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Review Article

Nonstandardized Assessment of Cognitive-Communication Abilities Following Pediatric Traumatic Brain Injury: A Scoping Review

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Purpose: The purpose of this study is to describe and synthesize existing research on nonstandardized assessment of cognitive-communication abilities in children with traumatic brain injury (TBI) in order to improve the detection, diagnosis, and tracking of injury sequelae and guide appropriate service provision.
Materials and Method: A search of peer-reviewed journal databases revealed 504 unique articles published between January 2000 and August 2019. For full inclusion, articles had to report on empirical studies examining variables related to the nonstandardized assessment of cognitive-communication skills following TBI in children. Review articles, expert opinion pieces, and non–English language articles were excluded. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guided this process.
Results: Results were tabulated for each of the 14 articles that met full inclusion criteria. Included studies presented five different types of nonstandardized assessment: discourse analysis (n = 3), systematic observation of child's performance during an instrumental activity of daily living (n = 4), virtual reality tasks (n = 3), structured cognitive tasks (n = 2), and functional rating scales (n = 2). The majority of included studies compared the outcomes of nonstandardized assessment against subtest scores and checklists drawn from a variety of existing standardized and criterion-referenced assessments. Targeted cognitive-communication skills included attention, working memory, self-regulation, planning, multitasking, social problem-solving, inferencing, and macrolevel discourse.
Conclusions: Preliminary research suggests that a well-designed and systematically implemented nonstandardized assessment can yield essential information about children's cognitive-communication abilities in real-world contexts. Further research is needed to validate these assessments and to determine in which settings and situations they may prove most effective.
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Pediatric traumatic brain injury (pTBI) is a chronic disease process caused by an injury to the developing brain. The associated disruption in neurologic function may permanently alter the course of a child's development, giving rise to subtle impairments in cognitive, linguistic, and social functioning that can become more debilitating over time as academic and social demands increase (Babikian et al., 2015; Garcia et al., 2015; Prasad et al., 2017). Common sequelae of pTBI include difficulty processing, integrating, and storing new information; impaired judgment and reasoning (S. W. Anderson et al., 2000; V. Anderson et al., 2005); impaired discourse functioning (Chapman et al., 2006; Walz et al., 2011); and limited social skills (Deighton et al., 2020; Schmidt et al., 2010; Turkstra et al., 2004). The hallmark deficits associated with pTBI are cognitive-communication impairments, which are defined as communication difficulties arising from disorganized thought and impaired behavioral regulation (Ewing-Cobbs & Barnes, 2002; Togher et al., 2014; Ylvisaker, 1993). These deficits can interfere with survivors' ability to access their school curricula and to access meaningful support from peers and teachers, which may adversely affect their academic and vocational prospects (Cameto et al., 2004; Prasad et al., 2017; Todis et al., 2011).

Once discharged from the hospital, children with TBI usually return to school; however, discrepancies in case counts

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between hospitals and schools suggest that these children are not consistently identified or tracked by school service providers (Haarbauer-Krupa et al., 2017; Schutz et al., 2010). Fewer than 18% of students with an identified TBI-related disability were receiving support services in the schools in 2015 (Ettel et al., 2016). The greater the interval between the injury and the onset of academic problems, the lower the likelihood that school personnel will recognize the influence of the prior TBI (Prasad et al., 2017; Taylor et al., 2003), which may partially explain why children who sustain injuries in early childhood show particularly high rates of unmet need for services (Kingery et al., 2017; Salley et al., 2021). Longitudinal studies conducted during the K–12 school years have shown that problems associated with TBI tend to persist or worsen as children progress through school, culminating in poor academic, social, and vocational outcomes for these students (Ewing-Cobbs et al., 1998; Glang et al., 2008; Prasad et al., 2017). According to a 2004 study by Cameto et al., fewer than half of students with moderate-to-severe TBI were able to obtain a paying job outside the home within a year of departing school. Individuals who sustain a TBI during childhood are also significantly less likely than individuals with other types of disabilities (e.g., specific language impairment, learning disability, autism spectrum disorder) to enroll in postsecondary education or live independently following graduation (Cameto et al., 2004; Todis et al., 2011).

The current reliance on standardized and norm-referenced assessment procedures in schools constitutes another significant barrier to the proper identification, treatment, and tracking of children and adolescents with TBI. Children often must score at the low end of the normative distribution on standardized tests of language to qualify for speech and language services in schools (Spaulding et al., 2006); however, test scores alone do not accurately identify, diagnose, or describe cognitive-communication disorders (Cermak et al., 2019; Coelho et al., 2005; Steel & Togher, 2019), especially for children and adolescents. As many experts have pointed out, there are serious challenges to the ecological validity, sensitivity, and predictive value of currently available standardized tests when evaluating short- and long-term effects of pTBI (Chaytor & Schmitter-Edgecombe, 2003; Chevignard et al., 2012; Ciccia et al., 2009; Lundine & Hall, 2020; Turkstra et al., 2015). These challenges include the highly structured conditions of test administration (i.e., in a quiet, controlled environment, one-on-one with an examiner), the limited nature of skill sampling, and a disproportionate focus on explicit and premorbid knowledge of language form and social rules. Although standardized testing has its place in any comprehensive assessment protocol (American Speech-Language-Hearing Association [ASHA], 2019), even severely impaired survivors of pTBI can score within the average range on such tests (Ewing-Cobbs et al., 1998; Haarbauer-Krupa et al., 2018; Jaffe et al., 1993), which highlights the need for new and alternative methods of testing.

Nonstandardized assessments are defined as systematic clinical procedures that allow for observation of skill performance in functional contexts with and without clinician support (ASHA, 2019; Coelho et al., 2005; Steel & Togher, 2019). They enable the clinician to sample existing functions (e.g., discourse, executive functioning, pragmatics) while also making note of compensatory and/or maladaptive strategies the individual may have developed in response to these deficits (Ciccia et al., 2009; Spaulding et al., 2006). Once clinicians identify specific areas, tasks, and contexts in which a student's skills or behavior tend to break down (e.g., busy classroom, unstructured work time, deviation from routine), they can begin to design appropriate supports and strategies to be implemented by the student's caregivers and education team. Nonstandardized evaluations would ideally be conducted in multiple contexts and over time in order to monitor how disorder-specific effects interact with continuously changing environmental demands (Ciccia et al., 2009). For example, a student's social behavior can be observed and rated according to established criteria in both the classroom and the lunchroom, and these data may be gathered both before and after treatment to monitor the effects of intervention.

Consistent with the World Health Organization's (WHO) International Classification of Functioning, Disability and Health, nonstandardized assessment encourages a focus on activities, participation, and context rather than specific body structure and function (Coelho et al., 2005; WHO, 2007). When done well, this type of assessment informs the development of intervention plans and accommodations that are functional, relevant, and supportive of the individual within his or her everyday environment (Chevignard et al., 2012; New Zealand Guidelines Group, 2006). Earlier studies have shown that situational or functional assessments have been found to be more predictive of vocational success than standardized test scores (LeBlanc et al., 2000), since dissociation between test performance and everyday functioning is a defining characteristic of the frontal lobe dysfunction that often accompanies TBI (S. W. Anderson et al., 2000; Coelho et al., 2005).

Although the ASHA's Practice Portal designates nonstandardized assessment as an essential tool in evaluating pTBI (ASHA, 2019), relatively few clinicians prioritize the use of nonstandardized assessment protocols over standardized assessments in their daily practice (Brown et al., 2019; Duff & Stuck, 2015; Pavelko et al., 2016). Two recently published reviews (Sohlberg et al., 2019; Steel & Togher, 2019) offered several recommendations for improving assessment of social communication following TBI in adults; however, literature examining cognitive-communication impairments for children with TBI remains sparse. The systematic implementation of nonstandardized assessment methods would be greatly facilitated by a robust literature that includes (a) descriptions of how such techniques have been implemented in the past; (b) an analysis of when, where, and for whom they may be most helpful; and (c) guidelines for ensuring sufficient levels of reliability and validity in the future. As first steps, working clinicians need to know what methods exist, whether those methods are appropriate to their clinical setting and their clients, and what materials, training, and analysis may be involved in implementation. Once aware of their evidence-based options for assessment, clinicians

must then determine facilitators and barriers to the practice changes that would be required within their particular environment (Cane et al., 2012; Michie et al., 2005).

To date, there are a limited number of studies investigating nonstandardized forms of assessment for children with cognitive-communication disorders following TBI, and these studies span multiple disciplines, including neuropsychology, occupational therapy, education, and speech-language pathology. Tricco et al. (2018) propose utilizing scoping reviews as a method of "identify[ing] gaps in the literature to aid the planning and commissioning of future research" and "summariz[ing] findings from a body of knowledge that is heterogeneous in methods or discipline" (p. 467). Furthermore, Arksey and O'Malley (2005, p. 20) recommend selecting a scoping review over a systematic review for "broader [research] topics where different study designs might be applicable" and for which a rigorous or homogenizing quality assessment may leave out important exploratory studies. Therefore, a scoping review was determined to be the most appropriate method to explore the extant literature on this topic.

The goals of this scoping review are (a) to describe and synthesize existing research on nonstandardized assessment of cognitive-communication impairment in children with TBI and (b) to identify gaps in the literature in order to inform future research efforts. Of note, this scoping review differs from previous investigations of social communication assessment following TBI (Sohlberg et al., 2019; Steel & Togher, 2019) in that it focuses (a) exclusively on children and (b) more broadly on cognitive and educational as well as social domains of communicative functioning. Deighton et al. (2020) published a valuable scoping review pertaining to pragmatic language comprehension difficulties following pediatric TBI; however, assessment methods were not specifically examined or compared.

Method

The framework for this scoping review was derived from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018), and informed by scoping review methodology recommendations from Arksey and O'Malley (2005) and Levac et al. (2010). See Supplemental Material S1 for the completed PRISMA-ScR Checklist.

Data Sources and Search Strategy

The first and second authors, in consultation with a reference librarian, identified search terms for this review using an iterative discussion and problem-solving process. They examined multiple combinations of various terms and their search results to lead to the final search terms chosen for this scoping study (Levac et al., 2010). The medical librarian then completed an electronic search of the literature in August 2019, using the following electronic databases: Education Full Text, ERIC, SCOPUS, PsycINFO, and OVID/Medline. Search terms targeted the diagnosis under study (e.g., "traumatic brain injury") along with various terms pertaining to nonstandardized assessment ("naturalistic observation," "functional assessment," "ecological assessment," etc.). Because schools are the most naturalistic rehabilitation environment for children and adolescents following TBI, several educational terms (e.g., "education," "school") were also included in our search. As shown in Table 1, our search was not limited by the inclusion of these terms. Each search was expressed in Boolean logic using the terms *OR* to connect each subject together followed by *AND* to combine multiple terms. Search terms and strategy can be found in Table 1. Following the initial search, titles and abstracts were exported into Rayyan QCRI, a web-based application for systematic reviews (Ouzzani et al., 2016).

Screening Process

Authors followed a three-stage screening process to determine the eligibility of the articles identified in the search. During the first stage, titles and abstracts were independently screened by two trained assessors, both of whom were undergraduate students at The Ohio State University (one in the Department of Speech and Hearing Science and one in the Department of Health Sciences). The first author served as a third reviewer to verify reliability and resolve any disagreements. Articles marked as "include" or "maybe" during the first stage were then collaboratively screened by the first author and one of the trained assessors. During this second stage, assessors conducted a full-text review and came to consensus regarding whether each article met the criteria for inclusion in this scoping review. Finally, to ensure published literature saturation, the reference sections of the selected articles and the "similar articles" features in Google Scholar were perused for further relevant studies.

Eligibility Criteria

Inclusion Criteria

Only primary research studies with empirical design (qualitative, quantitative, or mixed methods) were included in this scoping review. This eliminated expert opinion papers, book chapters, dissertations, presentation or conference abstracts, narrative reviews, and reviews that represented secondary research (i.e., scoping reviews, systematic reviews, and meta-analyses). Selected articles were all peer-reviewed empirical studies, including single-subject experimental designs.

Another key inclusion criterion pertaining to study design was a focus on the assessment of cognitive-communication disorders following pTBI in the absence of treatment, specifically nonstandardized methods of assessment (as opposed to or in comparison to standardized methods). Studies that evaluated the validity/reliability of published criterion-referenced or standardized assessments (e.g., the Behavior Rating Inventory of Executive Function–Second Edition [BRIEF-2; Gioia et al., 2015], Student Version of the Functional Assessment of Verbal Reasoning and Executive Strategies [S-FAVRES; MacDonald, 2013]) were excluded. Finally, abstracts had to mention at least

Table 1. Search strategy utilized in scoping review.

Research component	Research terms
#1 assessment	(nonstandardized*) OR (informal) OR (ecological) OR (functional) OR (naturalistic) OR (dynamic) OR (alternative) OR (observational)
#2 traumatic brain injury	(traumatic brain inj*) OR (acquired brain inj*) OR (brain inj*) OR (TBI)
#3 education	(education) OR (schools) OR (students) OR (teachers)
#4	#1 AND #2
#5	#1 AND #2 AND #3

one variable related to cognitive-communication disorders (e.g., executive function, memory, discourse, social communication) in order to proceed to the full-text review stage.

Exclusion Criteria

Articles written in languages other than English were excluded, as were articles published before the year 2000. Assessors also ruled out studies that did not pertain to the target population, such as those that focused on adults with TBI (i.e., those who were age 21 years or older at the time of their injury), children with neurodevelopmental disorders of nontraumatic origin (i.e., autism, attention-deficit/hyperactivity disorder, learning disability, epilepsy), and children whose brain injury was sustained pre-, peri-, or immediately postnatally (i.e., cerebral palsy). Samples could include some children with nontraumatic acquired brain injury (ABI) as long as children with TBI were also present. Due to the confounding psychosocial and neuropsychological complexities present in cases of child abuse, assessors further excluded studies focusing on children with nonaccidental trauma.

Studies that examined general outcomes of TBI and/or discussed predictors of severity were also excluded, as the purpose of this study was to inform the practical assessment of cognitive-communication impairments associated with pTBI. Finally, assessors excluded studies that used neuroimaging as their primary method of assessment, since speech-language pathologists (SLPs) can neither complete neuroimaging studies nor interpret them. However, they did include some studies that compared nonstandardized assessment methods to existing neuroimaging, as this may yield powerful data regarding possible links between observable neurological damage and changes in everyday functioning.

Data Extraction and Synthesis

Data were extracted and tabulated by the first author according to the self-designed, inductive criteria detailed in supplemental materials. Information extracted from the articles included aims of the study, skills targeted, nonstandardized assessment methods used, other forms of assessment included in the study, and study findings. (See Supplemental Material S2 for a full list of extracted data.) For each included paper, all data points were confirmed by the second author, and discrepancies were resolved by consensus discussions. Once data were recorded, the first two authors reviewed the studies, discussed similarities and differences across the included assessments, and identified categories of nonstandardized assessments to facilitate comparison within and across assessment subtypes. Synthesis and discussion took place until authors reached consensus. In the acknowledgement of the underdeveloped nature of the literature in this area and the challenges associated with capturing objective data from nonstandardized assessments, critical appraisal of the included articles was not undertaken as a part of this scoping review (Munn et al., 2018).

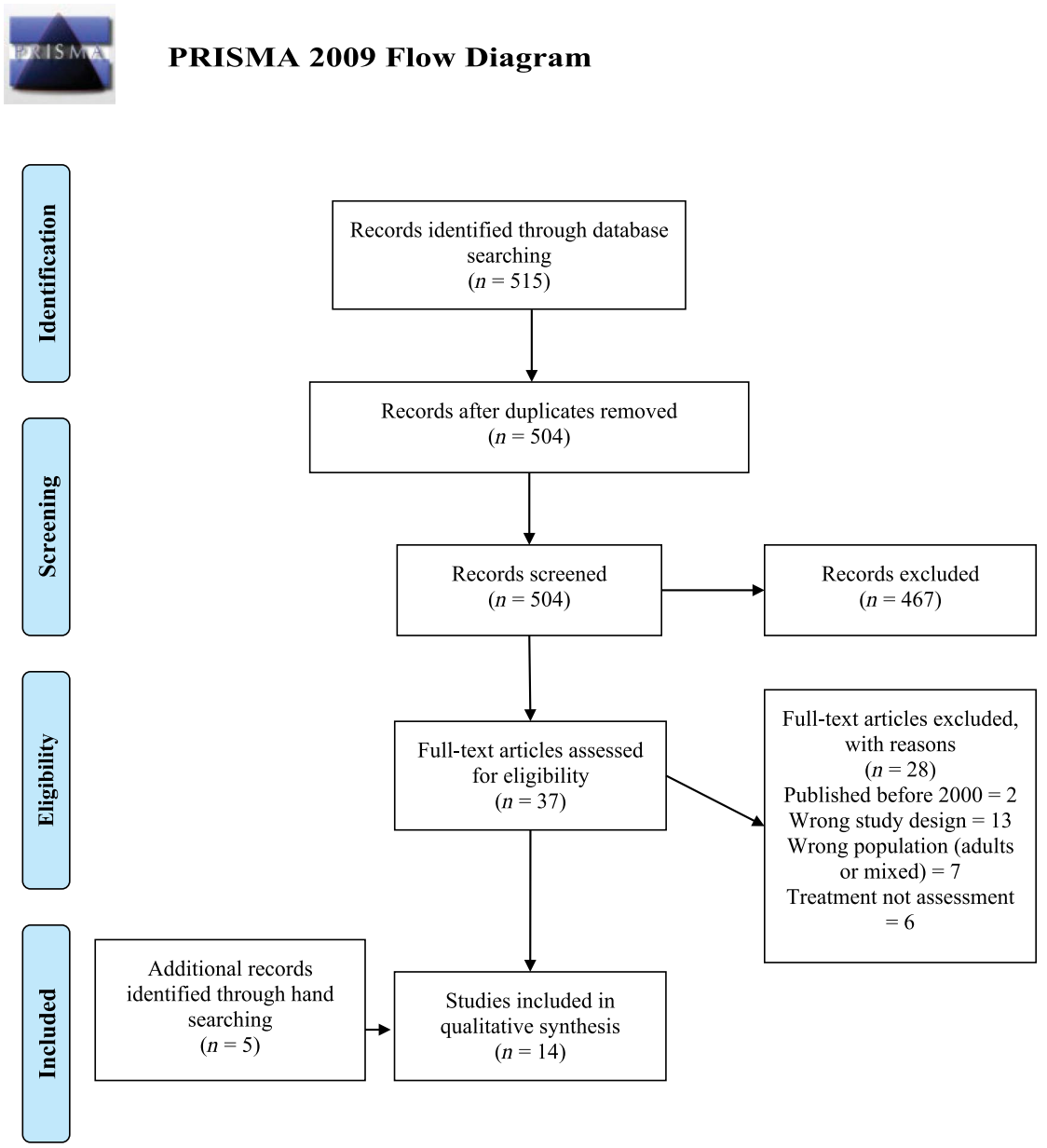
Results

The initial electronic search yielded 504 total articles after removal of 11 duplicates. A secondary hand search of reference lists and database suggestions yielded five additional articles to be considered for inclusion. Forty-two abstracts were flagged for full-text review, 14 of which were selected for inclusion in the study. The study selection process is summarized in a PRISMA flow diagram (see Figure 1). For a description of the purpose, scope, origin, and sample population of each study, see Table 2.

Description of Qualifying Studies

This scoping review yielded 14 articles that described and analyzed five different types of nonstandardized assessment: discourse analysis (n = 3), systematic observation of child's performance during an instrumental activity of daily living (IADL; n = 4), virtual reality tasks (n = 3), structured cognitive tasks (n = 2), and functional rating scales (n = 2). Sample sizes ranged from as few as two participants to as many as 128, with a similarly broad age range of 4–20 years. Studies originated from a variety of disciplines (i.e., speech-language pathology, neuropsychology, occupational therapy, and rehabilitation science) and were conducted in a variety of settings (i.e., university research labs, children's hospitals and rehabilitation centers, school, and home). Targeted cognitive-communication skills included attention, working memory, self-regulation, planning, multitasking, social problem-solving, inferencing, and macrolevel discourse, with more studies focusing on academic and adaptive skills (n = 12) compared to social skills (n = 2). It should also be noted that researchers themselves came from a wide array of countries around the world, namely, Australia, Canada, France, Israel, New Zealand, United Kingdom, and the United States. For a description of each study's procedures and results, see Table 3.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for papers included in this scoping review. Adapted from Moher et al. (2009).



The majority of included studies compared the outcomes of a nonstandardized assessment protocol against subtest scores and checklists drawn from a variety of existing standardized and criterion-referenced assessments, including the Wechsler Abbreviated Scale of Intelligence (WASI; Weschler, 1999), the Wechsler Intelligence Scale for Children–Third Edition (Wechsler, 1991), the National Institutes of Health (NIH) Toolbox Cognition Battery (Gershon et al., 2013), the Test of Adolescent and Adult Language–Third Edition (Hammill et al., 1994), the BRIEF-2 (Gioia et al., 2015), the Behavioral Assessment of the Dysexecutive Syndrome for Children (BADS-C; Emslie et al., 2003), the Rivermead Behavioral Memory Test–Third Edition (Wilson et al., 2008), the Test of Everyday Attention for Children (TEA-Ch; Manly et al., 1998), and the Clinical Evaluation of Language Fundamentals (CELF-4 and -5; Semel et al., 2003; Wiig et al., 2013), among others. This enabled a side-by-side comparison of performance on structured, everyday tasks versus performance on standardized tests. Two of 14 studies (Dennis et al., 2013; Hanten et al., 2011) utilized neuroimaging to

Table 2. Characteristics of studies included in full review.

Study	Assessment method	Skill(s) targeted	Disciplines involved	Sample size (*N*)	Clinical setting	Country of origin
Discourse analysis						
Chapman et al., 2004	Text genre: narrative; response modality: verbal	Discourse macrolevel processing and verbal expression	SLP and neuropsychology	*N* = 55–23 children with severe TBI (≥ 2 years postonset) vs. 32 controls with TD. Ages 7–14 years.	University department.	USA (Texas)
Lundine et al., 2018	Text genre: expository; response modality: verbal	Discourse macrolevel processing and verbal expression	SLP only	*N* = 55: 5 adolescents with TBI vs. 50 controls with TD. Ages 13–18.	University department, with participants recruited from a local children's hospital.	USA (Ohio)
Moran et al., 2012	Text genre: expository/ persuasion; response modality: verbal	Spoken persuasive discourse and working memory	SLP only	*N* = 16: 8 adolescents with (A)BI vs. 8 matched controls with TD. Ages 11–17 years.	School or home, depending on the participant.	New Zealand and USA (Oregon)
Instrumental activity of daily living (IADL)						
Chevignard et al., 2009	Children's Cooking Task	Executive functioning, specifically multitasking	OT and SLP	*N* = 28: 10 children with moderate-to-severe TBI vs. 18 matched controls with TD. Ages 8–14 years.	Pediatric rehabilitation hospital with a mix of inpatients and outpatients.	France
Chevignard et al., 2010	Children's Cooking Task	Executive functioning, specifically multitasking	OT and SLP	*N* = 46: 25 children with TBI vs. 21 matched controls with TD. Ages 8–20 years.	University department, with participants recruited from local outpatient clinics.	France
Krasny-Pacini et al., 2015	Children's Cooking Task	Prospective memory	OT and SLP	*N* = 87: 54 children with (A)BI vs. 33 controls with TD. Ages 8–20 years.	Not reported.	France
Cook et al., 2008	Birthday Task	Executive functioning, specifically self-regulation	SLP only	*N* = 32: 11 children with severe TBI vs. 21 controls with TD. Ages 8–16 years.	University department.	USA (Texas)
Virtual reality						
Erez et al., 2013	The Four-Item Test in the "Virtual Supermarket"	Executive functioning	OT only	*N* = 40: 20 children with TBI vs. 20 matched controls. Ages 8–16 years.	Children's hospital and university laboratory.	Israel
Gilboa et al., 2015	Sustained attention task in the "Virtual Classroom"	Attention	OT and SLP	*N* = 76: 41 children with (A)BI (TBI or brain tumor) vs. 35 matched controls with TD. Ages 8–16 years.	Not reported.	Israel and France
Hanten et al., 2011	Interpersonal negotiations strategy interview	Social skills, specifically conflict resolution	Neuropsychology, radiology, rehab specialists	*N* = 28: 15 adolescents with moderate-to-severe TBI vs. 13 controls with TD. Ages 12–19 years.	University laboratory with access to neuroimaging equipment.	USA (Texas)

(*table continues*)

Table 2. *(Continued).*

Study	Assessment method	Skill(s) targeted	Disciplines involved	Sample size (*N*)	Clinical setting	Country of origin
Structured cognitive task						
Dennis et al., 2013	The Literal Truth, Ironic Criticism, and Empathic Praise Task (Dennis et al., 2001)	Social skills, specifically parsing of indirect speech	Neuropsychology	*N* = 128: 71 children in the chronic stage of TBI vs. 57 matched controls with orthopedic injuries (OIs). Ages 8–13 years.	Hospital setting.	Canada (Toronto) and USA (Ohio)
Shanahan et al., 2011	The Party Planning Task	Executive functioning, specifically planning	SLP and OT	2 adolescents with severe TBI. No control group. Ages 16.8 and 18.5 years.	Isolated meeting rooms within a school setting.	Australia
Functional rating scale						
Long et al., 2005	Functional Independence Measure for Children (WeeFIM)	Functional communication and social cognition	OT, PT, SLP	23 patients with (A)BI. No control group. Ages 1;2–5;8.	Pediatric rehabilitation hospital with an in-house educational program.	USA (Virginia)
West et al., 2014	School Function Assessment (SFA)	Participation in school environment	OT, PT, SLP	70 patients with (A)BI (31 TBI, 29 nontraumatic BI, and 10 anoxic BI). No control group. Ages 4–18 years.	Pediatric rehabilitation hospital with an in-house educational program.	UK

Note. SLP = speech-language pathologist; TBI = traumatic brain injury; TD = typically developing; OT = occupational therapist; PT = physical therapist; (A)BI = (acquired) brain injury.

Table 3. Nonstandardized methods of assessment described in included studies.

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Discourse analysis				
Chapman et al., 2004	Following a brief lesson and guided practice with summarization, participants were asked to verbally summarize a lengthy narrative passage containing a clear moral.	Summaries were broken into T-units and analyzed for reduction and transformation of narrative text information. Degree of reduction was measured by comparing number of T-units in summary to that of the original. Degree of transformation was evaluated using a 0- to 9-point rating scale.	Block Design and Vocabulary subtests of the WASI; CLVT-C; Formulated Sentences subtest of the CELF-4.	Compared to controls, the TBI group produced equally reduced but less transformed information in their summaries. Children who were > 8 at injury were significantly more capable of transforming information than those who were < 8 at injury. Summarization ability was significantly related to problem solving, but not to lexical or sentence-level language skills or memory.
Lundine et al., 2018	Following a brief lesson and guided practice with summarization, participants were asked to verbally summarize 2 expository video lectures (1 compare–contrast and 1 cause–effect).	Summaries were segmented into C-units and analyzed using a holistic scoring rubric. Summaries were assigned macro- and microstructural composite scores as well as total quality scores.	5 subtests from the NIH Toolbox Cognition Battery; Recalling Sentences subtest of the CELF-5.	Mean summary quality scores for both exposition types were at least 1 *SD* lower for TBI compared to TD and 2 *SD*s below for the cause–effect passage. The majority of adolescents with TD showed the opposite pattern: Performance on the cause–effect passage was better than the compare–contrast. Scores on discourse analysis were not significantly related to expressive syntax scores.
Moran et al., 2012	After viewing a narrated photomontage that presented both sides of the issue, participants stated whether they thought team sports or individual sports were better and to provide reasons to support their claim.	Spoken samples were transcribed into SALT and broken into T-units (with mazes and repetitions excluded from the count) and analyzed for syntactic complexity and persuasive content, with special attention paid to mixed claims (i.e., reasons that support both arguments).	CELF-4, TOAL-3, CLPT.	No group differences were found for productivity or syntactic complexity. ABI group produced almost twice as many mazes, half as many supporting reasons, and twice as many tangential utterances as the control group. Working memory was significantly different between the two groups but did not appear to influence performance on the discourse task.

(*table continues*)

Table 3. *(Continued).*

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Instrumental activity of daily living (IADL)				
Chevignard et al., 2009	Participants received ingredients, utensils, and step-by-step instructions and were asked to make 2 different recipes within 90 min. Distractor ingredients and utensils were present.	Errors were classified at a descriptive level (e.g., omissions, additions) and then tagged with underlying neuropsychological mechanisms (e.g., context neglect). Researchers recorded the duration of cooking, the number of dangerous behaviors, and the success or failure of the venture.	BADS-C; Prospective Memory subtests of the RBMT-C; TMT-B; WCST; RCF; TOL. Parents were asked to complete the BRIEF.	Mean number of errors in TBI vs. control group was 95.3 (*SD* = 61.3) vs. 22.5 (*SD* = 11.6), indicating that children with TBI made 4.2 times more errors, on average, but were also much more variable as a group. Task failure was associated with lower scores on tests of executive functioning. More children with TBI were identified by the cooking task than by cognitive tests or questionnaires.
Chevignard et al., 2010	See above.	See above.	D-KEFS; Six Part Test from the BADS-C. Parent questionnaires: BRIEF; DEX-C.	Children with TBI, including mild TBI, made significantly more errors compared to controls. Results were correlated with several tests and one questionnaire of executive functioning. Internal consistency and test–retest reliability of the CCT were found to be high.
Krasny-Pacini et al., 2015	See above.	See above.	Prospective Memory subtests o f the RMBT and WISC III.	ABI and controls significantly differed in total number of errors, and children who made more errors overall were found to have a lower prospective memory score on the CCT. No significant correlation was found between the PM score on the CCT and the sum of PM raw scores on the RMBT in the ABI group.
Cook et al., 2008	Participants were told to prepare a birthday lunch for a friend. They each completed 3 tasks: making sandwiches, wrapping a birthday present, and writing a birthday card.	Errors were coded as omissions, object substitutions, or action additions. Totals in each category were tabulated, along with the total number of errors.	None. Authors suggest using the BRIEF and the Six Elements Test in future iterations of the study.	Children with TBI were significantly more likely to use distractor objects in place of target objects compared to controls.

(*table continues*)

Table 3. *(Continued).*

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Virtual reality				
Erez et al., 2013	Participants were asked to "shop" for 4 items in a virtual supermarket. Items were listed on a whiteboard in full view of the participants to minimize influence of memory deficits.	Measured duration of task, number, type of mistakes, and feelings of self-efficacy (perceived skill, perceived effort).	Feedback questionnaire; Borg's scale of perceived exertion; Zoo Map subtest of the BADS-C.	All children were able to complete the shopping task in < 20 min and reported "high sense of success" regardless of performance. Mean shopping time and number of mistakes were both higher for children with TBI. VMall scores correctly classified 65% of participants. No significant group differences were found on the Zoo Map subtest; however, Zoo Map scores did boost accuracy of classification by 10% when combined with VMall scores.
Gilboa et al., 2015	Participants viewed a series of numbers on a blackboard in a virtual classroom and tapped to select when a specific digit sequence appeared. Twenty visual, auditory, and mixed audiovisual distractor stimuli were administered.	Counted total number of correct hits, number of commission errors, reaction time, and head movements.	Subtests of the WASI; subtests of the TEA-Ch; CPRS-R.	ABI group made significantly fewer correct hits, though reaction time and head movements were the same. Overall, significant correlations were found between the VC variables, TEA-Ch subtest scores, and the CRPS-R:S.
Hanten et al., 2011	Adolescents viewed 6 animated scenarios depicting social conflict between either parents and youth or youth and peers and were asked to define the problem, generate solutions, select solutions, and evaluate the likely outcome.	Scoring was based on a developmental scale in which responses were judged as impulsive, unilateral, reciprocal, or collaborative, in order of increasing score.	Neuroimaging of cortical gray matter thickness of orbitofrontal regions, frontal pole, cuneus, and temporal pole. WASI; CELF-3; GORT-4.	Significant group differences were strongest and most consistent for defining the problem and evaluating outcomes. Performance was inversely related to complexity of scenario in youth with TBI. Increases in cortical thickness in the temporal pole and the cuneus were related to better performance.
Structured cognitive task				
Dennis et al., 2013	Six pictured situations with standard captions were narrated with neutral, ironic, or empathic intonation. Participants were asked 2 factual, 2 belief, and 2 intent questions about each image.	Factual questions were scored as correct or incorrect. Belief and intent questions were scored as correct (2), underspecified (1), or incorrect (0).	Neuroimaging of injury severity, including diffuse and focal CT abnormality scores (when available).	Group differences emerged on indirect speech acts, but not on direct speech acts. In general, belief was easier to understand than intention; however, the severe TBI group demonstrated significant difficulty with belief as well.
Shanahan et al., 2011	Participants were asked to organize an imaginary party using a color-coded chart as a visual planning aid while also narrating their process out loud.	Analysis of visual planning aid, verbal protocol. Each visual planning aid was coded for errors (omission, time, allocation).	None reported.	Provided insight into not only effectiveness and efficiency, but also independent use of strategies (including chunking, monitoring, and self-evaluation).

(*table continues*)

Table 3. *(Continued).*

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Functional rating scale				
Long et al., 2005	OTs, PTs, and SLPs observed the child during an inpatient rehab stay and rated the extent to which the child was able to care for him or herself independently.	Consists of 18 items, each with a 7-level rating scale. Ratings range from *total assistance* (1) to *complete independence* (7) within a given functional domain.	E-LAP for patients aged 0–36 months. LAP-D for patients aged 3–7 years.	Only moderate correlations were found between some of the functional cognitive measures of the WeeFIM and the standardized cognitive and language measures of the developmental assessment.
West et al., 2014	OTs, PTs, and SLPs observed the participant in various school settings, rated the student's level of participation, and identified necessary supports to maximize participation in the future.	Consists of 316 items across 3 categories: Participation, Task Performance, and Activity Performance. Rating scale: 1 = *does not perform*, 2 = *partial performance*, 3 = *inconsistent performance*, 4 = *consistent performance*.	None reported.	Provided data on outcomes that could be used to improve the overall rehabilitation service. For example, progress in "Safety" showed the least improvement, which alerted staff to consider incorporating safety awareness into all aspects of intervention.

Note. WASI = Wechsler Abbreviated Scale of Intelligence; CLVT-C = California Verbal Learning Test–Children's Version; CELF = Clinical Evaluation of Language Fundamentals; TBI = traumatic brain injury; NIH = National Institutes of Health; TD = typically developing; TOAL = Test of Adolescent and Adult Language; CLPT = Competing Language Processing Test; BADS-C = Behavioral Assessment of the Dysexecutive Syndrome for Children; RBMT-C = Rivermead Behavioral Memory Test for Children; TBT-B = Trail-Making Test, Part B; WCST = Wisconsin Card Sorting Test; RCF = Rey Osterreith Complex Figure Copy; TOL = Tower of London; BRIEF = Behavior Rating Inventory of Executive Function; D-KEFS = Delis-Kaplan Executive Function system; DEX-C = Dysexecutive Questionnaire for Children; CCT = Children's Cooking Task; RBMT = Rivermead Behavioral Memory Test; PM = Prospective Memory; VC = virtual classroom; WISC = Wechsler Intelligence Scales; TEA-Ch = Test of Everyday Attention for Children; CPRS-R = Conners' Parent Rating Scales–Revised; GORT = Gray Oral Reading Test; E-LAP = Early Learning Accomplishment Profile; LAP-D = Learning Accomplishment Profile–Diagnostic.

study the effects of the site and severity of brain lesions on target behaviors.

Discourse Analysis (n = 3)

Three studies examined students' verbal or written discourse skills via language sampling (Chapman et al., 2004; Lundine et al., 2018; Moran et al., 2012). All three compared the performance of students with TBI to typically developing (TD) peers of similar age, and although the tasks and conditions differed slightly, the procedures were largely similar. Participants listened to or read a discourse passage and were asked to either summarize the source material or make a persuasive argument based upon it. Source material differed by genre (narrative vs. expository) and level of complexity as well as by delivery method (e.g., text vs. audio recording vs. video recording). Response modality was either written or verbal, and each study offered participants differing levels of preteaching (e.g., reviewing elements of an effective summary) prior to collecting their sample.

Once discourse samples were gathered, researchers analyzed the resulting text or transcript on a range of measures, including microlevel structure, macrolevel structure, content, and persuasiveness. Microlevel structure is defined as intrasentence construction and intersentence semantic conjoinment (Liles et al., 1995) and is typically measured by breaking sentences into T-units (where a T-unit is defined as an independent clause and all the dependent clauses that modify it) and running analyses for length (number of words per T-unit) and syntactic complexity (number and type of embedded clauses). Macrolevel structure refers to the organization and flow of ideas in a given text (Liles et al., 1995). In two of three studies, this component was assessed via self-designed rating scales and scoring rubrics with adequate levels of interjudge reliability. Content and persuasiveness were judged based on the percentage of key information included (for summaries) and the overall logic and effectiveness of the participant's argument (for opinion pieces).

Across all three studies, the performance of participants with TBI differed significantly from that of peers with typical development on metrics related to content, quality, and macrolevel structure, but not on metrics related to productivity (i.e., length) or microlevel structure (i.e., syntactic complexity). In general, scores assigned during the discourse analysis task were not significantly related to the expressive syntax scores derived from subtests of the CELF-4 (Chapman et al., 2004; Moran et al., 2012; Semel et al., 2003) and the CELF-5 (Lundine et al., 2018; Wiig et al., 2013). No clear relationship was found between discourse ability and working memory scores (Chapman et al., 2004; Moran et al., 2012); however, discourse ability did correlate with problem-solving skills as measured by the WASI (Chapman et al., 2004; Weschler, 1999). Lundine et al. (2018) also found a significant relationship between overall cognitive abilities (as measured by the NIH Toolbox Cognition Battery; Gershon et al., 2013) and discourse ability, with children scoring in the average range on the cognitive battery (i.e., > 85) showing the same overall pattern of discourse performance as peers with TD (i.e., superior performance summarizing a cause–effect passage compared to compare–contrast), while children with below-average cognitive scores showed the opposite pattern (i.e., superior performance summarizing compare–contrast compared to cause–effect).

As for areas of weakness that were highlighted by discourse analysis, Chapman et al. (2004) found significantly less transformation in the summaries of children with TBI, meaning that children with TBI were more likely to repeat what they had heard rather than restating the source content in their own words. Interestingly, children who were injured after age 8 years were significantly more capable of transforming information than those who had been injured before age 8 years, which supports the authors' hypothesis that summarization skills emerge around the age of 8 years. On a persuasive discourse task, Moran et al. (2012) found that adolescents with ABI produced half as many supporting reasons and twice as many tangential (i.e., off-topic) utterances compared to age- and gender-matched controls. They also exhibited almost twice as many instances of mazing, which indicates reduced efficiency of expression. Mazing is defined as a series of words, initial parts of words, or unattached fragments, which do not contribute meaning to the ongoing flow of language (Loban, 1976). Finally, Lundine et al. (2018) found poorer quality summaries across two different types of expository discourse, with adolescents with TBI earning lower scores on the cause–effect passage (2 *SD*s below peers with TD) compared to the compare–contrast (1 *SD* below peers with TD).

Systematic Observation of an IADL (n = 4)

This category of nonstandardized assessment involves the observation and coding of children's behavior during a functional everyday task (e.g., following a recipe or planning a birthday party), staged within a relatively controlled environment (Chevignard et al., 2009, 2010; Cook et al., 2008; Krasny-Pacini et al., 2015). Targeted skills fell within the category of executive functioning, including self-regulation, prospective memory (i.e., remembering to follow through on stated plans), and multitasking. All four studies presented participants with a standard procedure and standard materials (including some unnecessary, "distractor" tools and ingredients) and then tracked deviations from the standard procedure—not unlike a standardized test, with its correct and incorrect responses, but with more hands-on, engaging activities and naturalistic conditions. Three out of four studies used the Children's Cooking Task (Chevignard et al., 2009), a task designed collaboratively by neuropsychologists, occupational therapists, and SLPs. Variables included the amount of direct instruction provided, the amount of scaffolding built in, and the amount of assistance provided during the task (e.g., online error correction).

As participants completed the assigned tasks, researchers measured some assortment of the following variables (see Table 2 for study-specific details):

- efficiency (i.e., How long did the task take?),
- overall success/failure (i.e., Was the dish edible? Was the gift properly wrapped?),

- number and type of errors made during task,
- instances of error monitoring and correction,
- instances of novel problem-solving and cognitive flexibility (e.g., missing a necessary tool, but working around it),
- responses to hints and redirection during the task,
- the quality and content of participants' self-talk, and
- the quality and accuracy of participants' self-assessment on close of task.

Both tasks (i.e., the Children's Cooking Task and the Birthday Task) revealed significant differences between participants with TBI and controls with TD, with the former group making a greater number and assortment of errors relative to the latter. On the first iteration of the Children's Cooking Task (Chevignard et al., 2009), children with TBI not only made 4.2 times more errors, on average, compared to peers with TD but were also much more variable as a group, as evidenced by a standard deviation of 61.3 errors for participants with TBI compared to 11.6 for the control group. Even children with mild TBI who scored in the average range on neuropsychological tests and parent questionnaires made a clinically significant number of errors on the Children's Cooking Task (Chevignard et al., 2009, 2010), which suggests the task was sensitive to TBI-related difficulties. Clinical significance in this case was defined as exceeding the mean number of errors made by the control group plus 2 *SD*s (Chevignard et al., 2009). Results otherwise correlated well with validating measures of executive functions, which included the BADS-C (Emslie et al., 2003) and the Delis-Kaplan Executive Function System (Delis et al., 2001), among others. Researchers also reported good internal consistency and test–retest reliability across multiple administrations of the task (Chevignard et al., 2010). Performance on the Birthday Task was not compared to scores on standardized tests or questionnaires; however, Cook et al. (2008) found that children with TBI were significantly more likely to use distractors in place of target items.

Virtual Reality Tasks (n = 3)

Virtual reality tasks were used as a nonstandardized method of assessment in three studies identified for this scoping review. The first, conducted by Erez et al. (2013), sought to assess performance of an IADL (i.e., grocery shopping) within a virtual supermarket, with measures very similar to those developed for in-person IADL scenarios (see previous section). Researchers found higher mean shopping time and greater incidence of mistakes among children with TBI, but no significant correlation with Zoo Map subtest scores (BADS-C; Emslie et al., 2003). Performance in the virtual supermarket identified children with TBI with 65% accuracy, whereas the Zoo Map subtest did not find any significant differences across groups (Erez et al., 2013). Notably, all participants reported high levels of self-efficacy and low levels of effort on the supermarket task regardless of their actual performance.

Gilboa et al. (2015) took a traditional computer-based test of sustained attention (i.e., clicking the left or the right arrow in response to a stimulus on the screen) and mapped it onto a virtual classroom, in which participants were asked to maintain attention to figures projected on a virtual blackboard while ignoring preprogrammed visual and auditory distractors (e.g., paper airplanes, loud noises). This enabled the researchers to take quantitative data on phenomena that can be difficult for observers to estimate (e.g., average reaction time). Results showed similar reaction time and number of head movements across TBI and TD groups, but lower accuracy of responses in participants with TBI compared to those with TD (Gilboa et al., 2015). Significant correlations were found between virtual classroom performance, parent rating scales, and scores on standardized tests of attention (TEA-Ch; Manly et al., 1998), but not intelligence scores (WASI; Weschler, 1999).

The third study involving virtual reality (Hanten et al., 2011) was one of only two studies in this scoping review that examined social skills as an indicator of cognitive-communication ability. It positioned each participant as a witness to and arbiter of a series of animated scenarios depicting social conflicts with either parents or peers. Participants were asked to define the problem and generate possible solutions, which were then analyzed for their thoughtfulness and effectiveness via rating scales. Group differences were strongest and most consistent for defining the problem and evaluating outcomes, especially in more complex scenarios. Results of neuroimaging linked poor performance to decreased cortical thickness in the temporal pole and cuneus in test subjects with TBI (Hanten et al., 2011). No statistical comparisons were made to scores on standardized tests of intelligence, language, and literacy, although these data were gathered during recruitment.

Taken together, the studies belonging to this category found that children with TBI exhibited higher rates of error, decreased efficiency, and decreased problem-solving skills on virtual reality tasks compared to children without TBI. Concurrent validity with standardized tests, when measured, was limited across studies.

Structured Cognitive Tasks (n = 2)

Two studies in the data set (Dennis et al., 2013; Shanahan et al., 2011) targeted complex reasoning and judgment via self-designed paper-and-pencil tasks that required participants to correctly interpret, organize, and/or report on information within a more traditional testing environment. In the first study, Dennis et al. (2013) targeted comprehension of literal, inferential, and intentional communication via "The Literal Truth, Ironic Criticism, and Empathic Praise Task" (Dennis et al., 2001), which required participants to view a series of pictures; listen to a series of captions narrated with neutral, ironic, or empathic intonation; and determine whether the speaker's intent was honest, sarcastic, or altruistic. It is one of relatively few experimental tasks documented in the literature that evaluates children's ability to integrate context cues with paralinguistic cues in order to construe social meaning. Group differences were

found in interpretation of indirect speech acts, but not direct speech acts. Indirect speech acts are utterances whose meaning must be inferred from context, since the speaker does not explicitly state the intended message (e.g., "The dishes are still in the sink" vs. "Go wash the dishes"; Yule, 1996). Within the category of indirect speech acts, the children with TBI had a relatively easier time detecting underlying beliefs (i.e., speakers' opinions of one another) compared to underlying intentions (i.e., speakers' motives for interacting; Dennis et al., 2001).

In the second study, Shanahan et al. (2011) utilized a complex planning task in which two participants with severe TBI were asked to organize an imaginary party using a visual planning aid while also narrating their thought process aloud. Planning aids and verbal protocols were first analyzed for efficiency, reasoning, and metacognitive skill. Researchers then compared these results to those of a previous study by Pentland et al. (1998), which used the same protocol and included a control group as well as multiple groups of children with TBI of differing severity levels. In the 2011 study, researchers found that the participant who used more compensatory strategies for executive functioning (e.g., self-talk, chunking, checklists) earned a score that was more on par with the mild-to-moderate TBI cohort in the 1998 study, despite the severity of his injury. The other participant did not demonstrate independent use of compensatory strategies and did not perform outside of the range of performance for severe TBI (Shanahan et al., 2011; Pentland et al., 1998).

Functional Rating Scales (n = 2)

The final two studies (Long et al., 2005; West et al., 2014) required a multidisciplinary team of rehabilitation therapists to observe and dynamically assess children hospitalized with TBI across multiple settings (e.g., therapy gyms, patient rooms, in-house educational programs) and rate the children's level of independence across various domains (e.g., self-care, physical movement, receptive/expressive language, cognition). The two rating scales utilized were the Functional Independence Measure for Children (WeeFIM; Msall et al., 1994), a 7-point scale measuring how much assistance the child requires to complete self-care tasks and remain safe within the environment, and the School Function Assessment (SFA; Coster, et al., 1998), a 4-point scale evaluating the extent to which the child is able to participate in school tasks. Long et al. (2005) found moderate correlations between the functional cognitive measures on the WeeFIM and standardized tests of language development. West et al. (2014) did not compare the results of the SFA to any standardized assessments; however, they did note that children made the least progress in safety awareness during their inpatient rehabilitation stay, which they proposed could influence the level of direct supervision students may need upon return to school.

Discussion

The goals of this scoping review were to (a) describe and synthesize existing research on nonstandardized assessment of cognitive-communication abilities in children with TBI and (b) identify gaps in the literature in order to inform future research efforts. The review identified 14 unique studies involving more than 300 children with TBI and presenting five different types of nonstandardized assessment that have been used to evaluate cognitive-communication abilities following pTBI: discourse analysis, systematic observation of an IADL, virtual reality tasks, structured cognitive tasks, and functional rating scales. Each of these methods offers its own set of advantages and disadvantages depending on the clinical setting (e.g., inpatient rehabilitation vs. schools) and clinicians' degree of access to necessary tools and resources (e.g., virtual reality technology). Since the purpose of the current review was to inform clinical practice and future research for nonstandardized assessment of cognitive-communication abilities within academic, functional, and social contexts, the next section of the discussion will explore implications for clinical practice and recommendations for future studies.

Implications for Clinical Practice and Future Research

Clinical applications for each of the five methods of nonstandardized assessment identified in this scoping review are discussed in terms of the contributions they may offer, some settings where they might best be implemented; aspects of their procedures, materials, time, and labor considerations that may act as barriers to implementation; and research needed to develop effective implementation strategies.

Discourse Analysis

Multiple prior studies have found discourse analysis to be a sensitive assessment tool in cases of TBI for the purpose of identifying and describing functional challenges (Chapman et al., 1997, 2006; Coelho et al., 2005; Davis & Coelho, 2004). Lê et al. (2011) attribute this sensitivity to the cognitive processes underpinning discourse ability, which rely on synergistic activity across a variety of cortical areas, including the prefrontal cortex, the temporoparietal and anterior temporal regions, and the posterior cingulate cortex (Mar, 2004). In the three studies identified in this scoping review, macrolevel organization and content were found to be more severely disrupted in children with TBI, whereas sentence-level syntax remained roughly equivalent to that of the control group (Chapman et al., 2004; Lundine et al., 2018; Moran et al., 2012). This suggests that, within the context of assessment, lengthier discourse samples are not only preferable, but in fact necessary to adequately evaluate the cognitive-communication abilities of individuals with TBI, especially in the context of academic writing.

Unfortunately, relatively few school-based SLPs report gathering and analyzing language samples, let alone extended discourse samples, because the process is deemed too time-consuming (Frith, 2014; Pavelko et al., 2016). According to a nationwide survey by Pavelko et al. (2016),

SLPs who served middle and high school students were less likely to use language sample analysis than those who served elementary students. Those who did report commenting on discourse in their clinical documentation tended to do so informally in the context of conversation, without recording or transcribing a formal sample (Frith, 2014). Computer-based technologies such as the Systematic Analysis of Language Transcripts software (Miller & Iglesias, 2012; utilized by Lundine et al., 2018, and Moran et al., 2012) may substantially increase the efficiency of transcription and micro-level language analysis. School-based SLPs may also save time by obtaining and analyzing work samples from the classroom rather than eliciting a novel sample. Indeed, ASHA's Committee on Language Learning Disorders has recommended collaborating with other Individualized Education Program (IEP) team members (e.g., parents, teachers) to maximize the validity of discourse sampling and interpretation (ASHA, 1991).

Although discourse or language sample analysis appears to be sensitive to some of the more subtle, higher level challenges experienced by individuals with TBI, the present review identified only three studies that utilized this type of assessment. The protocols and discourse genres explored were different as were outcome variables assessed across these three studies. Future research efforts should focus on developing and documenting the effectiveness of manualized protocols and rubrics that correspond to the genre, purpose, and complexity of the sample elicited.

Systematic Observation of an IADL

The complexity involved with systematically observing a child perform an IADL constitutes both a strength and a weakness when considering clinical applications, especially in environments where time and resources are limited. Clinicians may need to be trained on specific protocols and instructions, how much support to give, and procedures for remedying potentially dangerous errors (e.g., putting a dish towel down on a flaming stove top). The detailed error analysis described in the Children's Cooking Task, in which each mistake was coded according to its underlying cognitive-communication deficit (e.g., context neglect, purposeless actions, poor safety awareness), provides valuable insight into affected cognitive domains but would likely require the clinician to review a video recording of the assessment, in addition to the data taken during in-person observation. School-based SLPs in particular may lack access to the requisite equipment, environment (e.g., a kitchen), training, and/or opportunities for interdisciplinary consultation (e.g., with occupational therapy). Inpatient or outpatient rehabilitation may be the most appropriate setting for this form of assessment, especially given its focus on adaptive functioning and safe return to the home environment.

Despite these potential drawbacks, the Children's Cooking Task was the most valid, reliable, and sensitive nonstandardized assessment tool found in this scoping review. Researchers found significant associations between performance in the cooking task and scores on multiple standardized tests of executive functioning, with relatively weaker correlations found between the Children's Cooking Task and parent questionnaires (Chevignard et al., 2010, 2009). Procedures for error analysis (described above) could be used to develop a cognitive-communication profile for each participant that could help inform individualized interventions and supports within the context of a variety of functional daily tasks, such as doing laundry, planning a project, or going gift shopping. The generalizability of these results to other contexts and other types of tasks was not explicitly addressed in any of the three studies, however, and should be explored in future research.

Virtual Reality Tasks

As virtual reality technology becomes increasingly accessible via computer and smartphone, researchers are investigating ways to create immersive, interactive experiences that are also tightly controlled and easily reproducible—virtual laboratories, in other words, in which a computer simulation delivers highly patterned and predictable responses to participants' decisions and actions, while also creating a more vivid task environment for clients. The potential uses of this new experimental tool are wide ranging, as evidenced by the stark differences among the three virtual reality studies identified for this scoping review. Clinicians may evaluate students' navigation and problem-solving abilities within a virtual store (Erez et al., 2013), identify attention difficulties within a virtual classroom (Gilboa et al., 2015), or provide a low-stakes virtual environment in which to analyze and resolve social conflict (Hanten et al., 2011). Therapeutic applications may also be considered, such as practicing safety awareness within a bustling cityscape, attention and memory skills in a simulated classroom environment, or social skills in the context of an immersive role-playing game. The ability to "transport" the student outside of a restrictive environment (e.g., a hospital or clinic room) and into a virtual scenario where they may face future challenges (e.g., a classroom or a supermarket) could prove particularly useful in inpatient rehabilitation, home, and community settings.

Advantages of virtual reality tasks include fidelity, since the scenario plays out in the same way each time; efficiency of administration and scoring, as much of the data are captured and synthesized automatically; and high levels of engagement on the part of students, the majority of whom described the virtual reality experience as either "fun" or "a lot of fun" in the study by Hanten et al. (2011). Disadvantages include the need for specialized tools (e.g., virtual reality headgear), which may be expensive and/or require training to manipulate and maintain; the limited availability of well-designed virtual reality "games" or scenarios; and concerns about ecological validity, as additional research is needed to establish that performance in a virtual reality environment carries over into real-life activities. Since the resemblance between virtual reality and real life is limited, participants may treat a gamified experience less seriously than they would a real-life task. There may also be unique challenges involved for students with vision, balance, and

sensory integration deficits, which are common in severe TBI. Interestingly, Hanten et al. (2011) found that the less "realistic" participants judged the virtual reality experience to be, the longer it took them to complete the task, which implies that a sense of disorientation within the virtual environment could potentially impair efficiency and depress overall performance, thus making generalizability of findings to real-world function less valid.

Future research could directly compare performance on a virtual task to performance on its real-life counterpart (e.g., picking up the same four items at a grocery store) to determine whether virtual reality is an adequate proxy for the real world. Some of this research has already been conducted in adult survivors of TBI, with promising results (Rose et al., 2005; Zhang et al., 2001).

Structured Cognitive Tasks

Complex paper-and-pencil tasks such as the Party Planning Task (Shanahan, et al., 2011) offer opportunities to analyze students' reasoning, problem-solving, and metacognitive skills within a relatively controlled context and could easily be adapted to a variety of clinical settings (e.g., inpatient/outpatient rehabilitation, schools). Clinicians who are interested in assessing students' use of previously learned strategies may also incorporate verbal protocols, in which students talk through their thought process as they complete the task. This level of detail is often difficult to obtain through standardized testing, as students are rarely required to "show their work" on standardized tests and may not recall later how they arrived at a given answer. The greater the level of detail, however, the more complex and time-consuming the scoring will become. From a procedural standpoint, manualized protocols and scoring sheets are necessary to ensure the fidelity and reliability of administration and interpretation. The S-FAVRES (MacDonald, 2013) provides several examples of what manualized cognitive tasks might look like, and there is certainly a need for more such assessments as well as examinations of their concurrent and predictive validity.

Disadvantages of this type of evaluation are similar to those of neuropsychological tests: The environment is less naturalistic, the scenarios provided are usually out of context for the individual, and performance may be significantly impacted by levels of motivation/engagement. Unless the chosen task has specific real-world implications for the individual (e.g., helping to plan a school field trip or organizing a surprise party for a friend), clinicians may not be able to properly distinguish between responses based on rote learning (i.e., what one "should" do) versus those that would reflect real-time behavior. This is especially true of measures targeting social skills, such as the "The Literal Truth, Ironic Criticism, and Empathic Praise Task" (Dennis et al., 2001, 2013), in which participants were asked to judge situations based on pictures and captions read aloud. Future studies may target nonstandardized assessment of social communication in structured role-play scenarios, preferably in a group context where children can engage in social problem-solving alongside peers.

Functional Rating Scales

Lastly, functional rating scales such as the WeeFIM and the SFA may be used to evaluate a child's functioning across various domains of school readiness and to estimate burden of care in both home and school environments. Since these measures are designed to assess activity limitations and participation restrictions, they tend to yield more practical and flexible treatment plans than those derived from neuropsychological and language tests, which focus almost exclusively on underlying impairments. Functional rating scales may also be helpful for identifying necessary supports during challenging tasks, which may prevent failure and build self-efficacy in recovering children (Farmer & Peterson, 1995; Semrud-Clikeman, 2010). Although the WeeFIM is primarily used within inpatient rehabilitation settings at present, a framework such as this could potentially be adopted by multidisciplinary IEP teams as they seek to determine the behavioral, academic, and social supports necessary to optimize participation in the school environment. Training must be rigorous to maximize the validity and reliability of ratings, and this can be a complex and costly process. Some redundancy in ratings may also be desirable to ensure interrater reliability (e.g., asking both the classroom teacher and the SLP to rate cognition, or asking both the physical therapist and the physical education teacher to rate mobility).

Due to the lack of focus on specific impairments, rating scales should be viewed as descriptive rather than diagnostic tools when determining the presence or absence of cognitive-communication disorders in children post-TBI. On the WeeFIM, for instance, there are only five scored items within the cognitive domain: language comprehension, expressive language, social interaction, problem-solving, and memory (Msall et al., 1994). Though scores in each of these areas may help illustrate the child's current level of functional independence, additional testing would be necessary to identify strengths and weaknesses in the full range of cognitive-communication skills underpinning these domains (e.g., attention, working memory, reasoning). It remains to be seen whether functional rating scales provide sufficient information for clinicians and educators to determine what level and type of support a student may need in the classroom. Future research could compare functional rating scale scores on discharge to parent and teacher checklists and academic grades in order to assess the predictive validity of these commonly used measures.

Summary

This scoping review aimed to identify and describe the nonstandardized cognitive-communication assessments for pTBI that have been reported in the literature within the past 2 decades. For a summary of the strengths, weaknesses, clinical contexts, and research needs corresponding to each of the identified methods, see Table 4. Altogether, discourse analysis and structured cognitive tasks would require comparatively fewer resources and less training, which might make them more accessible to a larger number of working SLPs. Observation of IADLs and virtual reality

Table 4. Clinical implications of reviewed nonstandardized assessment methods.

Assessment method	Contributions	Barriers	Possible contexts	Research needs
Discourse analysis	• Analysis is sensitive to deficits in macrolevel organization and content • Tasks are similar to academic tasks • Analysis can use existing writing or language samples	• Data are time-consuming to analyze • Scoring criteria will vary by discourse type, genre, purpose, etc.	• School • Outpatient rehabilitation	• Development of effective protocols/ rubrics for systematically evaluating performance • Explication of differences between genres/types
Systematic observation of an instrumental activities of daily living (IADLs)	• Studies offer reliability and validity evidence • Data are sensitive to higher level cognitive challenges • Tasks are ecologically grounded	• Cueing and scoring protocols will require considerable training • Methods are time-consuming to obtain and analyze • Access to specific environments and equipment is needed	• Inpatient rehabilitation • Outpatient rehabilitation • Home health	• Investigation of generalizability among IADLs • Exploration of compatibility with school environment
Virtual reality tasks	• Environment is immersive and reproducible • Data analysis is efficient	• Access to specialized equipment is required • Utility will be limited for those with motor and sensory deficits	• All settings	• Investigation of generalizability to real-world function
Structured cognitive tasks	• Tasks require integration of multiple cognitive domains • Verbal protocols enable assessment of metacognitive skill	• Tasks are less naturalistic than those used in other nonstandardized assessments? • Students may report what they "should" do instead of what they would actually do	• All settings	• Establishment of concurrent and predictive validity • Investigation of generalizability to real-world function
Functional rating scales	• Scales capture level of functional independence • Scales are designed to identify level and types of support needed	• Scales are descriptive of function rather than of underlying impairments • Training must be rigorous and may be costly	• Inpatient rehabilitation • School	• Establishment of predictive validity

tasks would necessitate comparatively more training, as well as access to specialized environments (e.g., a kitchen) or technology (e.g., virtual reality headgear). Functional rating scales fall somewhere in the middle, as they would be time-efficient and fairly straightforward to implement following comprehensive team training; however, such training might be difficult for some facilities to provide due to costs and requirements for ongoing certification.

While this review article provides a promising start, additional resources and research are needed to develop consistent, contextually relevant, nonstandardized assessment procedures that can effectively identify and categorize the subtle cognitive-communication difficulties that follow pTBI (Meaux & Norris, 2018). The process of establishing methodologically sound procedures that can be implemented in a reliable and valid fashion by various clinicians across settings constitutes standardization. Yet, unlike previous standardization efforts that have led us to scores of assessments that are inadequate for the reliable identification of significant persisting deficits in children after TBI, standardization of what we are calling nonstandardized assessments will require careful attention to maintaining the flexibility and dynamism that can come from clinician scaffolding and purposeful manipulation of test conditions. At its core, valid assessment of cognitive-communication abilities should maximize the real-world contexts in which children with TBI are assessed, preserving what Sohlberg et al. (2019) have termed *ecological grounding*.

Limitations

This scoping review was extensive but may have missed appropriate articles due to unforeseen limitations in search terms and the exclusion criteria selected (e.g., the decision to only accept studies published after the year 2000). The initial search terms may not have been sufficient to identify all relevant studies. For example, the formal search yielded just one out of three studies that utilized the Children's Cooking Task, with the remaining two uncovered via hand search. Similarly, the study in our sample that focused on the WeeFIM (Long et al., 2005) is not the only study that has examined the validity of this assessment. In fact, a subsequent hand search of relevant articles revealed that the majority of studies evaluating the reliability and internal consistency of the WeeFIM were published in the 1990s, with relatively few in-depth articles published since. Those published since 2000 have tended to focus more on physical than cognitive recovery, thus excluding them from this review.

It is also important to note that authors chose to limit the target population to children with TBI, rather than taking a broader view of assessment methods developed for children from other disorder categories, such as autism spectrum disorder. A more inclusive search may have turned up additional discourse and pragmatic assessments whose applicability to pTBI would require further investigation. Nevertheless, the assortment of nonstandardized assessment methods captured by our search indicates that the review had sufficient breadth to provide a fairly representative sample of current clinical practices in this area and for this specific population of youth.

Conclusions

Preliminary research and clinical experience suggest that a well-designed and systematically implemented nonstandardized assessment can yield essential information about students' cognitive-communication abilities in real-world contexts, whereas traditional standardized tests of language and cognition may not. Much like a language sample, nonstandardized assessment can elicit a behavior sample that illustrates specific cognitive-communication deficits arising from injury to the developing brain. Validity can be established through comparison to performance on other measures (standardized, criterion-referenced, or otherwise), although reliability may be difficult to achieve due to the diversity of settings, participants, and responses. Moreover, the appropriateness and viability of these methods of assessment will vary considerably depending on the setting in which they are implemented and the level of training afforded practitioners. For instance, the Children's Cooking Task may have implications for adaptive functioning in the home environment, but will it have predictive validity in a school setting? Discourse analysis may be helpful for predicting school success, but will it have any impact on vocational outcomes or social success? Additional research is needed to answer these questions.

Because treatment plans must be *relevant* to clients' needs and circumstances in order to be truly effective, there is an urgent need for evaluation procedures that help clinicians elicit and interpret clients' behavior and patterns of difficulty in the context of real-life activities. To quote Nelson (1989), if clinicians cannot pinpoint "some significant way that a client's life has changed for the better, or has improved potential for change, then we had better rethink our intervention efforts" (p. 172). The nonstandardized assessment methods identified in this scoping review—discourse analysis, observation of IADLs, virtual reality tasks, structured cognitive tasks, and functional rating scales—show promise in helping move those evaluation, and ultimately intervention, efforts forward. The existing literature offers several opportunities for clinicians and researchers to advance the evidence for nonstandardized protocols to incorporate into cognitive-communication assessments for children with TBI. Future research into these specific assessment approaches will enable SLPs to better serve children living with TBI.

Author Contributions

Audrey Hall: Conceptualization (Supporting), Data curation (Lead), Formal analysis (Equal), Methodology (Supporting), Writing – original draft (Lead), Writing – review & editing (Lead). **Jennifer P. Lundine:** Conceptualization (Lead), Data curation (Supporting), Formal analysis (Supporting), Investigation (Equal), Methodology (Lead), Project administration (Lead), Supervision (Lead), Writing – original draft

(Supporting), Writing – review & editing (Supporting). **Rebecca J. McCauley:** Formal analysis (Supporting), Writing – original draft (Supporting), Writing – review & editing (Supporting).

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References

Studies included in scoping review are marked with an *.

American Speech-Language-Hearing Association. (1991). *A model for collaborative service delivery for students with language-learning disorders in the public schools* [Relevant paper]. https://www.asha.org/policy/RP1991-00123/

American Speech-Language-Hearing Association. (2019). *Pediatric traumatic brain injury* [Practice portal]. https://www.asha.org/Practice-Portal/Clinical-Topics/Pediatric-Traumatic-Brain-Injury/

Anderson, S. W., Damasio, H., Tranel, D., & Damasio, A. R. (2000). Long-term sequelae of prefrontal cortex damage acquired in early childhood. *Developmental Neuropsychology, 18*(3), 281–296. https://doi.org/10.1207/S1532694202Anderson

Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2005). Attentional and processing skills following traumatic brain injury in early childhood. *Brain Injury, 19*(9), 699–710. https://doi.org/10.1080/02699050400025281

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Babikian, T., Merkley, T., Savage, R. C., Giza, C. C., & Levin, H. (2015). Chronic aspects of pediatric traumatic brain injury: Review of the literature. *Journal of Neurotrauma, 32*(23), 1849–1860. https://doi.org/10.1089/neu.2015.3971

Brown, J., O'Brien, K., Knollman-Porter, K., & Wallace, T. (2019). The speech-language pathologists' role in mild traumatic brain injury for middle and high school-age children: Viewpoints on guidelines from the centers for disease control and prevention. *American Journal of Speech-Language Pathology, 28*(3), 1363–1370. https://doi.org/10.1044/2019_AJSLP-18-0296

Cameto, R., Levine, P., & Wagner, M. (2004). *Transition planning for students with disabilities: A special topic report of findings from the National Longitudinal Transition Study-2 (NLTS2)*. National Center for Special Education Research. http://files.eric.ed.gov/fulltext/ED496547.pdf

Cane, J., O'Connor, D., & Michie, S. (2012). Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation Science, 7*(1), 37. https://doi.org/10.1186/1748-5908-7-37

Cermak, C. A., Scratch, S. E., Reed, N. P., Bradley, K., Quinn de Launay, K. L., & Beal, D. S. (2019). Cognitive communication impairments in children with traumatic brain injury: A scoping review. *The Journal of Head Trauma Rehabilitation, 34*(2), E13–E20. https://doi.org/10.1097/HTR.0000000000000419

Chapman, S. B., Gamino, J. F., Cook, L. G., Hanten, G., Li, X., & Levin, H. S. (2006). Impaired discourse gist and working memory in children after brain injury. *Brain and Language, 97*(2), 178–188. https://doi.org/10.1016/j.bandl.2005.10.002

***Chapman, S. B., Sparks, G., Levin, H. S., Dennis, M., Roncadin, C., Zhang, L., & Song, J.** (2004). Discourse macrolevel processing after severe pediatric traumatic brain injury. *Developmental Neuropsychology, 25*(1–2), 37–60. https://doi.org/10.1080/87565641.2004.9651921

Chapman, S. B., Watkins, R., Gustafson, C., Moore, S., Levin, H. S., & Kufera, J. A. (1997). Narrative discourse in children with closed head injury, children with language impairment, and typically developing children. *American Journal of Speech-Language Pathology, 6*(2), 66–76. https://doi.org/10.1044/1058-0360.0602.66

Chaytor, N., & Schmitter-Edgecombe, M. (2003). The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. *Neuropsychology Review, 13*(4), 181–197. https://doi.org/10.1023/B:NERV.0000009483.91468.fb

***Chevignard, M. P., Catroppa, C., Galvin, J., & Anderson, V.** (2010). Development and evaluation of an ecological task to assess executive functioning post childhood TBI: The children's cooking task. *Brain Impairment, 11*(2), 125–143. https://doi.org/10.1375/brim.11.2.125

***Chevignard, M. P., Servant, V., Mariller, A., Abada, G., Pradat-Diehl, P., & Laurent-Vannier, A.** (2009). Assessment of executive functioning in children after TBI with a naturalistic open-ended task: A pilot study. *Developmental Neurorehabilitation, 12*(2), 76–91. https://doi.org/10.1080/17518420902777019

Chevignard, M. P., Soo, C., Galvin, J., Catroppa, C., & Eren, S. (2012). Ecological assessment of cognitive functions in children with acquired brain injury: A systematic review. *Brain Injury, 26*(9), 1033–1057. https://doi.org/10.3109/02699052.2012.666366

Ciccia, A. H., Meulenbroek, P., & Turkstra, L. S. (2009). Adolescent brain and cognitive developments: Implications for clinical assessment in traumatic brain injury. *Topics in Language Disorders, 29*(3), 249–265. https://doi.org/10.1097/TLD.0b013e3181b53211

Coelho, C., Ylvisaker, M., & Turkstra, L. S. (2005). Nonstandardized assessment approaches for individuals with traumatic brain injuries. *Seminars in Speech and Language, 26*(4), 223–241. https://doi.org/10.1055/s-2005-922102

***Cook, L. G., Chapman, S. B., & Levin, H. S.** (2008). Self-regulation abilities in children with severe traumatic brain injury: A preliminary investigation of naturalistic action. *Neuro-Rehabilitation, 23*(6), 467–475. https://doi.org/10.3233/NRE-2008-23603

Coster, W., Deeney, T., Haltiwanger, J., & Haley, S. (1998). *School Function Assessment (SFA)*. The Psychological Corporation.

Davis, G. A., & Coelho, C. A. (2004). Referential cohesion and logical coherence of narration after closed head injury. *Brain and Language, 89*(3), 508–523. https://doi.org/10.1016/j.bandl.2004.01.003

Deighton, S., Ju, N., Graham, S. A., & Yeates, K. O. (2020). Pragmatic language comprehension after pediatric traumatic brain injury: A scoping review. *The Journal of Head Trauma Rehabilitation, 35*(2), E113–E126. https://doi.org/10.1097/HTR.0000000000000515

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System (D-KEFS)*. APA PsycTests. https://doi.org/10.1037/t15082-000

Dennis, M., Purvis, K., Barnes, M. A., Wilkinson, M., & Winner, E. (2001). Understanding of literal truth, ironic criticism, and deceptive praise Following childhood head injury. *Brain and Language, 78*(1), 1–16. https://doi.org/10.1006/brln.2000.2431

***Dennis, M., Simic, N., Agostino, A., Taylor, H. G., Bigler, E. D., Rubin, K., Vannatta, K., Gerhardt, C. A., Stancin, T., & Yeates, K. O.** (2013). Irony and empathy in children with traumatic brain injury. *Journal of the International Neuropsychological Society, 19*(3), 338–348. https://doi.org/10.1017/S1355617712001440

Duff, M. C., & Stuck, S. (2015). Paediatric concussion: Knowledge and practices of school speech-language pathologists. *Brain Injury, 29*(1), 64–77. https://doi.org/10.3109/02699052.2014.965747

Emslie, H., Wilson, C. F., Burden, V., Nimmo-Smith, I., & Wilson, B. A. (2003). *Behavioral Assessment of the Dysexecutive Syndrome for Children (BADS-C)*. Thames Valley Test Company.

***Erez, N., Weiss, P. L., Kizony, R., & Rand, D.** (2013). Comparing performance within a virtual supermarket of children with traumatic brain injury to typically developing children: A pilot study. *American Journal of Occupational Therapy, 33*(4), 218–227. https://doi.org/10.3928/15394492-20130912-04

Ettel, D., Glang, A. E., Todis, B., & Davies, S. C. (2016). Traumatic brain injury: Persistent misconceptions and knowledge gaps among educators. *Exceptionality Education International, 26*(1), 1–18. https://doi.org/10.5206/eei.v26i1.7732

Ewing-Cobbs, L., & Barnes, M. (2002). Linguistic outcomes following traumatic brain injury in children. *Seminars in Pediatric Neurology, 9*(3), 209–217. https://doi.org/10.1053/spen.2002.35502

Ewing-Cobbs, L., Fletcher, J. M., Levin, H. S., Iovino, I., & Miner, M. E. (1998). Academic achievement and academic placement following traumatic brain injury in children and adolescents: A two-year longitudinal study. *Journal of Clinical and Experimental Neuropsychology, 20*(6), 769–781. https://doi.org/10.1076/jcen.20.6.769.1109

Farmer, J. E., & Peterson, L. (1995). Pediatric traumatic brain injury: Promoting successful school reentry. *School Psychology Review, 24*(2), 230–243. https://doi.org/10.1080/02796015.1995.12085764

Frith, M. H. J. (2014). *Speech pathology assessment of language and cognitive-communication following traumatic brain injury and developmental language impairment: A survey of international clinical practices* (Postgraduate thesis, The University of Sydney). https://ses.library.usyd.edu.au/handle/2123/12788

Garcia, D., Hungerford, G. M., & Bagner, D. M. (2015). Topical review: Negative behavioral and cognitive outcomes following traumatic brain injury in early childhood. *Journal of Pediatric Psychology, 40*(4), 391–397. https://doi.org/10.1093/jpepsy/jsu093

Gershon, R. C., Wagster, M. V., Hendrie, H. C., Fox, N. A., Cook, K. F., & Nowinski, C. J. (2013). NIH toolbox for assessment of neurological and behavioral function. *Neurology, 80*(11 Suppl. 3), S2–S6. https://doi.org/10.1212/WNL.0b013e3182872e5f

***Gilboa, Y., Kerrouche, B., Longaud-Vales, A., Kieffer, V., Tiberghien, A., Aligon, D., Mariller, A., Mintegui, A., Canizares, C., Abada, G., & Chevignard, M. P.** (2015). Describing the attention profile of children and adolescents with acquired brain injury using the Virtual Classroom. *Brain Injury, 29*(13–14), 1691–1700. https://doi.org/10.3109/02699052.2015.1075148

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2015). *Behavior Rating Inventory of Executive Function (BRIEF-2)* (2nd ed.). Psychological Assessment Resources.

Glang, A., Todis, B., Thomas, C. W., Hood, D., Bedell, G., & Cockrell, J. (2008). Return to school following childhood TBI: Who gets services. *NeuroRehabilitation, 23*(6), 477–486. https://doi.org/10.3233/NRE-2008-23604

Haarbauer-Krupa, J., Ciccia, A., Dodd, J., Ettel, D., Kurowski, B., Lumba-Brown, A., & Suskauer, S. (2017). Service delivery in the healthcare and educational systems for children following traumatic brain injury: Gaps in care. *Journal of Head Trauma Rehabilitation, 32*(6), 367–377. https://doi.org/10.1097/HTR.0000000000000287

Haarbauer-Krupa, J., Lundine, J. P., DePompei, R., & King, T. Z. (2018). Rehabilitation and school services following traumatic brain injury in young children. *NeuroRehabilitation, 42*(3), 259–267. https://doi.org/10.3233/NRE-172410

Hammill, D. D., Brown, V. L., Larsen, S. C., & Wiederholt, J. L. (1994). *Test of Adolescent and Adult Language–Third Edition (TOAL-3)*. Pro-Ed.

***Hanten, G., Cook, L., Orsten, K., Chapman, S. B., Li, X., Wilde, E. A., Schnelle, K. P., & Levin, H. S.** (2011). Effects of traumatic brain injury on a virtual reality social problem solving task and relations to cortical thickness in adolescence. *Neuropsychologia, 49*(3), 486–497. https://doi.org/10.1016/j.neuropsychologia.2010.12.007

Jaffe, K. M., Fay, G. C., Polissar, N. L., Martin, K. M., Shurtleff, H. A., Rivara, J. B., & Winn, H. R. (1993). Severity of pediatric traumatic brain injury and neurobehavioral recovery at one year: A cohort study. *Archives of Physical Medicine & Rehabilitation, 74,* 587–595. https://doi.org/10.1016/0003-9993(93)90156-5

Kingery, K. M., Narad, M. E., Taylor, H. G., Yeates, K. O., Stancin, T., & Wade, S. L. (2017). Do children who sustain traumatic brain injury in early childhood need and receive academic services 7 years after injury. *Journal of Developmental and Behavioral Pediatrics, 38*(9), 728–735. https://doi.org/10.1097/DBP.0000000000000489

***Krasny-Pacini, A., Servant, V., Alzieu, C., & Chevignard, M.** (2015). Ecological prospective memory assessment in children with acquired brain injury using the children's cooking task. *Developmental Neurorehabilitation, 20*(1), 53–58. https://doi.org/10.3109/17518423.2015.1058298

LeBlanc, J. M., Hayden, M. E., & Paulman, R. G. (2000). A comparison of neuropsychological and situational assessment for predicting employability after closed head injury. *The Journal of Head Trauma Rehabilitation, 15*(4), 1022–1040. https://doi.org/10.1097/00001199-200008000-00005

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5,* 69. https://doi.org/10.1186/1748-5908-5-69

Lê, K., Mozeiko, J., & Coelho, C. (2011). Discourse analyses: Characterizing cognitive-communication disorders following TBI. *The ASHA Leader, 16*(2), 18–21. https://doi.org/10.1044/leader.FTR4.16022011.18

Liles, B. Z., Duffy, R. J., Merritt, D. D., & Purcell, S. L. (1995). Measurement of narrative discourse ability in children with language disorders. *Journal of Speech and Hearing Research, 38*(2), 415–425. https://doi.org/10.1044/jshr.3802.415

Loban, W. (1976). *Language development: Kindergarten through grade twelve*. National Council of Teachers of English.

***Long, C. E., Blackman, J. A., Farrell, W. J., Smolkin, M. E., & Conaway, M. R.** (2005). A comparison of developmental versus functional assessment in the rehabilitation of young children. *Pediatric Rehabilitation, 8*(2), 156–161. https://doi.org/10.1080/13638490400022287

Lundine, J. P., & Hall, A. (2020). Using nonstandardized assessments to evaluate cognitive-communication abilities following pediatric traumatic brain injury. *Seminars in Speech and Language, 41*(2), 170–182. https://doi.org/10.1055/s-0040-1701685

***Lundine, J. P., Harnish, S. M., McCauley, R. J., Zezinka, A. B., Blackett, D. S., & Fox, R. A.** (2018). Exploring summarization differences for two types of expository discourse in adolescents with traumatic brain injury. *American Journal of Speech-Language Pathology, 27*(1), 247–257. https://doi.org/10.1044/2017_AJSLP-16-0131

MacDonald, S. (2013). *Student Version of the Functional Assessment of Verbal Reasoning and Executive Strategies (S-FAVRES)*. CCD Publishing.

Manly, T., Robertson, I. H., Anderson, V., & Nimmo-Smith, I. (1998). *(TEA-Ch): The Test for Everyday Attention for Children*. Thames Valley Test Company.

Mar, R. A. (2004). The neuropsychology of narrative: Story comprehension, story production, and their interrelation. *Neuropsychologia, 42*(6), 1414–1434. https://doi.org/10.1016/j.neuropsychologia.2003.12.016

Meaux, A. B., & Norris, J. A. (2018). Curriculum-based language interventions: What, who, why, where, and how. *Language, Speech, and Hearing Services in Schools, 49*(2), 165–175. https://doi.org/10.1044/2017_LSHSS-17-0057

Michie, S., Johnson, M., Abraham, C., Lawton, R., Parker, D., & Walker, A. (2005). Making psychological theory useful for implementing evidence based practice: A consensus approach. *BMJ Quality & Safety, 14*(1), 26–33. https://doi.org/10.1136/qshc.2004.011155

Miller, J., & Iglesias, A. (2012). *Systematic Analysis of Language Transcripts (SALT), Research Version 2012* [Computer software]. SALT Software, LLC.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLOS Medicine, 6*(7), Article e10000097. https://doi.org/10.1371/journal.pmed.1000097

***Moran, C., Kirk, C., & Powell, E.** (2012). Spoken persuasive discourse abilities of adolescents with acquired brain injury. *Language, Speech, and Hearing Services in Schools, 43*(3), 264–275. https://doi.org/10.1044/0161-1461(2011/10-0114)

Msall, M. E., DiGaudio, K., Rogers, B. T., LaForest, S., Catanzaro, N. L., Campbell, J., Wilczenski, F., & Duffy, L. C. (1994). The Functional Independence Measure for Children (WeeFIM): Conceptual basis and pilot use in children with developmental disabilities. *Clinical Pediatrics, 33*(7), 421–430. https://doi.org/10.1177/000992289403300708

Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology, 18*(1), 143. https://doi.org/10.1186/s12874-018-0611-x

Nelson, N. W. (1989). Curriculum-based language assessment and intervention. *Language, Speech, and Hearing Services in Schools, 20*(2), 170–184. https://doi.org/10.1044/0161-1461.2002.170

New Zealand Guidelines Group. (2006). *Traumatic brain injury: Diagnosis, acute management, and rehabilitation*. Accident Compensation Corporation.

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan—A web and mobile app for systematic reviews. *Systematic Reviews, 5,* 210. https://doi.org/10.1186/s13643-016-0384-4

Pavelko, S. L., Owens, R. E., Ireland, M., & Hahs-Vaughn, D. L. (2016). Use of language sample analysis by school-based SLPs: Results of a nationwide survey. *Language, Speech, and Hearing Services in Schools, 47*(3), 246–258. https://doi.org/10.1044/2016_LSHSS-15-0044

Pentland, L., Todd, J. A., & Anderson, V. (1998). The impact of head injury severity on planning ability in adolescence: A functional analysis. *Neuropsychological Rehabilitation, 8*(3), 301–317. https://doi.org/10.1080/713755572

Prasad, M. R., Swank, P. R., & Ewing-Cobbs, L. (2017). Long-term school outcomes of children and adolescents with traumatic brain injury. *Journal of Head Trauma Rehabilitation, 32*(1), E24–E32. https://doi.org/10.1097/HTR.0000000000000218

Rose, F. D., Brooks, B. M., & Rizzo, A. A. (2005). Virtual reality in brain damage rehabilitation: Review. *Cyberpsychology & Behavior, 8*(3). https://doi.org/10.1089/cpb.2005.8.241

Salley, J., Crook, L., Iske, T., Ciccia, A., & Lundine, J. P. (2021). Acute and long-term services for elementary and middle school children with early childhood brain injury. *American Journal of Speech-Language Pathology, 30*(2S), 908–919. https://doi.org/10.1044/2020_AJSLP-20-00045

Schmidt, A. T., Hanten, G. R., Li, X., Orsten, K. D., & Levin, H. S. (2010). Emotion recognition following pediatric traumatic brain injury: Longitudinal analysis of emotional prosody and facial emotion recognition. *Neuropsychologia, 48*(10), 2869–2877. https://doi.org/10.1016/j.neuropsychologia.2010.05.029

Schutz, L., Rivers, K. O., McNamara, E., Schutz, J., & Lobato, E. J. (2010). Traumatic brain injury in K–12 students: Where have all the children gone. *International Journal of Special Education, 25*(2), 55–71.

Semel, E., Wiig, E. H., & Secord, W. A. (2003). *Clinical Evaluation of Language Fundamentals (CELF-4)* (4th ed.). Pearson.

Semrud-Clikeman, M. (2010). Pediatric traumatic brain injury: Rehabilitation and transition to home and school. *Applied Neuropsychology, 17*(2), 116–122. https://doi.org/10.1080/09084281003708985

***Shanahan, L., McAllister, L., & Curtin, M.** (2011). The party planning task: A useful tool in the functional assessment of planning skills in adolescents with TBI. *Brain Injury, 25*(11), 1080–1090. https://doi.org/10.3109/02699052.2011.607781

Sohlberg, M. M., MacDonald, S., Byom, L., Iwashita, H., Lemoncello, R., Meulenbroek, P., Ness, B., & O'Neil-Pirozzi, T. M. (2019). Social communication following traumatic brain injury part I: State-of-the-art review of assessment tools. *International Journal of Speech-Language Pathology, 21*(2), 115–127. https://doi.org/10.1080/17549507.2019.1583280

Spaulding, T. J., Plante, E., & Farinella, K. A. (2006). Eligibility criteria for language impairment: Is the low end of normal always appropriate. *Language, Speech, and Hearing Services in Schools, 37*(1), 61–72. https://doi.org/10.1044/0161-1461(2006/007)

Steel, J., & Togher, L. (2019). Social communication assessment after traumatic brain injury: A narrative review of innovations in pragmatic and discourse assessment methods. *Brain Injury, 33*(1), 48–61. https://doi.org/10.1080/02699052.2018.1531304

Taylor, H. G., Yeates, K. O., Wade, S. L., Drotar, D., Stancin, T., & Montpetite, M. (2003). Long-term educational interventions after traumatic brain injury in children. *Rehabilitation Psychology, 48*(4), 227–236. https://doi.org/10.1037/0090-5550.48.4.227

Todis, B., Glang, A., Bullis, M., Ettel, D., & Hood, D. (2011). Longitudinal investigation of the post-high school transition experiences of adolescents with traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 26*(2), 138–149. https://doi.org/10.1097/HTR.0b013e3181e5a87a

Togher, L., Wiseman-Hakes, C., Douglas, J., Stergiou-Kita, M., Ponsford, J., Teasell, R., Bayley, M., & Turkstra, L. S. (2014). INCOG recommendations for management of cognition following traumatic brain injury, part IV: Cognitive communication. *The Journal of Head Trauma Rehabilitation, 29*(4), 353–368. https://doi.org/10.1097/HTR.0000000000000071

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., Lewin, S., … Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169*(7), 467–473. https://doi.org/10.7326/M18-0850

Turkstra, L. S., Dixon, T. M., & Baker, K. K. (2004). Theory of mind and social beliefs in adolescents with traumatic brain injury. *NeuroRehabilitation, 19*(3), 245–256. https://doi.org/10.3233/NRE-2004-19307

Turkstra, L. S., Politis, A. M., & Forsyth, R. (2015). Cognitive-communication disorders in children with traumatic brain injury. *Developmental Medicine and Child Neurology, 57*(3), 217–222. https://doi.org/10.1111/dmcn.12600

Walz, N. C., Yeates, K. O., Taylor, H. G., Stancin, T., & Wade, S. L. (2011). Emerging narrative discourse skills 18 months after traumatic brain injury in early child hood. *Journal of Neuropsychology, 6*(2), 143–160. https://doi.org/10.1111/j.1748-6653.2011.02020.x

Wechsler, D. (1991). *(WISC-III): Manual for the Wechsler Intelligence Scale for Children–Third Edition*. The Psychological Corporation.

Weschler, D. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI)*. The Psychological Corporation.

***West, S., Dunford, C., Mayston, M. J., & Forsyth, R.** (2014). The school function assessment: Identifying levels of participation and demonstrating progress for pupils with acquired brain injuries in a residential rehabilitation setting. *Child: Care, Health and Development, 40*(5), 689–697. https://doi.org/10.1111/cch.12089

Wiig, E. H., Semel, E., & Secord, W. A. (2013). *(CELF-5): Clinical Evaluation of Language Fundamentals–Fifth Edition*. Pearson Assessment.

Wilson, B. A., Cockburn, J., & Baddeley, A. (2008). *(RBMT-3): The Rivermead Behavioral Memory Test*–Third Edition. Pearson Canada Assessment, Inc.

World Health Organization. (2007). *International Classification of Functioning, Disability and Health Children and Youth Version (ICF-CY)*.

Ylvisaker, M. (1993). Communication outcome in children and adolescents with traumatic brain injury. *Neuropsychological Rehabilitation, 3*(4), 367–387. https://doi.org/10.1080/09602019308401447

Yule, G. (1996). *Pragmatics*. Oxford University Press.

Zhang, L., Abreu, B. C., Masel, B., Scheibel, R. S., Christiansen, C. H., Huddleston, N., & Ottenbacher, K. J. (2001). Virtual reality in the assessment of selected cognitive function after brain injury. *American Journal of Physical Medicine & Rehabilitation, 80*(8), 597–604. https://doi.org/10.1097/00002060-200108000-00010