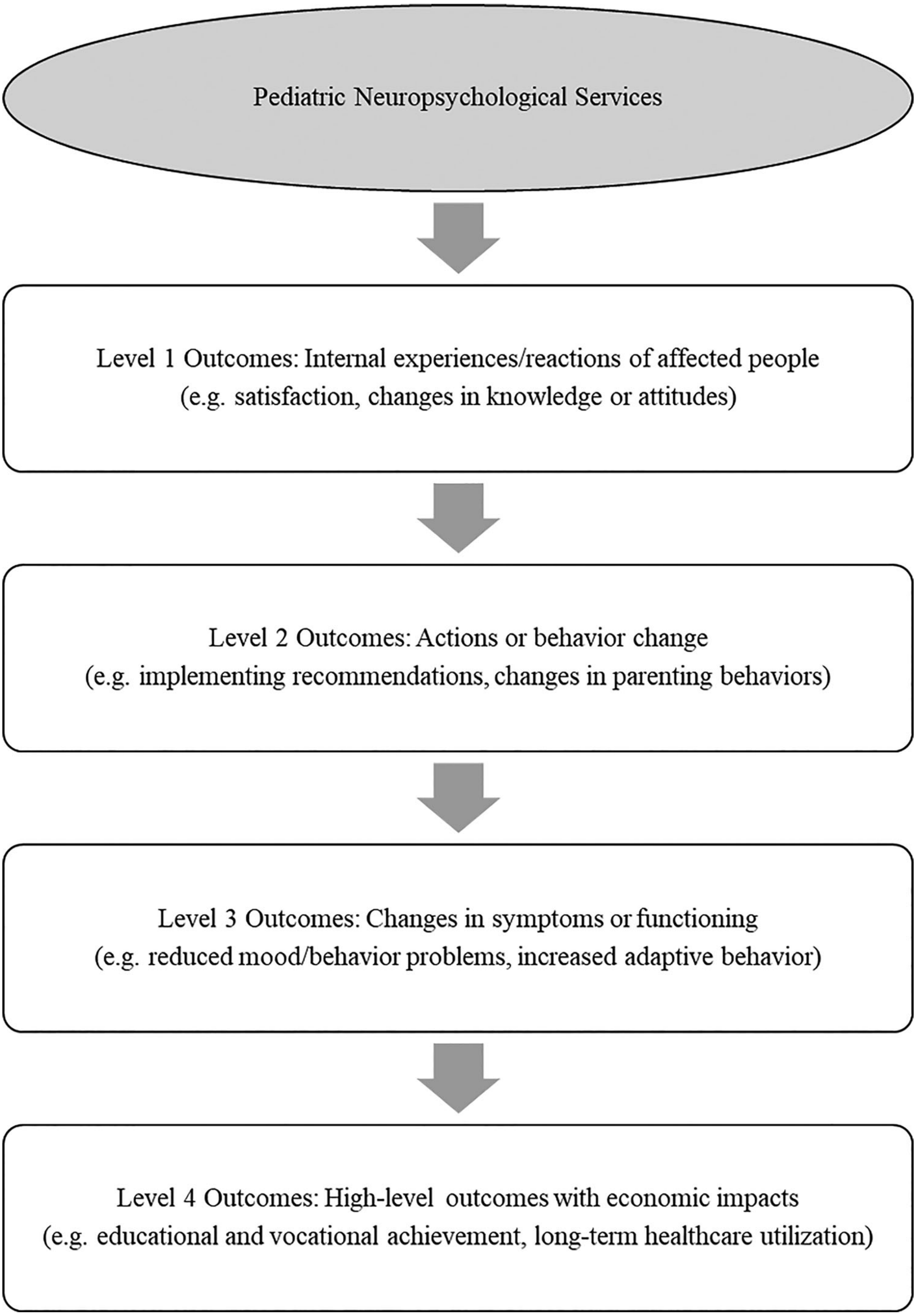

Figure 1. Model of outcomes of pediatric neuropsychological services.

Method

Search protocol

The methods adhere to PRISMA guidelines for systematic reviews (Liberati et al., 2009). On 20 March 2020, we conducted a literature search using the following electronic databases: CINAHL Complete, PsycInfo, PsycArticles, Medline, Web of Science, and Google Scholar. We developed search terms after a preliminary review of the literature. The search strategy (i.e. terms and fields) varied slightly by database in response to differences in indexing. See Table S1 for exact search terms used with each database. In addition to the electronic database search, we reviewed reference lists of included studies. We also received referrals to studies from researchers in this area.

Inclusion and exclusion criteria

We included studies that met the following criteria:

1. Participants were any relevant person who provided information about the outcomes of pediatric neuropsychological services (e.g. children who received services, parents, teachers, or referring providers).
2. *Pediatric* neuropsychology was the primary subject of the study; the majority of the individuals who received services were between four and 18 years old.
3. The study presented original data involving at least one outcome of pediatric neuropsychological services (e.g. satisfaction with the services, financial impact of services, recommendation implementation, or changes in any of the following: knowledge, efficacy, alliance, resource or strategy utilization, child symptoms, child or family functioning, or medical or psychiatric treatment adherence).
4. The full-text of the study was available in English or could be obtained by contacting the corresponding author.

We excluded studies for the following reasons:

1. The study reported only on changes to diagnoses and/or the provision (not implementation) of recommendations by the neuropsychologist.
2. Services were provided by professionals other than neuropsychologists or trainees who were supervised by neuropsychologists (e.g. psychoeducational evaluations provided by child psychologists).
3. The study examined outcomes from a highly atypical model of pediatric neuropsychological service delivery and did not present data from a control group. In other words, studies were excluded if their aim was to establish the feasibility and acceptability of a new model of neuropsychological services. If the study had a control group, that received traditional neuropsychological evaluations, this data was included.
4. The study combined data from samples who received a variety of clinical services, and data from the subset who received neuropsychological services could not be clearly identified.

Two authors independently reviewed all records in order to determine eligibility. They discussed instances in which their conclusions differed until they reached a consensus.

Data extraction

We created and used a data extraction form to organize bibliographic information, methodological variables, risk of bias issues, and primary findings from each study. The first author completed all data entry, and all data were verified by at least one of the other authors.

In accordance with our model, we classified outcomes into four types. Level 1 Outcomes: *Satisfaction and related respondent experiences*, including broad satisfaction, satisfaction with specific components of the services, clinician-parent alliance, respondent knowledge, and respondent efficacy. Level 2 Outcomes: *Resource or strategy utilization*, including both recommendation implementation and other indications of actions. Level 3 Outcomes: Child or family *symptoms or functioning,* including changes in child emotional, behavioral, cognitive, or academic problems, parent stress, or family functioning. Level 4 Outcomes: *Economic or financial effects*, including cost-effectiveness, adherence to pre-existing medical or psychiatric treatment, and educational or vocational achievement.

Risk of bias

We developed a list of study risk of bias variables after consulting relevant resources and considering the impact of certain methodological issues on the quality of the information derived from a study with regard to the research question of this systematic review (The EQUATOR Network | Enhancing the QUAlity and Transparency Of Health Research, n.d.; Thompson et al., 2005). Desirable study characteristics included:

1. The study was published in a peer-reviewed journal.
2. A detailed description of the components of the neuropsychological services was included. For example, the authors reported on the completion/duration of a parent interview, testing procedures, feedback, and reports.
3. The nature of the involvement of the respondent with the neuropsychological services was clear. If professionals, such as teachers or referring providers, were asked to provide outcome information, the authors also presented information about the degree of interaction those professionals had with neuropsychological services (e.g. how many reports they had reviewed). If the service was provided by an interdisciplinary team, then the role of the neuropsychologist was described.
4. The complete item content of the measure was either in the text or referenced.
5. At least one measure has known psychometric properties.
6. The study included attrition/non-participant analyses.

Note that we did not exclude studies on the basis of risk of bias. Rather, we took an inclusive approach to study selection. This allowed us to maximize the comprehensiveness of our systematic review and minimize the impact of publication bias, while also collecting and presenting data related to the risk of bias. In the results section, we identify studies with major methodological concerns and devote less text to their review.

Results

Systematic review results

See Figure S1 for the PRISMA flow chart detailing search results. Eligibility agreement after initial review was 99.6%; 12 out of 3359 non-duplicate records required further discussion to determine eligibility. The final sources of data were 26 records (19 publications and 7 gray literature [i.e. unpublished] items). In a few instances, we included multiple records that reported on a single sample because each contributed unique information related to outcomes. Given this, it should be noted that the 26 records reported on 21 distinct samples.

Methodological characteristics

Methodological characteristics are in Tables S2 and S3. The studies varied in settings (medical, university, or private practice) and primary presenting concerns (medical, neurodevelopmental, or mixed). The respondents were 949 parents, 129 referring providers, 105 children, and 20 teachers. Common participant exclusion criteria were the child being in foster care and the respondent not being proficient in English. The notable exception to the second criterion was Elias et al. (2020), in which outcome data were obtained from both English and Spanish-speaking parents. Regarding neuropsychological service type, 16 studies involved traditional neuropsychological evaluation, two involved neuropsychological consultation (i.e. abbreviated evaluations, lasting 90 minutes to three hours), and one involved neuropsychologically-based interdisciplinary evaluation. Outcome measures varied widely, with the most common measurement approach being author-developed items.

Risk of bias

A checklist of desirable study characteristics is included in Table S4. Survey response rates ranged from 27% to 100%. Authors of seven studies presented analyses of differences between participants and non-participants. Significant findings observed in multiple samples included that participants were of higher SES than non-participants (Bodin et al., 2007; Combs et al., 2020; Waber et al., 2017).

Study findings

The included studies examined satisfaction and related respondent experiences (Level 1 Outcomes studies; $k = 19$), resource or strategy utilization (Level 2 Outcomes studies; $k = 8$), and changes in symptoms or functioning (Level 3 Outcomes studies; $k = 6$). No studies examined financial or economic outcomes or adherence to pre-existing medical or psychiatric treatment (Level 4 Outcomes studies). Summaries of results by outcome types are available in Tables 1–3.

Level 1 Outcomes: satisfaction and related experiences

Parent satisfaction. Each of these studies was unique in scope, and specific topics we identified included broad satisfaction, satisfaction with specific components of the neuropsychological service (e.g. the report), knowledge, efficacy, and clinician-parent alliance. Two studies used factor analysis to explore the structure of parent satisfaction measures. Bodin et al. (2007) identified four factors: general satisfaction, clinician acceptance/empathy, provision of help (i.e. parent perception that the neuropsychologist provided concrete assistance), and facilities/administrative assistance. Arffa and Knapp (2008) identified two factors: improved understanding (e.g. understanding of child's problems and strengths) and parent report that services led to changes (e.g. in diagnosis, treatment, school services).

Regarding broad parent satisfaction, all studies indicated that the majority of parents had a positive experience with the neuropsychological services their children received. In many studies, high ratings were nearly unanimous, such that 94–100% of parents reported satisfaction with neuropsychological services (Cheung et al., 2014; Dodd et al., 2018; Farmer & Brazeal, 1998; Kirkwood et al., 2017; Nissirios et al., 2018; Stark et al., 2014). However, in two of the largest studies, ratings of broad satisfaction indicated that 10–20% of parents were not satisfied with the services (Bodin et al., 2007; Waber et al., 2017).

Studies that examined patterns across subtopics within satisfaction indicated higher ratings of clinician empathy and increased knowledge compared to the provision of help. For example, Bodin et al. (2007) found that parents rated provision of help significantly lower than the three other factors they identified. Using the same measures, Kirkwood et al. (2017) observed a similar pattern, with the provision of help rated significantly lower than clinician empathy/acceptance. Also consistent with this, in Farmer and Brazeal (1998), parents provided lower ratings of help-related items (e.g. improvements in school services) than knowledge-related items (e.g. better understanding of child's strengths and problems). Thus, parents typically experience neuropsychologists as being empathetic and report gaining knowledge as a result of their child's neuropsychological evaluation. However, they do not always feel that concrete help was provided.

Parent satisfaction with service components

A few studies inquired about parent opinion of specific components of the neuropsychological services, including the clinician-parent therapeutic alliance, feedback experiences, and neuropsychological reports. See Table 1 for details about satisfaction with therapeutic alliance and feedback. Regarding perceived quality and utility of neuropsychological reports, Elias et al. (2020) found that 98% of parents felt the report was understandable, while in a small sample of children with cancer, parents understood the report less often (73%; Cheung et al., 2014). In Farmer and Brazeal's (1998) study, the largest proportion of parents rated the written report as the most useful part of the evaluation (44%), as opposed to the testing day (25%) or feedback session

Table 1. Level 1 outcome study results.

Study	Primary findings with regard to satisfaction and other respondent experiences	Correlates of satisfaction and other respondent experiences
Arffa & Knapp, 2008	• Highest rating was for improved understanding of child strengths and weakness • Lowest rating was for documenting treatment progress • Factor analysis of items indicated two factors: 1) parent report of improved understanding, and 2) parent report that services led to changes (e.g. diagnosis, treatment, school services) • Parents rated the value of the services highly, regarding time and money spent	• Parent ratings of the value of services was unrelated to out-of-pocket payment amount or diagnostic changes
Austin, 2019	• Parents of children participating in their first neuropsychological evaluation reported increased knowledge and efficacy across the time points • They also perceived an increase in knowledge on the part of medical providers and school personnel • Parents of children participating in a re-evaluation rated themselves higher in knowledge and efficacy at the first time point, and they did not show significant change over time	—
Baum, 2018	• The sum of report quality ratings was higher for the new (shortened, more readable, and re-structured for clarity) report format	—
Bodin, 2007	• 82% of parents endorsed general satisfaction with services • Factor analysis of items indicated four factors: 1) general satisfaction, 2) acceptance/empathy, 3) provision of help, and 4) facilities/administrative assistance • Satisfaction ratings were highest for general satisfaction, acceptance/empathy, and facilities/administrative assistance • Provision of help ratings were lower than other satisfaction factors, and a large minority of participants (45%) did not endorse that the evaluation improved their child's life	• Parents for whom maternal education was some college or a college degree were less satisfied than parents for maternal education was either lower or higher
Cheung, 2014	• All parents and teachers were "satisfied with the support they received from the neuropsychologist" • Report quality was generally described positively, though a few (4 out 15) parents found some aspects of the report confusing • When asked for suggestions to improve services, parents requested, 1) more follow-up with the neuropsychologist (6 out of 15) and 2) direct communication between neuropsychologist and school (5 out of 15)	—
Connery, 2016 & Kirkwood, 2017	• 94% of parents reported being satisfied with the service • Clinician empathy/acceptance received higher ratings compared to provision of help • Proportion of sample that was not satisfied was highest for wait-time (36%)	• Parents with lower education and parents whose children had longer time-since-injury duration endorsed higher satisfaction • Parents of children with non-credible effort reported similarly high satisfaction to those with credible effort

(*continued*)

Table 1. Continued.

Study	Primary findings with regard to satisfaction and other respondent experiences	Correlates of satisfaction and other respondent experiences
DeVries, 2017	• Most feedback factors were rated as important by parents; lowest ratings were observed for child participation in the feedback (62%), contact after evaluation (62%), and use of visual aids (35%) • Most feedback factors were rated as well-done by evaluators, but not feedback during the evaluation (58%) contact after evaluation (46%), child feedback (42%), and use of visual aids (15%) • In qualitative notes, some parents indicated they felt overwhelmed by the volume of information in feedback • Suggestions for improvement included more specific referrals for services and more time to process information in feedback	—
Dodd, 2018	• Parents indicated very high satisfaction on the questionnaire (96% of items were given the highest possible rating), and indicated that the neuropsychological evaluation helped to improve their understanding of their child and what to expect	—
Elias, 2020	• 98% of parents reported that the report was understandable • 73% reported that the report was helpful in getting services	—
Farmer & Brazeal, 1998	• Parent ratings were highest for improved understanding of child's problems and strengths (87 and 93%, respectively) • Ratings were lowest for identifying other helpful professionals (70%) • Parents rated the written report as the most useful part of the evaluation (as opposed to the interview or feedback) • Two most important contributors to overall satisfaction were recommendation quality and rating of quality of the professional	• Demographic variables were not related to satisfaction
Green, 2011	• Parent ratings of alliance with the clinician were very high • More variability was noted in the item about parent expectation of problem improvement following evaluation	—
Keenan, 2019	Themes reported by teachers regarding their experience of reports included: • Teachers find recommendations to be the most important part of the report • Natural, minimally disruptive inventions and whole-class activities were preferred for ease of implementation • Teachers expressed dissatisfaction with reports due to 1) inaccessible language, 2) lack of clarity re. how diagnoses were reached, 3) overly vague recommendations	—
Nissirios et al., 2018	• Parents indicated high satisfaction on the questionnaire (96% of items were given positive ratings)	• Satisfaction did not vary by child age, sex, or IQ

(*continued*)

Table 1. Continued.

Study	Primary findings with regard to satisfaction and other respondent experiences	Correlates of satisfaction and other respondent experiences
[a]Nowinski, 2009	• Overall satisfaction was high, and decreased marginally from the post-feedback to post-evaluation time points • Alliance increased between testing and feedback time points on the Collaboration, Agreement on Goals, and Bond subscales	—
[a]Pilgrim, 2010 & Tharinger & Pilgrim, 2012	• Child ratings were high overall, with the highest rated subscale being Child-Assessor Relationship and the lowest rated subscale being Learned New Things • Parent ratings were high overall, with the highest rated subscale being Assessor-Parent Relationship and the lowest rated subscale being Family Involvement	—
Postal, 2018	• 41% of referring providers reported that long report turnaround times have a negative effect on their patient care • They rated the recommendations (65%) and diagnoses/impressions (64%) sections as most valuable • They rated the history (22%) and description of cognitive domains (20%) sections as most unnecessary • 90% described reports as moderately or very effective in communicating finding to themselves and other professionals • 61% described reports as moderately or very effective in communicating findings to patients and families	—
Pritchard, 2014	• Ratings of satisfaction were generally high, both post-feedback and five months later. However, satisfaction did decrease over that time frame • Lowest rated item was parent report of being "less stressed" after evaluation	—
Stark, 2014	• Overall satisfaction ratings on the questionnaire were high • The lowest ratings were observed for identifying other helpful professionals • Themes that emerged in interviews included 1) parent anxiety prior to neuropsychological evaluation, 2) praise for the clinician's interpersonal skills, 3) variable reactions to reports [some said helpful, other said too long/complex], 4) helpfulness of evaluation with regard to a) providing insight about child, b) providing practical strategies, c) helping parents advocate for the child	—
Waber, 2017	• 87% of parents reported being satisfied with the neuropsychological evaluation • 78% of parents reported that the school responded positively to the findings	• Lower SES and positive school response to the evaluation were associated with higher satisfaction

[a]Result refers to combined findings across control (i.e. assessment as usual) and experimental (i.e. new assessment technique) groups, which were presented after authors verified that these groups did not differ in the outcome of interest.

Table 2. Level 2 outcome study results.

Study	Primary findings with regard to resource or strategy utilization	Correlates of resource or strategy utilization
Blechschmidt, 2016	• 47% "very much" and 45% "somewhat" adhered to recommendations • Most (90%) parents were at least "somewhat" adherent to the following recommendation types: tutoring, non-medical assessments, school changes, home changes, family therapy, and other resources • Lower adherence was noted for other medical assessments (73%) • 84% of parents felt number of recommendations was good	—
Cheung, 2014	• 47% of home and 41% of school recommendations were implemented • Most recommendations were rated as effective and not difficult • Home recommendations that were most likely to be implemented were instructional and cognitive strategies (e.g. "monitor fatigue" and "give simple instructions") • Home recommendations that were less likely to be implemented were accessing certain types of resources (e.g. social groups, cognitive remediation software) • For teachers, practical classroom strategy recommendations were most often implemented compared to other school recommendations	—
Elias, 2020	• 52% of recommendations were implemented (40% of medical, 53% of home/community, 62% of school) • Less likely to be implemented: referrals to new medical providers (35%), referrals to advocacy organizations (16%), and referrals to non-licensed professionals, such as tutors (14%) • More likely to be implemented: referrals to established medical providers (58%), home strategies (87%), initiating special education services (62%), changes to school services (50%), and school instructional strategies (71%)	• Higher income was related to more implementation of medical recommendations, but not home or school ones • Parents of children with an ADHD diagnosis implemented more recommendations
Nowinski, 2009	• At feedback, parents reported intent to pursue an average of 6 recommendations • At follow-up, parents report had pursued/ intended to pursue an average of 4 recommendations	—
Pritchard, 2014	• Compared to children who did not receive a neuropsychological evaluation, those who did had a greater increase in the rate of 1) child participation in special education services, 2) initiation of ADHD medication, and 3) parent management training • Rate of participation in individual therapy also increased, but this was similar between the two groups	—
Quillen, 2011	• Parents followed 48% of recommendations • Only 60% of parents gave the report to the school, though this was recommended for all • Adherence varied substantially by parent • 97% of implemented recommendations were perceived as helpful	—

(*continued*)

Table 2. Continued.

Study	Primary findings with regard to resource or strategy utilization	Correlates of resource or strategy utilization
Shephard, 2019	• Overall recommendation adherence was 81% (i.e. parents had either started or were following the recommendation) • 100% shared report with school • 80% accessed recommended resources • 78% obtained psychiatric consultation • 65–70% pursued psychotherapy or other follow-up evaluations	• Higher baseline parent efficacy in managing child behavior was related to greater recommendation adherence • Trend for a positive relationship between SES and recommendation implementation ($p = .07$)
Waber, 2017	• Among children who did not already have an IEP, 58% received one following the evaluation • Among children who did have an IEP, 62% received increased services • Parents whose children got special education service changes thought they were helpful (95%) • Parents whose children got instruction technique changes thought they were helpful (99%)	• Lower SES children more likely to get increase in special education services

(25%). Interestingly, two studies which allowed for qualitative remarks from parents suggested mixed views on reports, with some parents describing reports positively, and others indicating that they were too long, overly technical, or confusing (Cheung et al., 2014; Stark et al., 2014). These findings support the utility of reports, but also indicate opportunities for improvement to ensure that reports are accessible to parents. They also highlight the usefulness of inviting qualitative remarks in neuropsychological outcomes studies broadly, as these may provide information not captured on quantitative measures.

Correlates of parent satisfaction and related experiences

The only significant correlate of parent satisfaction replicated across more than one study was SES, with both Waber et al. (2017) and Kirkwood et al. (2017) finding that lower SES was associated with higher satisfaction. Bodin et al. (2007) found that satisfaction ratings were lower for mothers with some college or a college degree relative to mothers with a lower or higher level of education.

Several studies examined the relationships between satisfaction and other demographic variables (e.g. child age, sex, and race/ethnicity), with no significant results (Bodin et al., 2007; Farmer & Brazeal, 1998; Kirkwood et al., 2017; Nissirios et al., 2018). Regarding change in satisfaction and related experiences over time, both Pritchard et al. (2014) and Nowinski (2009) found modest decreases in satisfaction over time, from post-feedback to follow-up, several months later, though the majority of parents continued to endorse satisfaction.

Teacher satisfaction and related experiences. Studies involving teachers provide data on preferences for report style and content, and particularly highlight the importance

Table 3. Level 3 outcome study results.

Study	Primary findings with regard to symptoms or functioning	Correlates of symptoms or functioning
Blechschmidt, 2016 & DeVries, 2017	• Most parents indicated improved child functioning following the evaluation (31% much better, 42% better, 12% a little better) • Average recommendation adherence and parent report of functional outcome were positively correlated • Relationship between ratings of feedback quality and functional outcome was non-significant	—
Combs, 2020	Following neuropsychological evaluation, parents reported: • Improved functioning in school, community, and home activities • Lower levels of overall problems and academic problems • No change in problems with peers or family members	• Older children showed a greater decrease in overall problem severity
Connery, 2016 & Kirkwood 2016	• Parent and child-reported concussion symptoms decreased following neuropsychological consult • Symptoms did not change among the pre-consult time points, one month and one week prior to consult	• For child report of symptoms, children with non-credible effort experienced a greater reduction in symptoms after neuropsychological consult
[a]Nowinski, 2009	• Parenting stress did not change across the study time points • However, there was also missing data for this measure	—
[a]Pilgrim, 2010 & Tharinger & Pilgrim, 2012	• Parents' positive perceptions about their children increased from pre-to-post assessment • Parents' negative perceptions about their children did not change from pre-to-post assessment • Children's positive and negative perceptions about themselves did not change from pre-to-post assessment	—
Pritchard, 2014	• Parent report of child grades at school improved over time, though this was similar across children who did and did not receive a neuropsychological evaluation • Parent report of behavioral/emotional and social problems decreased over time, though this was similar across children who did and did not receive a neuropsychological evaluation • There was no change in family difficulties	—

[a] Result refers to combined findings across control (i.e. assessment as usual) and experimental (i.e. new assessment technique) groups, which were presented after authors verified that these groups did not differ in the outcome of interest.

of clear, concise reports and quality recommendations for teachers. Baum et al. (2018) found that teachers rated report quality as higher for a new (shortened, more readable, and re-structured for clarity) report format compared to an old report format. In both Cheung et al. (2014) and Keenan et al. (2019), teachers reported that the recommendations were the most important part of the report for them. In qualitative remarks, Keenan et al. (2019) further found that teachers preferred natural, minimally disruptive interventions and whole-class activities for ease of implementation. Teacher-reported sources of dissatisfaction with reports included careless errors, inaccessible language, lack of clarity about how diagnoses were reached, and vague recommendations.

Referring provider satisfaction and related experiences. We analyzed data from the subset of Postal et al. (2018) sample of referring providers who were primarily pediatric ($n = 129$). Regarding which report sections are most valuable, respondents preferred the recommendations (65%) and diagnoses/impressions (64%). Regarding which sections are too long or unnecessary, respondents most often selected the history (22%) and the description of cognitive domains (i.e. results section; 20%). Ninety percent of referring providers described reports as effective in communicating findings to themselves and other professionals. However, only 61% described reports as effective in communicating findings to patients and families.

Child satisfaction and related experiences. Research on child satisfaction and related experiences was sparse, but generally suggested that most children had a positive experience with neuropsychological services, especially, their relationship/alliance with the neuropsychologist (Nowinski, 2009; Pilgrim, 2010; Tharinger & Pilgrim, 2012).

Level 2 Outcomes: resource or strategy utilization

Important methodological differences complicate the summary of information on resource or strategy utilization. Three studies examined recommendation adherence using interview questions that were individualized for the respondent and inquired about the specific recommendations in the child's report (Cheung et al., 2014; Elias et al., 2020; Quillen et al., 2011). Two studies examined changes in participation in certain treatments or services over time, irrespective of recommendations (Pritchard et al., 2014; Waber et al., 2017). Three gray literature studies relied on informal methods involving parent recollection to examine adherence (Blechschmidt, 2016; Nowinski, 2009; Shephard et al., 2019). Given methodological concerns related to the parent recollection method, we focus on the more rigorous, published studies in our description of results (Cheung et al., 2014; Elias et al., 2020; Pritchard et al., 2014; Quillen et al., 2011; Waber et al., 2017). More information, including the majority of findings from gray literature studies, is available in Table S5.

Recommendation adherence. The three studies using the individualized interview method found overall recommendation adherence rates ranging from 44% to 52% (Cheung et al., 2014; Elias et al., 2020; Quillen et al., 2011).

School-based changes

The literature on school-based changes indicates that many children receive increased support following neuropsychological services. The proportion of parents who shared the report with the school was variable, with lower rates in two pediatric oncology samples (67% of parents providing consent to share the report with the school, and 50% of teachers reported having received the report in Cheung et al., 2014; 60% of parents shared the report with the school in Quillen et al., 2011) and a higher rate in a diverse sample of children with medical and/or neurodevelopmental concerns (93% in Elias et al. 2020).

Regarding implementation of school-based recommendations, Cheung et al. (2014) found that 41% of all school recommendations for brain tumor survivors were implemented. In a sample with diverse presenting concerns, Elias et al. (2020) found that 62% of all school recommendations were implemented. Two studies compared pre- and post-evaluation special education supports. Pritchard et al. (2014) and Waber et al. (2017) found 22 and 23% increases in the proportion of children who were receiving special education services following evaluation, respectively. Pritchard further notes that this increase was significantly larger than the one observed in a sample of children who did not receive a neuropsychological evaluation.

Medical and psychological treatments

There was considerable variability in the manner in which authors classified and inquired about changes in participation in medical and psychological treatments. When considering adherence to medical and psychological treatment recommendations broadly, Elias et al. (2020) reported 35% adherence to referrals to a new provider and 58% adherence for further consultation or treatment adjustment with an established provider. Regarding psychotropic medication treatment, Pritchard et al. (2014) reported a 40% increase in the proportion of children with ADHD who were receiving ADHD medication following neuropsychological evaluation. This increase was significantly larger than the one observed among children who had not received an evaluation.

Several authors found an increase in seeking psychological treatment following a neuropsychological report recommendation. Cheung et al. (2014) indicated that 43% of parents followed up on referrals to a clinical psychologist. Pritchard et al. (2014) observed a 20% increase in children with ADHD receiving individual therapy, a 20% increase in parents receiving parent management training, and no change in family therapy participation. The increase in parent management training was significantly larger than the one observed among children who had not received an evaluation.

Home/community-based changes

There was also variability in the manner in which authors classified and inquired about adherence to home/community-based recommendations. Overall, rates of home-based strategy use and accessing informational resources were higher than rates of accessing other resources (e.g. advocacy/support groups, social skills groups, cognitive remediation software, and tutoring). Cheung et al. (2014) and Elias et al (2020) found that parents implemented 52 and 87% of home-based strategies, respectively. Regarding recommendations to access specific resources, Elias et al. (2020) found that 45% of parents pursued informational resources, such as books and websites about the child's condition, and 16% contacted advocacy groups. Cheung et al. (2014) found that 0% of parents accessed specific resources for children (e.g. social skills groups, cognitive remediation software).

Correlates of resource or strategy utilization. Elias et al. (2020) found that higher SES was associated with greater implementation of medical recommendations, but not school or home-based recommendations. In contrast, Waber et al. (2017) found that lower SES was associated with an increase in special education services following evaluation. This pattern suggests a complex relationship between SES and resource of strategy utilization. Higher SES families may have better access to certain resources, especially specialty medical care. However, lower SES families may experience greater increases in school-based services following neuropsychological evaluation, perhaps because they are more likely to be underserved prior to evaluation. This interpretation is supported by the fact that Waber et al. (2017) found that lower SES children in their sample also demonstrated more severe deficits in academic skills, suggesting that the discrepancy between their needs and levels of services may have been larger prior to evaluation.

Barriers to strategy or resource utilization. Across studies, the most common barriers included lack of resources (e.g. time, money, geographical, other logistical problems), child resistance, and school personnel resistance (Cheung et al., 2014; Elias et al., 2020; Quillen et al., 2011). Two pediatric oncology studies identified the additional barrier of parent concern about stigma (e.g. fear that child would be "labeled") and feelings of being overwhelmed by the number of recommendations (Cheung et al., 2014; Quillen et al., 2011).

Level 3 outcomes: changes in symptoms or functioning

Child symptoms or functioning. Studies of changes in child symptoms or functioning following neuropsychological services suggest possible broad improvements in functioning and specific improvements in concussion symptomology. Combs et al. (2020) found reduced parent-reported problem severity at school and improved functioning in school, community, and home settings several months after neuropsychological evaluation. Likewise, Pritchard et al. (2014), found improvements in school grades and behavioral/emotional and social problems. However, these improvements were similar across children with ADHD who did and did not receive evaluations. In Kirkwood et al. (2016), parents and children rated concussion symptoms at several time points before and after neuropsychological consultation. Symptoms remained stable among the pre-consultation time points and decreased following consultation. Taken together, the evidence for broad improvements is promising.

Parent or family functioning. Findings regarding changes in parent and family functioning following neuropsychological evaluation are equivocal. Pilgrim (2010) found that parent ratings of positive perceptions about their children increased following neuropsychological evaluation, and negative perceptions did not change; additionally, two studies indicated no changes (Nowinski, 2009; Pritchard et al., 2014).

Correlates of changes in symptoms or functioning. Only two studies examined correlates of changes in symptoms or functioning. In Combs et al. (2020), greater decreases in parent-rated overall problem severity were associated with older child age, but no other demographic variables. In Connery et al. (2016 [same data as Kirkwood et al., 2016]), the authors observed greater decreases in child-reported concussion symptoms among children who exhibited non-credible effort during testing, as opposed to children who exhibited credible effort.

Qualitative comments

Several studies encouraged respondents to provide qualitative comments about their experience with neuropsychological services. Both parents and teachers noted a desire for additional follow-up with the neuropsychologist (Cheung et al., 2014; Keenan et al., 2019; Shephard, 2019). Parents also suggested increased communication between the neuropsychologist and the child's school (Cheung et al., 2014). Similarly, in Stark et al. (2014), parents expressed particular appreciation of the neuropsychologist's advocacy for the child with the school. Stark et al. (2014) further noted a high level of emotional content in the study interviews (e.g. parents reporting trauma, grief, and chronic stress related to their children's illnesses or injuries), and concluded that parents often have unmet emotional needs that may be partly addressed through interaction with the neuropsychologist. Finally, parents in one study also indicated a desire for the neuropsychologist to provide feedback to the child as well (Cheung et al., 2014).

Discussion

Overall, the findings of this systematic review indicated high levels of parent satisfaction, consistent with the model in Figure 1, which suggests robust effects for the most proximal outcomes (Level 1 outcomes). Given variable methodology and relatively fewer studies, the data on resource and strategy utilization based on recommendation type (Level 2 outcomes) and changes in symptoms or functioning (Level 3 outcomes) is less straightforward and will be described in more detail below.

Regarding parent satisfaction, most studies reported unanimous or nearly unanimous satisfaction. Comparisons across subtopics indicated higher parent ratings for clinician empathy and increased knowledge compared to ratings of provision of help. The relatively lower parent ratings for the provision of help is expected in the context of our model, and perhaps indicate parent awareness of limitations of the neuropsychologist's influence on these types of outcomes. Nonetheless, this pattern may also suggest possible avenues for improving clinical services. For example, neuropsychologists may be able to increase provision of help by giving more specific referrals or following-up with parents and teachers to engage in additional problem-solving around addressing child difficulties identified during the neuropsychological services.

The literature on resource or strategy utilization indicates that approximately half of all pediatric neuropsychological service recommendations are implemented (Cheung et al., 2014; Elias et al., 2020; Quillen et al., 2011). Relative to 75% adherence to non-psychiatrist physicians' recommendations overall (DiMatteo, 2004), these numbers do not compare favorably, suggesting a need to develop strategies to increase implementation rates. Regarding adherence rates by recommendation type, there is evidence of higher adherence for informal home and school-based strategies compared to accessing certain types of treatments/support, such as tutoring, cognitive remediation software, and medical appointments with new providers. This is likely explained by the fact that the latter types of recommendations are more taxing on family resources (i.e. time and money). Consistent with this, parents commonly cited family resources as a barrier to implementing recommendations, in addition to child resistance and school personnel resistance.

Fewer studies examined changes in child or family symptoms or functioning associated with neuropsychological services. The extant literature generally suggests that improvements in functioning are often reported by parents (Combs et al., 2020; Pritchard et al., 2014). However, these findings should be interpreted cautiously, given limited studies, use of unvalidated questionnaires, and variability in study designs. For example, Pritchard et al. (2014) observed improvements in functioning, but found that those improvements were similar among children who did and did not receive neuropsychological evaluation, suggesting that changes observed in their study and other studies could reflect factors unrelated to the neuropsychological evaluation, such as regression to the mean or maturation. This highlights the need for additional rigorous studies in this area, which control for the effects of the passage of time when examining changes in symptoms or functioning. Furthermore, studies related to parent or family functioning following the neuropsychological services were few, with equivocal findings.

Future research directions

Research is lacking in several areas. First, the literature on referring provider, teacher, and child responses to neuropsychological evaluations were all limited. Additional research on the preferences of referring providers will be important for advocating for the profession within the healthcare setting. The dearth of research on children and teachers is noteworthy, given that commonly reported barriers to recommendation implementation include both school and child resistance, which highlights the need to better understand teacher and child reactions to services.

Studies that measured financial or economic impacts (Level 4 outcomes) in pediatric populations were completely absent. One related study asked parents to report whether their child's neuropsychological evaluation was worth the money they spent on it, and found almost unanimously positive responses (Arffa & Knapp, 2008). In-depth research into the cost-effectiveness of neuropsychological services for children would undoubtedly be a complex undertaking, though extremely valuable to the profession. Regarding healthcare utilization, it is likely that neuropsychological services increase spending in the short-term, as subsequent treatments and consultations are often recommended. However, spending may decrease in the long-term, in cases in which the neuropsychological services and subsequent recommendations decrease the severity of the child's functional disability. Similarly, we did not identify any studies that measured the impact of neuropsychological services on adherence to pre-existing medical or psychiatric treatments. This is surprising, given that several authors have discussed the important role that neuropsychologists can play in ensuring a safe and successful transition of care for adolescents with chronic conditions (Bernstein & Rey-Casserly, 2013; Murdaugh et al., 2019; Warschausky et al., 2017). Furthermore, in Allott et al. (2011)'s research on young adults, referring providers frequently reported that neuropsychological evaluations helped them tailor mental health treatment to the needs of their patients, suggesting that neuropsychological evaluation could lead to improvements in treatment effectiveness. Finally, as described by Prigatano & Morrone-Strupinsky (2010), increased outcome research is needed to demonstrate that neuropsychological tests can be integrated with neuroimaging results to improve patient care and clinical outcomes.

Overall, the literature on outcomes of pediatric neuropsychological services is in its infancy, and larger studies with rigorous designs are needed. These studies could potentially be embedded in routine quality improvement programs. Larger sample sizes would enable exploration of outcomes in specific demographic groups or diagnoses. Using existing waitlists to measure change in the outcome of interest over time without neuropsychological services, similar to Kirkwood et al. (2016), would be one way to increase the study quality. Broadly, more comparison studies between children who did and did not receive neuropsychological services are needed in order to understand the added value of the services and apply that information to improve services and advocate for the profession.

More studies involving group comparisons of outcomes among different neuropsychological services will also be important. In particular, examination of the impact of variations in typical practice (e.g. inclusion of child in feedback, degree of communication with schools) would be helpful for informing clinician priorities. Relatedly, gathering information on parent expectations before neuropsychological services may be helpful in explaining dissatisfaction and improving clinical care by increasing the neuropsychologist's awareness of these. Considering the established importance of a strong alliance to better therapy outcomes (e.g. Karver et al., 2006), more research is clearly needed to determine how the child- and/or parent-neuropsychologist relationship affects outcome of a neuropsychological assessment, which while brief, can be very meaningful for families. Finally, given the COVID-19 pandemic, bolstering research on the costs and benefits of using tele-communications for neuropsychological services would be timely (Hague et al., 2018).

Finally, two measurement issues were noteworthy. First, follow-up time frames varied tremendously, and questions remain about the optimum times for collecting data on outcomes, which presumably differ by outcome type. Studies involving data collection at regular intervals over time may help to clarify this issue. Second, we do not yet have any accepted, systematic method for classifying recommendation types. The authors also varied in terms of whether or not they permitted a response of "somewhat" or "started this" when asking parents whether they implemented a recommendation. These issues complicate comparisons across studies and limit our ability to observe patterns across populations and regions. Developing a consistent method for measuring recommendation implementation would be helpful to the future of research on outcomes of pediatric neuropsychological services.

Limitations of this systematic review

A limitation of the present review is the exclusion of studies that examined outcomes of neuropsychological services only in terms of diagnostic clarification. These were deemed outside the scope of this review, in order to allow us to conduct a more focused systematic review of satisfaction, related experiences, resource or strategy utilization, and changes in symptoms or functioning. However, it should be noted that diagnostic clarification is also a mechanism by which the neuropsychologist may have a positive impact on patients' lives, via increasing the likelihood that appropriate treatments and supports are obtained. For more information related to the incremental validity of neuropsychological evaluation, see Donders' (2020) review.

Also, we are not able to address the impact of neuropsychological service quality on outcomes, as the information we obtained is not sufficient to draw conclusions about the relative quality of services across the included studies. Furthermore, it is possible that neuropsychologists who conduct outcomes research are unique in ways that influence outcomes, and thus, our findings may not well represent the experiences of all families who receive neuropsychological services.

Finally, the practice of summarizing information across studies in a systematic review necessarily complicates the interpretation of findings due to minimizing the importance of methodological and theoretical diversity. To accommodate for this, we have included a great deal of methodological information in tables, in order to allow the reader to evaluate this issue.

Clinical implications

The clinical implications we can draw from these studies are preliminary. As the volume and quality of pediatric neuropsychology outcome research increases, these can be refined. Regarding satisfaction and related experiences, several findings point to the importance of considering the unique needs of the individual family and clarifying goals with parents and/or other stakeholders early in the evaluation process. For example, Austin et al. (2019)'s findings suggest that parent goals from a re-evaluation are likely different, given high self-ratings of knowledge at baseline, and re-evaluations may need to be tailored as such. Findings of lower satisfaction among high SES parents may also reflect differences in goals and expectations, which might be resolved through direct discussion early in the interaction (Kirkwood et al., 2017; Waber et al., 2017). Clarification of goals may also be helpful in identifying specific symptoms or areas of functioning that are targets for change.

Results of several studies, especially qualitative comments from both parents and teachers, highlight the benefits of reports that are concise and have minimal jargon (Baum et al., 2018; Cheung et al., 2014; Keenan et al., 2019; Postal et al., 2018; Stark et al., 2014). This observation is consistent with expert opinion about the disadvantages of lengthy, technical report-writing styles (Donders, 1999). Moreover, qualitative comments from parents and teachers also provided several suggestions for areas in which the neuropsychologist's time would be better spent (Cheung et al., 2014; Keenan et al., 2019; Shephard et al., 2019; Stark et al., 2014). The most frequently documented constructive feedback was a lack of follow-up with the neuropsychologist after the initial services. In addition to increasing satisfaction, follow-up from the neuropsychologist could facilitate coordination of care, increase recommendation implementation, and improve long-term outcomes. Similarly, parents and teachers identified a desire for increased neuropsychologist-school collaboration.

Regarding recommendations, families may be most likely to adhere to home and school-based strategies that are minimally disruptive. When asked to consider new treatments, the neuropsychologist may need to discuss barriers to care with the family in order to increase adherence. Some parents may also benefit from learning specific educational advocacy strategies to increase their success in obtaining school-based supports. Finally, parents and teachers indicated that child resistance was a barrier to recommendation implementation, suggesting the possible benefits of directing feedback to the child to increase buy-in for getting support.

Conclusions

This is the first systematic review to synthesize the literature on outcomes of pediatric neuropsychological services. We identified robust findings of high parent satisfaction, variable resource and strategy utilization across different types of common recommendations, and promising, though limited, evidence of improvement in child symptoms or functioning. Priorities for future research include gathering information from referring providers, teachers, and children, evaluating cost-effectiveness and medical or psychiatric treatment adherence outcomes, and conducting larger, longitudinal studies of outcomes. From a clinical standpoint, our findings provide preliminary support for the importance of clarifying goals with stakeholders, producing concise and accessible reports, exploring potential barriers to recommendation implementation, collaborating with schools, and following up with parents after the initial evaluation in order to maximize benefit from pediatric neuropsychological services.

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*References marked with an asterisk indicate sources of data included in the systematic review.

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